TECHNICAL SPECIFICATION

FOR

BATTERY & BATTERY CHARGER

TABLE OF CONTENTS
OF
BATTERY & BATTERY CHARGER

TECHNICAL SPECIFICATION FOR 48V VRLA TYPE STORAGE BATTERY ALONGWITH BATTERY CHARGER

PART - A

1.0 SCOPE :Supply, installation and commissioning of 48 VRLA 100 AH Battery anlong with batterycharger. The materials offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. Tthe Type Test reports shall be submitted along with the bid.

2.0 STANDARDS :

The equipment shall comply in all respects with the latest edition of relevant Indian Standard Specifications and IEC except for the modifications specified herein. A Photo copy of such standards in English shall be enclosed with the offer.

3.0 INSTALLATIONS :

Equipments covered under these specifications shall be suitable for indoor installation.

4.0 DETAILS OF SPECIFICATIONS OF VRLA Type (48V)

Battery:

The batteries shall be made of closed type lead acid cells with VRLA Type (48V) plates manufactured to conform to IS: 1652-1991.

Capacity :

The capacity of the batteries shall be as follows :

i)Voltage. - 48V

ii) Output at 27^0 C - 100AH at 10 hrs. discharge rate.

The batteries shall normally remain under ôfloatingôcondition with the ôtrickleô charger supplying the continuous load. However, the batteries shall be capable of supplying the following loads under emergency conditions without any assistance from the chargers and without their terminal voltage falling below 43V [90% of rated voltage]

Stage emergency - 15A for 3 hours for lighting.

The number of cells for 48V batteries shall be so chosen that for the nominal floating voltage of the cells, the battery voltage shall be 51.85V and for the minimum [discharged condition] voltage of the cells, the voltage of the battery shall not be less than 43.2V, while the assigned rating of the battery bank can not lowered below its rated voltage of 48V volts. Minimum no of cell shall not be less than 24.

5.0 DESIGN AND CONSTRUCTIONAL DETAILS:

5.1 **Plates** :

Positive plates shall be made of flat pasted type using lead-cadmium antimony alloy for durability, high corrosion resistant, maintenance free, long life both in cyclic as well as in float applications.

Negative plates shall be heavy duty, durable flat plate using lead calcium alloy pasted box grid. Negative plates shall be designed to match the life of positive plates and combination of negative and positive plates shall ensure long life, durability and trouble free operation of battery.

PLC (programmable logic control) operated equipment should be deployed for preparation of paste to ensure consistency in paste quality. Conventional / manual type of paste preparation is not allowed.

5.2 **CONTAINER AND LID :**

The containers and lids shall be made of a special grade polypropylene copolymer plastic material. They shall be sufficiently robust and not liable to deformation under internal operating pressures and within the temperature range naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapour permeability

5.3 **Separators** :

The separators shall be of synthetic material conforming to the latest edition of IS-6071-1986. These shall permit free flow of electrolyte and would not be affected by the chemical reaction inside the cell and shall last for indefinite time. The internal resistance factor of the separators shall assure high discharge characteristics under all operating conditions. Proper arrangement to keep end plates in position shall be furnished by the bidder along with his offer.

5.4 **Electrolyte** :

The electrolyte shall be prepared from the battery grade Sulphuric acid conforming to IS-266-1993 and shall have a specific gravity of 1.2 at 27^0C. The Sulphuric acid of battery grade shall be colorless liquid. The concentrated Sulphuric acid on dilution with an equal volume of distilled water shall be free from suspended matter and other visible impurities. The Sulphuric acid shall meet the requirements of columns ï 4 and 5 Table ï 1 of IS-266-1993.

5.5 **Plate group bar with terminals** :

The plate group bar with terminals shall conform to IS-1652-1991. The positive and negative terminals shall be clearly marked for easy identification. The legs of the plates of like polarity shall be connected to the load, turned to a horizontal group bar having an upstanding terminal post adopted for connection to the external circuit. The group bars shall be sufficiently strong to hold the plates in position.

5.6 **Buffers/spring**:

Suitable buffers / springs shall be provided in the cells to keep the end plates in position. These shall have adequate length and strength.

5.7 **Cell lids** :

Lids used with sealed or closed type cells shall be of glass, plastic or ebonite and shall be provided with vent plugs. Terminal post shall be suitably sealed at the lid to prevent escape of acid spray, by means of rubber grommets, sealing compound or other suitable device. The positive and negative terminal posts shall be clearly and indelibly marked for easy identification.

5.8 **Water** :-

Water used for preparation of electrolyte and also to bring the level of electrolyte to approximately correct height during operation / testing shall conform to relevant standards.

5.9 **Venting device** :

The venting device shall be anti splash type and shall allow gases to escape freely but shall effectively prevent acid particles or spray from coming out. There shall be two vent holes, one serving as a guide for acid level indicator for checking the electrolyte level and other to permit drawing of electrolyte samples, servicing, checking of specific gravity etc.

5.10 **Marking** :

Acid level line shall be permanently and indelibly marked around on all the containers.

The following information shall be indelibly marked on the outside surface of each cell :

[i] Manufacturerôs name, type and trade mark.
[ii] Nominal voltage.
[iii] AH capacity at 10 hours rate with specified end cell voltage.
[iv] Cell number.
[v] Upper and lower electrolyte level in case of transparent containers.
[vi] Type of positive plate.
[vii] Type of container.
[viii]Date of manufacture [month and year] or [week and year].

5.12 **CONNECTORS:**

Bars tinned copper lead connectors shall be employed for Inter-cell and inter-row, inter-tier connections. However, the tee-off connection from the battery unit shall be made with acid resisting cables of suitable size. A suitable terminal box along with acid-resisting cable shall be provided by the Contractor for this purpose. The connectors shall preferably be of bolted type and the bolts and nuts shall be of similar material as that of connectors and shall be provided with corrosion resisting lead coating. The connectors shall be of sufficient cross-section to withstand all the working conditions including one minute discharge rate as well as short circuit conditions.

[a] Lead coated connection hardware such as bolts, nuts etc. 5% extra, or any other connector suitable for VRLA type Battery.
[b] Ampere-hour Meter [10 hour discharge rate] of 100 ï 120 AH range-1 no.
[c] Any other accessories, not specified but required for installation, satisfactory operation and maintenance of batteries for a period of 5 [five] years.

6.0 MAXIMUM SHORT CIRCUIT CURRENT :

The Bidder shall state the maximum short circuit current of each battery along with the safe duration in seconds which it can withstand. Methods, proposed to be adopted for protecting batteries from the short circuit conditions should also be stated to avoid damage to the battery and loss to the associated equipment.

7.0 CHARGING :

The bidders shall state whether an equalizing charge is recommended for the battery. If so, the equalizing charge voltage, current, duration and the interval between the equalizing charging shall be specified in the Data sheet. Bidder shall also indicate the requirements for boost charging.

8.0 LIFE :

The minimum guaranteed life span of the battery should not less than 5 years. The bidder shall quote in his offer the guaranteed life of the battery when operating under the conditions specified.

9.0 INSTRUCTION MANUALS :

Fifteen sets of instruction manuals for installation, commissioning, charging and maintenance instruction shall have to be furnished.

10.0 TESTS:

10.1 **TYPE TESTS** :

The bidder shall submit the Type **Test reports** along with the drawing for approval for the following type tests, conducted as per relevant IS & IEC within five years from the date of opening of the bid from any Govt. approved laboratory and test witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

[a] Verification of constructional requirements.
[b] Verification of dimensions.
[c] Test for capacity.
[d] Test for retention of charge.
[e] Endurance Test.
[f] Ampere-hour and watt-hour efficiency test.
[g] Test for voltage during discharge.

If the **Type Test report** [s] does/do not meet the requirements as per this specification, OPTCL at its discretion may ask the Contractor to conduct the above type tests [s] at the Contractorôs cost in the presence of OPTCLôs representative without any financial liability to OPTCL.

10.2 **ACCEPTANCE TESTS** :

Following shall constitute the acceptance tests which shall be test witnessed by the purchaserôs representative at the works of the manufacturer at the cost of supplier.

[i] Verification of marking.

[ii] Verification of dimensions.

[iii] Test for capacity for 10 hours discharge rate along with the Test for voltage during discharge.

[iv] Ampere-hour and watt-hour efficiency test.

10.3

The Purchaser may at his discretion undertake test for capacity and voltage during discharge after installation of the battery at site without any extra cost.

10.4

The Contractor shall arrange for all necessary equipments including the variable resistor, tools, tackles and instruments. If a battery fails to meet the guaranteed requirement, OPTCL shall have the option of asking the Contractor to replace the same within 15 [fifteen] days from the date of declaring the same to be insufficient/failed / not as per the specification [s].

11.0 DRAWINGS / DOCUMENTS :

The tenderer shall submit the following drawings / documents along with his offer failing which the offer is liable for rejection.

[a] General battery arrangement, proposed size of individual and over all dimensions along with sectional views showing all connections etc.

[b] Pamphlets and technical literature giving detailed information of the batteries offered.

The Contractor shall submit the following drawings / documents in two copies for approval. :-

[a] Lay out details of the batteries.

[b] OGA and cross-sectional details for battery cells.

[c] Instruction manuals for initial charging and subsequent charging.

[d] Technical data, curves etc.

12.0 GUARANTEED TECHNICAL PARTICULARS :

The Guaranteed Technical Particulars, as called for in the E21 shall be furnished along with the drawing for approval.

13.0 DEVIATION FROM SPECIFICATION

All deviations from the specification shall be separately listed, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

PART – B

CHARGER FOR 48 V,100AH VRLA BATTERIES

(15 Amp single phase Charger (Float Cum Boost Charger) suitable for 48V, 100 AH, Maintenance Battery Type VRLA.

1.0 BRIEF DESCRIPTION

Charging equipment comprising of a **Float cum Boost (15 Amp,Float Cum Boost Charger) suitable for 48V, 100 AH, Maintenance free VRLA Battery** charger, is required to meet the D.C. power requirement of the sub-station under normal conditions, i.e., when AC auxiliary power supply is available and also to keep all the cells in the state of full charge. The float charger shall supply the continuous DC load at the bus bars in addition to keeping, batteries floated in a healthy condition. In case of failure of A.C. mains or sudden requirement of additional DC power, the battery shall meet the demand as the battery shall be connected in parallel with the charger. After the battery has discharged to a considerable extent, it shall be fully recharged by the ôboostô charger unit in a short period so as to prepare it for the next emergency. Even during the ôboostôcharging of the battery, the continuous DC load at the bus shall be met by the trickle-charging unit. The ôboostô charging unit shall however be provided with suitable control arrangement to function as a stand-by for float charging unit in case of necessity.

2.0 ARRANGEMENTS :

2.1 **Trickle (Float) Charger :**

(a) The trickle charger shall have arrangement for regulation of D.C. output voltage by:-

(a) automatic voltage regulation system.

(b) Shall be of thyristor control type with both áauto/manualôcontrol arrangement.

2.2 **Quick (Boost) Charger :**

The quick charger shall be similar type as trickle charging equipment, but shall have the following features.

(i) Shall be provided with control arrangement for áauto/manualôcurrent regulation features, necessary for quick charging

(ii) Shall also have áauto/manualôvoltage control arrangement for use when the charger will be utilised as a trickle charger.

2.3 The ótrickleôand óquickôcharger shall be self supporting cubicle type with front panels hinged and suitable for mounting instruments, incoming A.C (3-ph) circuit breaker with thermal and instantaneous releases relays, contactors and control switches etc. The panels shall have access from the backside also. These cubicles shall also house transformers, rectifiers and other equipmentôs, accessories, as stipulated in this specification.

3.0 DESIGN AND CONSTRUCTION DETAILS:

3.1 The ótrickleôcharger and óquickôcharger shall be complete with silicon controlled rectifier units, dry type air-cooled transformers, control electronics, smoothing filters etc. suitable for operation from 415V $\pm$ 10%, 50 Hz $\pm$ 5%, 3- ph A.C. supply. The charger output shall be stabilized to $\pm$ 1% of set value for $\pm$ 10% input voltage variations and 0-100% load variation.

3.2 The battery charger shall have full-wave, Half-controlled thyristor controlled bridge rectifier circuit. The charger output voltage shall suit the battery offered. The float voltage shall be adjustable from 80% to 115% of nominal voltage. The boost voltage shall be adjustable from 80% to 135% of nominal voltage. Ripple voltage shall be less than 3% RMS voltage.

3.3 Each float charger shall be capable of floating each cell of the battery bank at the specified voltage and supplying specified float current continuously under normal system operation.

3.4 Under normal operation, the float charger shall be supplying the DC load current and at the same time trickle charge the station battery. When the battery voltage goes down considerably, automatic transfer arrangement shall be provided such that the battery is disconnected from the float charger and gets connected to the Boost charger. However, when battery is on boost charge, DC load shall be fed from the float charger. In addition, means shall be provided to ensure interruption free availability of control power from the battery whenever there is a power failure irrespective of whether the battery is on boost charge or float charge.

3.5 The selection of electronic components shall be used on ambient temperature of 50^0C. and shall be of worst-case design to ensure continuous and trouble free

service. The control electronics shall be built on plug in type glass epoxy printed circuit boards of modular design.

3.6 The maximum temperature, attained by any part of trickle charger and quick charger, when in service at site under continuous full load conditions shall not exceed the permissible limits as fixed by relevant standards and as corrected to site condition.

4.0 Charger Panel :

4.1 Charger Panels shall be rigid, self supporting structures, completely assembled and totally enclosed cubicle type construction, made out of structural steel members with sheet steel-coverings.

4.2 The enclosure of the charger shall be made of CRCA sheet steel of thickness not less than 3 mm for load bearing members, 2 mm for door and non-load bearing members and 3 mm for gland plates. Panels shall be offered with base frame of 3.0 mm thick CRCA sheet, painted black all around, suitable for bolting/ welding/ grouting on to the foundation. Gaskets on doors and inter panel gaskets shall be of neoprene rubber.

4.3 The panel shall have hinged front and back doors with concealed type hinged locks and latches.

4.4 The panel shall have adequate cross ï ventilation arrangement to avoid any undue rise in temperature.

4.5 All equipments and wiring used in the panel shall be tropicalised dust proof and vermin-proof.

4.6 Power wiring for the chargers shall be done with 1.1KV grade, heavy duty, single core, stranded copper conductor PVC insulated cables or suitable sized PVC sleeved copper bus bars. Control wiring for the charger shall be done with 1.1 KV grade PVC insulated copper wires of cross section 2.5 sq. mm for all control connection. Wire of 2.5 sq. mm cross section shall be used for control bus. All control wiring shall be ferruled.

4.7 Necessary terminals for grounding the panel with two separate earthings shall be arranged for bottom entry and suitable cable glands shall be provided for the cables.

4.8 Each charger panel shall incorporate all the necessary controls, Indications, interlocks, protective devices and timing features to ensure any operation.

Provision shall be made with necessary contact / relays for annunciation in the event of alternating current power failures to the charger and automatic shut down of the charger by over-voltage / current devices. Annunciation shall however be prevented when the charger is manually shutdown or when A.C. power supply is momentarily interrupted for adjustable period of 1 to 5 seconds.

4.9 The float and equaliser charging rates shall both be adjustable from the front of the charger control panel. Each charger shall be protected against any damage from over voltage/ load currents and shall be so designed that it can continuously deliver at least rated current output without operation of the protective over-load device for abnormal conditions of low battery voltage down to 38.4 V (80%) of the rated voltage). But the chargers shall be disconnected from A.C. input supply through an over-voltage relay, if the input voltage exceeds 10% of the rated voltage of the equipment. Necessary selector switches for "Trickle Charging" and "Quick charging" shall be provided. There shall be "make before break" type blocking Diodes and other equipments to be shown in the drawing or otherwise found necessary for charging or otherwise found necessary for charging the battery without increasing the voltage beyond safe value across the load shall also be supplied by the tenderer.

4.10 The rectifier units of the chargers shall be capable of supplying an impulse load of 6/7 times its rated capacity. The trickle charger in conjunction with automatic voltage regulators shall have drooping characteristics, So as to transfer the load beyond its capacity to the battery.

4.11 The incoming and outgoing circuits shall be provided with MCCBs with static releases for overload, short circuit and earth fault protections. The incoming power supply to the chargers will be from two sources with a facility of changeover switch. The change over facility shall be provided in the charger itself.

4.12 The battery circuit shall be provided with HRC fuse protection over a suitably rated load break isolator switch and reverse protection circuits.

4.13 Input volt meter and ammeter shall be of digital type and shall be 96 x 96 mm. Square. These meters shall be of accuracy class not less than 1.0 and shall be of flush mounting type with required PTs and CTs and selector switches. Output voltmeter shall be digital and ammeter shall be moving iron type and shall be 96 x 96 mm square. These meters shall be of accuracy class not less than 1.0 and shall be flush mounting type. The ammeter shall be centre zero type for measurement of charging and discharging current from the battery.

4.14 Cluster LED lamps for indicating õInput onö condition and õOutput onö condition, float status on / off, boost status on / off etc. shall be provided. Annunciation with audiovisual alarms shall be provided for the following.

a) Input mains failure.
b) Input phase failure.
c) Input fuse failure.
d) Rectifier fuse failure.
e) Filter fuse failure
f) DC over voltage
g) DC under voltage
h) Output fuse failure
i) Charger over-load
j) Earth leakage
k) Alarm supply fuse failure
l) Charger trip
m) Output MCCB tripped
n) AC under voltage
o) Battery low condition

ACCEPT, TEST AND RESET push buttons shall be provided. 20% spare annunciation windows shall be provided.

4.15 Any other item(s), not stipulated in this specification, but required for installation, operation and maintenance of the battery charger is / are included in the scope of supply without any extra charge to OPTCL.

5.0 TESTS

5.1 **Type Tests :** The bidder shall submit the Type **Test reports** along with the drawing for approval for the following type tests conducted on float cum boost charger as per relevant IS and IEC within five years from the date of opening of the bid and test-witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

1) Measurement of voltage regulation / AVR regulation
2) Efficiency and power factor measurement test
3) Temperature rises test so as to determine the temperature rise of SCR, Transformer primary, Secondary and core, Diode, capacitor, choke and cabinet etc.
4) Measurement of insulation resistance.

(i) AC input to earth.
(ii) AC input to DC output.
(iii) DC output to earth
(iv) Test for rectifier transformer.
(v) DC voltage current characteristic
(vi) High Voltage Tests.
(vii) Determination of regulation
(viii) Measurement of ripple
(ix) Reverse leakage test.

5.2 **Acceptance Tests :**

Followings shall constitute the Acceptance tests which shall be tested by the purchaserôs representative at the works of the manufacturer at the cost of the supplier (both for FC cum BC) for each charger. No sampling is allowed.

1. Measurement of voltage regulation / AVR Regulation
2. Efficiency and power factor measurement
3. Temperature rise test so as to determine the temperature rise of SCR, Transformer primary, secondary and core, diode, capacitor, choke and cabinet etc.
4. Measurement of insulation resistance.

2 AC input to earth
3 AC input to DC output
4 DC output to earth

5. Test for rectifier transformer (all relevant tests as per corresponding ISS)
6. DC voltage current characteristic
7. High voltage tests.

8. Determination of regulation.
9. Measurement of ripple
10. Tests for indications and alarms as per this specification
11. Tests for indicating instruments.
12. Determination of system set points.
13. Soft start test

N.B. : The supplier shall provide arrangements for monitoring the temperature across the elements, as stipulated above, continuously during the temperature rise test without disconnection of any of the temperature measuring devices across the hottest spot of each of the above elements.

All other tests, as may be necessary to ensure that all equipmentôs are satisfactory shall also be carried out. In addition to the above tests, manufacturerôs test certificates, vendorôs test certificates for different equipmentôs, accessories, instruments etc. shall be submitted, whenever required by the purchaser.

6.0 DRAWINGS / DOCUMENTS

The tenderer shall submit the following drawings / documents for approval.

I. OGA of the battery chargers
II. General layout with overall dimensions
III. Electrical schematic diagram showing connections and controls.
IV. Leaflets and technical literature giving detailed information of the panels offered.

The contractor shall submit the following drawings / documents in 7 (seven) copies within 15 (fifteen) days from the date of issue of the purchase order for purchaserôs approval.

a. OGA of the battery chargers
b. General layout with overall dimensions marked alongwith sectional views showing cable entry position etc.
c. Rating calculations for transformer, rectifiers, diode, capacitor, inductor etc.
d. Detailed schematic and connection and control wiring diagram for all the equipments.
e. Complete bill of materials
f. Technical excerpts on operation.
g. The circuit diagram of charger including circuit diagrams of all cards to facilitate the maintenance of chargers

7.0 GUARANTED TECHNICAL PARTICULARS

The guaranteed technical particulars of this specification shall be furnished along with the tender. Any tender, lacking complete information in this respect is likely to be rejected.

8.0 DEVIATION FROM SPECIFICATION

All deviations from the specification shall be separately listed in the technical deviation sheet, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

10.0 GENERAL TECHNICAL REQUIREMENTS FOR BATTERY CHARGER SUITABLE FOR 48V VRLA TYPE BATTERY

1	Type	Float & Float Cum Boost Charger for VRLA Type, full wave, full controlled type.	
2.	RATINGS	15 A Float cum Boost for 48V, 100 AH VRLA Type Battery	
3.	AC INPUT i) Voltage ii) Frequency iii) Phase	415 VAC ± 10% 50Hz ± 5% 3 - phase	
4.	D.C.OUTPUT VOLTAGE SETTINGS Nominal Float	FC 48/54.5V (adj. By + 20%, - 5%	BC 48/66.5V (adj. By + 2%, - 5%)
5.	OUTPUT CURRENT LIMIT	15A	15A
6.	POWER CONVERSION	AC to DC by means of three phase full wave, Half controlled bridge rectifier consisting of thyristors and diodes.	

7.	VOLTAGE REGULATION AT BRIDGE OUTPUT.	± 1% of set value for ± 10% Input Voltage Variations, 0-100% Load variation.
8.	RIPPLE VOLTAGE	Less than 3% RMS without battery connected.
9.	EFFICIENCY	More than 80% at full load
10.	PROTECTIONS	
	(a) Input side	AC input MCCB & ELBS with input ON/OFF switch and fuses, contactor
	(b) Output side	DC output MCCB with output ON/OFF switch and fuses.
	(c) Protection	Current limit protection, soft start feature, surge suppressor. Fast semiconductor fuses for rectifier bridge.
	(d) Control circuit	Fuses
	(e) Capacitor circuit	Rectifier HRC fuses.
	(f)	Over-voltage cut-back
	(g)	Charger over load / short circuit
	(h)	Blocking diode
11.	CONTROLS AND SWITCHES	Followings controls and switches are provided in the system 1 AC input source MCCBs with interlocking 2 DC output MCCB 3 Auto/Manual float/boost mode selector switch. 4 Float and boost voltage variable potentiometers. 5 Manual voltage adjustment Potentiometer 6 Test push button 7 Reset push button 8 Battery current adjustment potentiometers 9 Heaters power supply switch

		10 Socket power supply switch	
12.	FEATURES	The following features are provided in the systems: 10 Soft start on DC side 11 Class-F insulation for all magnetic 12 Automatic voltage regulation. 13 Automatic changeover from float to boost and vice versa based on current, drawn by battery. 14 Filter circuit to eliminate ripple. 15 Charger current limit 16 Separate battery path current limit. 17 Built-in auto phase reversal of operation.	
13.	METERS	F.C. (i)Input Voltmeter (ii) Input Ammeter (iii) Output Voltmeter (iv) Output Ammeter	B.C. (i) Common (ii) Input Ammeter (iii) Output Voltmeter (iv) Output Ammeter.
		Battery volt meter Battery ammeter Earth leakage ammeter	
14.	Indications	Phase ó ONô lamps (ii) Output ó ONô lamp	a) phase ó ONô lamps (ii) Output ó ONô lamp. (iii) Charger ó ONô float LED (iv) Charger ó ONô boost LED.

15.	Annunciation with audiovisual alarms.	(i) AC input mains failure (ii) Input phase failure (iii) AC under voltage iv) Input phase failure v) Rectifier fuse failure vi) Output fuse failure vii) Filter fuse failure viii) DC under voltage ix) DC over voltage x) Charger trip xi) Capacitor fuse fail xii) Output MCCB tripped xiii) Charger over load xiv) Earth leakage xv) DC earth fault xvi) Alarm supply fuse failure xvii) Battery low condition.	v) Rectifier fuse failure vi) Output fuse failure vii) Filter fuse failure viii) DC under voltage ix) DC over Voltage x) Charger trip xi) Capacitor fuse fail xii) Output MCCB tripped.
Note : All the alarms shall be provided through electronic display cards. Audio alarm through buzzer, visual indication through 10 mm LEDS & alarm ackn. / reset and LED provision is through push buttons.			
16.	Operating ambient temperature surrounding the panel	0^0 to 50^0C	
17.	Surrounding the panel Relative humidity.	0-95% non-condensing	
18.	PANEL (i) Protective grade (ii) Cooling (iii) Paint	IP ï 42 Natural air-cooled Smoke Grey of ISS-692 shade	

19.	MAGNETICS : a) Average winding temperature rise over ambient temperature b) Insulation class c) Insulation breakdown voltage.	As per relevant ISS. ôFô 3 kV for 1 min withstand.
20.	CABLES	1100 V grade PVC insulated copper. Ferrules shall be provided for identification of connection.

N.B.: -Besides the above general technical requirements, all other stipulations, as enumerated in this technical specification shall be followed. Any deviation should be clearly brought out with clear explanation.

Any extra feature/ equipment / instrument as necessary for operation and performance of the battery charger for the 48V battery set as per this specification shall be provided without any extra cost to OPTCL.

TECHNICAL SPECIFICATION

FOR

AC DISTRUBUTION BOARD
AND
DC DISTRIBUTION BOARD

TABLE OF CONTENTS
OF
DISTRUBUTION BOARDS

TECHNICAL SPECIFICATION FOR DISTRIBUTION BOARDS

1.0 **General**

Requirements of AC and DC systems
The electrical auxiliary systems shall be of a quality commensurate with the performance, reliability and availability requirements of the substation.
The electrical station services shall be in accordance with all the relevant standards, shall satisfy the requirements specified herein and shall be designed to operate in the environmental conditions specified in the relevant sections of this Specification.
The electrical station systems shall be required to provide the voltage classes indicated in Table 1.1. for operation of various plant equipment operating mechanisms, plants, control and communication systems

Nominal Voltage V	Tolerance	Frequency Hz or DC	Phases	Wires	Neutral Connection
430	±10%	50±5%	3	4	Solidly earthed
240	±10%	50±5%	1	2	Solidly earthed
50	±10%	DC	DC	2	ungrounded

Table 1.1.Voltage classes

The auxiliaries shall be capable of withstanding all over frequency and undervoltage conditions without loss of supply to the power circuits or shutdown of any auxiliary system meeting the essential loads of the substation plant and equipment.

The material offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. Tthe Type Test reports shall be submitted along with the bid.

1.1 **Configuration**

The basic design of the substation electrical auxiliary services shall be as shown in the schematic drawing. This drawing is for guidance only and the Contractor may propose an alternative keeping in view the design philosophy stipulated in this section of the Specification. The design philosophy for auxiliary supply systems shall be as follows:

The AC supply for station auxiliary systems shall generally be obtained from 33kV bus available at the substation site. The capacity of the station transformer is 100 KVA 33/0.43 KV shall be installed to provide reliable auxiliary power supplies.

1.2 **Essential loads**

These are loads whose failure will affect the capability of the station and station plant and equipment. These loads shall include station services of the substation like supply to CB control cubicles, relay panels, Battery charger, illumination, air conditioning system etc.

1.3 **Emergency loads**

These are loads that must remain in service during complete loss of the ac power supply. These loads shall include the station battery chargers, disconnecting switch and circuit breaker operating mechanisms, control room air-conditioning and the emergency lighting of the switchyard and control building. Some emergency loads operate on ac voltage and the others on dc voltage.

1.4 **Normal loads**

These loads, whose failure do not affect capability, shall include but not be limited to control building and switchyard lighting, control building air-conditioning ,water pumps, oil treatment loads, etc.

2.0 415V AC distribution system

2.1 **General**

The 430V secondary distribution system shall comprise 430V power centres serving the different classes of loads.

Each power centre shall consist of one station service transformer of 100 KVA capacity.The section of the 430V power centre shall be designed to carry the total load of the sub-station.

Restoration of normal supply conditions shall automatically return the power centre to the normal operating mode. The 430V power centres shall be of the metal enclosed switchgear type according to the relevant IEC or Indian Standards.

2.2 **AC distribution board**

The ACDBûs shall be in accordance with the relevant IEC or Indian Standards and shall also comply with the following requirements:

The ACDB shall be located inside the control room at a suitable place.

2.3 **Supply of essential loads**

Essential loads shall be fed from ACDB so as to meet the complete requirement of the essential loads of the substations.

2.4 **Supply of emergency loads**:

Only control room building shall have provision of emergency illumination fed from the DC system. The DC system is of 48 V.

2.5 **Supply of normal loads**:

Normal loads shall be fed from the ACDB & lighting distribution boards.

3.0 LVAC supplies and equipment

3.0.1 General

Switchboards shall be of the free standing design, suitable for mounting directly above the cable trenches laid inside the control room. Cable trench walls shall be flush with the control room floor. Switchboards shall be suitable for terminating all incoming and outgoing cables and will normally be of the bottom rear entry type, generally in accordance with IEC 947 and 439 and of metal clad design arranged for drawout isolation. Switchboards shall be equipped with moulded case & miniature circuit breakers. The use of fuse switches will not be permitted.

3.1 LVAC scheme

3.1.0 General Requirement

The 415V incoming supply shall be derived from the station auxiliary transformer.

3.1.1 Main Distribution Board

The main distribution board shall be supplied from station auxiliary transformer. The board shall feed the following panels:

- Outdoor Lighting distribution board
- indoor Lighting distribution board
- Air conditioning system
- Maintenance equipment and oil treatment plant supplies.
- Battery Charger
- Breaker cubicles 33 KV side
- Breaker cubicles 11 KV side
- Relay panels 33 KV side
- Relay panels 11 KV side
- Water pump system
- Spare feeder for future use

3.1.2 Main lighting distribution board (indoor & outdoor)

The main lighting distribution board shall receive incoming supplies from the main distribution board. This board shall be further connected to lighting distribution panel.

4.0 CONSTRUCTION

4.1 Panels

Engineer to give details as to the type of scheme required eg duplicate feeds with automatic changeover facilities etc or details of existing scheme where extensions to this are to be provided and where necessary detailing the number of spare ways etc.

For indoor applications the switchboards shall be of the cubicle pattern, each circuit being self-contained within its own cubicle (compartmentalized type). An access door shall be provided for each cubicle such that access can only be obtained to individual circuits. Circuits shall be segregated one from the other by earthed metal. For outdoor installation they shall be of multi-box construction. Sheet steel for fabrication of the panels shall be a minimum of 3 mm thick for load bearing including gland plate & all other shall be 2.5 mm thick. All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

4.2 **Switchboard**

Switchboards shall be vermin proof and suitable for use in a tropical climate. All ventilating louvers shall be covered with a fine mesh from inside. All switchboards shall be provided with a degree of protection of IP 52 as per IEC 947 or equivalent Indian standard. Provision shall be made in all compartments for providing IP 52 degree of protection, when circuit breaker or module trolley, has been removed. Switchboards shall be of uniform height and shall not exceeding 2450 mm. Switchboards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers. All switchboards shall be divided into distinct vertical sections, each comprising:

i) A completely enclosed busbar compartment for horizontal and vertical busbars. Busbar chamber shall be completely enclosed with metallic partitions. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance. Access shall be possible without disturbing feeder compartment.

ii) Completely enclosed switchgear compartment(s), one for each circuit for housing circuit breaker or motor starter.

iii) A compartment or alley for power and control cables. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts, and shall have no communication with busbar chamber.

iv) A compartment for relays and other control devices associated with a circuit breaker.

All access doors shall be provided with facilities for locking in the closed position. It shall be possible to move each circuit breaker or MCCB to the disconnected position without the need to open the cubicle access door. Attempted disconnection of a circuit breaker or MCCB when in the closed position shall not result in tripping of the particular equipment.

4.3 **Cubicle**

Cubicles may be arranged vertically in tiers, the number being limited only by the need to ensure that circuits are thermally independent. It shall be possible to work within each cubicle with the equipment withdrawn whilst the incoming contacts are energised. The minimum requirements for protection shall be:

- Insulating barriers installed between phases within the cubicle.
- An insulating cover to be affixed over the protruding feeder and busbar connections when the equipment is withdrawn.

Where this is not available, protection shall be provided by automatically operated shutters. It shall be possible to open the shutters intentionally, against spring pressure for testing purpose.

Each phase of the down dropper connections from the busbars to the equipment isolating contacts shall be separated from the incoming or outgoing connections and from the other phases by barriers. Cubicles shall be suitable for terminating all necessary cabling whether of copper or aluminium conductor design. It shall be possible to terminate any cable whilst adjacent circuits are energised.

4.4 **Busbar and other equipment housing**

All incoming connections, busbars and feeder connections up to the particular MCCB shall be capable of the short time current rating specified, but connections beyond the MCCB need only be matched to the MCCB characteristic. The overall height of each tier of cubicles shall be such that the operating handles of all equipment are within the reach of a person standing at ground level. Control switches as specified shall be fitted and suitably labelled to indicate their function. The equipment shall be complete with cable boxes and glands suitable for XLPE or PVC insulated cables. The switchboard shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch. Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.

All equipment associated with a single circuit shall be housed in a separate compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. The front of the compartment shall be provided with a hinged single leaf door complete with locking facilities. The main switch shall be operable from outside and will be interlocked with the compartment door such that the latter can be opened only when the switch is off. However, it shall be possible to defeat this interlock and open and close the door with the switch ON. The main switch shall have the facility of being pad-locked in both ON and OFF positions. The switch handle shall clearly indicate the position of main switch.

After isolation of power and control circuit connections it shall be possible to safely carry out maintenance in a compartment with the busbar and adjacent circuit live.

Necessary shrouding arrangement shall be provided for this purpose over the cable termination located in cable alley.
The temperature rise of horizontal and vertical busbars when carrying rated current along its full run shall in no case exceed 55 ºC, with silver plated joints and 40 ºC with all other type of joints over an outside ambient temperature of 50 ºC.
All single front switchboards shall be provided with removable bolted covers at the rear. The covers shall be provided with danger labels.
All identical circuit breakers and module chassis of same test size shall be fully interchangeable without having to carry out modifications.
The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.
All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to approval of the Project Manager.
All sheet metalwork shall be painted in accordance with the painting clause specified elsewhere in this Specification. The shade of the paint shall be 692 as per IS 5 (smoke grey).

5.0 **STANDARDS**

The equipment covered by this specification shall unless otherwise specified be built to conform to Indian Electricity Rule 2956 wherever applicable and shall satisfy the requirements of the latest Indian Standard. Permissible temperature rise shall be as per relevant ISS.

5.1 **SWITCH BOARD DESIGN**

The switch board shall be self supporting, steel cubicle, compartmentalized, fully enclosed with doors for access to the interior. The switch boards shall comprise a non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear 3 mm sheet shall be used for fabrication of the panels. Modular type construction for inter-changeability will be preferred.

The complete panels shall not be more than 2450 mm. high with the channel base and 500 mm. depth measured form rear to front faces and of suitable with. The working height shall be limited to maximum 2200 mm. The design shall be such as to permit extension at site on either end. The bottom of the switch board frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plates shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboard shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and holes shall be covered with fine wire mesh from inside

(for indoor use). All control and power cables will be laid in open distribution trenches running under the A.C. switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates grouting bolts, lock nuts, washer, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhesive matter or greases. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing allowed by application of an undercoat to serve as base and binder for the finishing coat. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel or dark batter ship grey, evenly sprayed to present a fine appearance while the interior faces shall be sprayed with a finishing coat of light grey paint to provide contrasting background for the wiring inside the cubicle.The internal illumination for working should be of adequate intensity CFL lamps.

A small quantity of finishing paint shall be supplied with the consignment of the Switchboards to enable the employer to restore at site any surface finish which may get damaged during transit.

5.2 **BUS BARS**

The bus bars shall be of E.G. copper/aluminum alloy, liberally sized for the specific current ratings (both short circuit and continuous currents). The size of the bus bars shall be such that the current density is not more than 1A/1.75 A per sq.mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying various phases of bus bars. Bus support shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creepage surface. Buses shall be spaced with adequate clearance between phases and phases to ground.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/riser from or to the bus bars should not be twisted but reasonable bend or joint may be allowed. The bidder shall sbsrish necessary calculations about the adequacy of sleeted bus suyyrot insulator cantilever sireugth w.r to short cicess forces.

5.3 **Earthing**

Earthing of current free metallic parts on the body of the switchboard shall be done with soft drawn bare copper bus. Tail connections shall have a minimum

cross sectional area of 16 mm2 and the main earth bar for the switchboard shall be brought out to two terminals for connection to the station earth grid.

Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.

5.4 **Clearances and insulation level**

Clearances and creepage distances in air shall be those stated in IEC 158 and 947 and be such that the equipment can withstand the dielectric tests specified.

5.5 **Thermal performance of switchboard and equipment**

The complete switchboard shall be capable of carrying rated load current without the temperature rise of any portion exceeding a level of 65C. Parts that may be touched by operating personnel shall not exceed a level of 35C. In determining the load current performance of tiered cubicles it shall be assumed that all circuits are carrying rated current.

The cross sectional area of the busbars may be graded according to the current rating, but shall remain capable of the short time current rating stated in the Schedules.

5.6 **Protection Co-ordination**

It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the MCCB with the upstream and downstream to provide satisfactory discrimination.

6.0 EQUIPMENT TO BE FURNISHED

6.1 **General**

The Contractor shall supply all equipment in accordance with this Specification in each of the modules as specified in the following sub clauses.

6.2 **Type Designation /Description of Modules**

Each 415V switchgear and distribution board shall comprise of a number of different type of modules as detailed in the following clauses.

415V switchgear modules and applications

ACDB:

1.	415V, 250A, P2 duty 20 kA, 50 Hz MCCB having 4 NO and 4 NC Aux. contacts.	1
2.	Auxiliary relays	1
3.	Indicating lamps with resistors and coloured lenses suitable for 240V AC.	3
	With over load & over current & earth fault protection.	
(a)	(415/√3)/ (110/√3) volts single phase voltage transformer star/star connected with star point solidly earthed mounted	3

	on common draw out chassis. Accuracy Class 0.5 for protection and metering with 50VA burden.	
(b)	HRC Fuses mounted on the above chassis.	6
(c)	Four position voltmeter selector switch.	1
(d)	Voltmeter (0-500V)	1
(e)	Under voltage protection	1
(f)	Indicating lamps with series resistor and colour lenses (Red, blue and yellow).	3

6.3 **INDICATING LAMPS**

Indicating lamps shall be LED type provided with suitable safety resistor, and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover. The lamp holders shall preferably be screwed type.

6.4 **SPACE HEATERS**

The A.C. switchboards shall be provided with space heaters rated for 240 volts single phase A.C. Each heater shall be provided with ON/OFF switch. The wattage of the heater shall be such as to keep 10 deg. C. above the ambient temperature during rainy season but the temperature shall not damage the wiring.

6.5 **CABLE TERMINATION**

Switchboards shall be designed to facilitate PVC cable entry from the bottom of the switchboards. Removal plates shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection.

Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029ò copper conductor for control and Aluminum for cables feeder up to 15 Amp. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with terminating the internal wiring and outgoing cables.

Power terminals shall be complete with lugs and control terminals shall be clamp type. Screw type terminals with screw directly impinging on conductor shall not be supplied.

Each terminal for 15 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.029ò copper wires at one end without any damage to the connector or any looseness of connection.

The terminal shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality. Terminal block connector built from cells of moulded dielectric and brass-stud inserts shall be provided. The connection stud shall project at least 6 mm. from the lock nut surface. All blocks shall be shrouded of easily removable shrouds moulded of transparent dielectric material of non-breakable type.

6.6 **WIRING**

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and inter-locking schemes.

All wiring shall be complete up to the terminal blocks at the factory.

Control wiring shall be carried out with flexible, heat resistant, switchboard wires. PVC insulated with 2.5 sq.mm. stranded copper conductors. Each wire shall be identified at both ends with wire destinations numbered ferrules in accordance with bidder's wiring diagram. Wires shall not be spliced or tapped between terminal points. Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminal, blocks, meters, relays, instruments, and other devices used in the switchboards. Red, Yellow, Blue and Black ferrules shall be used for Red. Yellow, Blue phases and Neutral respectively.

Wires shall be neatly bunched and adequately supported so as to prevent sagging and strain on termination.

All spare contacts of the equipment shall be wired up to the terminal block. The wiring shall be cf 1.1 KV grade. At least 20% spare terminals shall be provided.

- Terminal connection shall be such that the conductors. LM10 may be connected by means of screw or other equivalent means so as to ensure that the necessary contact pressure is maintained permanently.
- Terminal shall be such that they cannot turn or be LM10 displaced when the connecting screws are tightened and such that the conductor can also not become displaced.
- Terminals should be so mounted that the appropriate wire may be connected without impairing the normal performance of the unit.

7.0 A.C. DISTRIBUTION BOARD SCHEME

Power will be fed to A.C. distribution board through 1 No. incoming 250 Amp MCCB from 100 KVA station service transformers. Suitable annunciation for failure of A.C supply is to be provided.

A 415 V single line diagram accommodating the above facilities and to suit the system is to be design and submitted to the Employer for approval. However, exact requirement layout is to be taken up by the

contractor depending on the layout, rating and type of equipment for preparation of drawing.

7.1 **PROTECTION SCHEME FOR INCOMING**

The incoming circuit to the L.T. switchboard shall be provided by thermal overload relays, short circuit release and over current and earth fault protection.

D.C. operated audible as well as visible alarm with cancellation device shall be provided for the auto trip of the breakers.

7.2 **CURRENT TRANSFORMERS**

The current transformer to be provided with the incoming/outgoing circuit for metering shall be air-cooled of class 0.5M accuracy. The VA burden should be such as to suit the requirements. C.Ts shall be bar primary type moulded/cast resin type. The current transformer shall be manufactured and tested according to relevant I.S.S.

7.3 **INSULATION LEVEL**

The insulation at any point of the wiring in switchboards shall be suitable for 1100/660 volts grade service.

8.0 DC supply equipment

8.1 **General scheme**

The DC supply system (50V) shall comprise single battery set and battery charger, a dc distribution board and control gear. The system shall be arranged such that only one of the station batteries and one of the battery chargers shall be in service at any one time, but should either item of equipment fail or need to be taken out of service for maintenance, then the duplicate item of equipment can be brought into service without disruption of supplies. Battery chargers shall be provided with an automatic change-over facility that will operate should one of the charger units fail.

The batteries shall be located in a battery room and connected to the distribution boards and battery charger located in an adjacent room via a fuse box located in the battery room.

Where the battery size is less than 100 Ah, and the cells are of the totally enclosed type, consideration will be given to housing the battery in a sheet steel cubicle mounted alongside the charger and distribution board so as to form a complete suite of panels.

The 48V DC power supplies system will operate with both battery terminals free of earth whilst that for communications equipment (the 50V DC power supply) will

operate with the positive pole permanently earthed. A suitable earth fault detection scheme shall be provided.
The battery rated output shall be that available at the outgoing terminals, after making due allowance for the resistance of inter cell connections.

Earthing of current free metallic parts on the body of the distribution boards shall be done with soft drawn bare copper bus. Tail connections shall have a minimum cross sectional area of 16 mm2 and the main earth bar for the distribution shall be brought out to two terminals for connection to the station earth grid.

Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.
The distribution board shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch.

9.0 TECHNICAL SPECIFICATION FOR INDOOR TYPE 48 VOLT D.C. SYSTEM POWER DISTRIBUTION SWITCH BOARDS

9.1 SCOPE

This specification covers manufacture, assembly and testing at manufacturerôs works, supply and delivery of Indoor Type 50 volts D.C. Power Distribution on Switchboards complete in all respects as per system requirement for 33/11 KV substation and switchyards. 20% spare feeders shall be provided in each DCDB.

9.2 STANDARDS

The equipment covered by this specification shall unless otherwise specified, be built to conform to Indian Electricity Rules 1956 wherever applicable. Permissible temperature rise shall be as per relevant ISS.

Switchboard Design

The switchboards shall be self supporting steel cubicle compartmentalized fully enclosed with doors for access to the interior. The switchboards shall comprise of non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear. The material & thickness of the sheet to be used as per the description above.

The complete panels shall not be more than 2250 mm. high with me channel base and 600 mm. depth measured from rear to front faces and of suitable width.

The working height shall be limited to maximum of 2000 mm. The design shall be such as to permit extension at site on either end. The bottom of the switchboard frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the

base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plants shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboards shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and oleos shall be covered with fine wire-mesh from inside or inbuilt type. All control and power cables will be paid in open distribution trenches running under the D.C. Switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The successful bidder shall furnish foundation drawings for the switchboards showing the cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates, grounding bolts, lock nuts, washers, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhering matter or grease. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing followed by application of an undercoat to serve as base and binder. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel, or dark battleship grey, evenly sparyed to present a fine appearance, while the interior faces shall be approved with a finishing coat of light grey paint to provide a contrasting background for the wiring inside the cubicle.

A small quantity of finishing paint shall be supplied with each consignment or the switchboards to enable the Employer to restore at site any surface finish which may get damaged during transit.

9.3 **BUS BARS**

The bus bar shall be of E.G. copper/aluminum alloy, liberally sized for the specified current rating (both short circuit and continuous currents). The size of bus bars shall be such that the current density is not more than (1A/1.75A) per sq. mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying the positive and negative bus bars. Bus supports shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creep age surface.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/risers from or to the bus bars should not be twisted but reasonable bend or joint may be allowed.

9.4 **MCCB & MCB**

All incomer feeder will be provided with DC- MCCB(50 Amp) and all outgoing feeders with DC MCB (16 Amp) conforming to latest IS : standards as per system requirements.

9.5 **FUSE**

Fuses shall be HRC link type of renowned make conforming to latest issue of ISS 2208. Rewirable fuses shall not be supplied.

Fuse shall be complete with fuse bases and fittings of such design as to permit easy replacement of the fuse elements.

Link shall also be easily replaceable. Visible indication shall be provides on blowing of the fuse.

9.6 **INDICATING LAMPS**

Indicating lamps shall be LED type provided with suitable safety resistor and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover.

9.7 **CABLE TERMINATION**

Switch boards shall be designed to facilitate PVC cable entry from the bottom of the switchboard. Removable places shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection

Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029ò copper conductor for control and for feeders up to 15 Amps. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with screws, nuts. Washers and marking strips shall be furnished for terminating the internal wiring and outgoing cables.

Power terminal shall be complete with lugs and control terminals shall be clamp type. Scew type terminals with screw directly impinging on conductor shall not be supplied. Connectors built from cells of moulded dielectric and brass stud inserts shall be provided for terminating the internal wiring and outgoing cables.

Each terminal for 25 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.029ò copper wires at one end without any damage to the connector or any looseness of connection. The terminals shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality.

9.8 **WIRING**

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and interlocking scheme.

All wiring shall be complete up to the terminal blocks at the factory. The insulation grade of wire to be used for internal wiring if the switch board shall be 1100 volts grade. Wiring shall be carried out with flexible heat resistant, switchboard wires PVC insulated with 2.5 sq.mm. stranded copper conductors.

Earth wire shall be identified at both ends with ferrules showing wire designations in accordance with bidderôs wiring diagram. Wires shall not be spliced or tapped between terminal points.

Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminals, blocks, meters, relays, instruments and other devices used in the switchboards. Red ferrules with positive marking shall be used for positive terminals and white ferrule with negative marking shall be used for negative terminals for D.C. wiring.

Wires shall be beatly bunched and adequately supported so as to prevent sagging and strain on termination. All spare contacts of the equipment shall be wired up to the terminal block.

9.9 SAFETY EARTHING

Earthing of current free metallic parts of metallic bodies of the equipment on the switchboards shall be done with soft drawn bare copper bus Tail connections shall have minimum area of 26 sq. mm. and the main earth connection for each switchboards shall be brought out to two terminals for connection with the station earthing system.

Earth terminals should be identified by means of the sign marked in a legible and indelible manner on or adjacent to the terminals. Earth lugs shall be provided and all earthing connections shall be carried out with green wires.

9.10 SWITCH BOARD LIGHTING

The interior of each panel switchboard shall be illuminated by CFL lamps connected to 230 volts. Single phase A.C. supply and shall be controlled by a door-operated swich. All A.C. wiring shall be carried out with black wires. The incoming A.C. supply to the D.C. boards shall be provided with H.R.C. fuse and link of proper rating.

9.11 INDICATING INSTRUMENTS

All instruments shall be of switchboard type, back-connected suitable for flush mounting. The construction shall conform to the appropriate Indian Standard Specifications. The instruments shall be capable of indicating freely without error when operated continuously at any ambient temperature from 0 deg. C to 50 deg. C. Those shall withstand the effects of shock, vibration and humidity. All circuits of instruments shall be capable of withstanding 20% overload for a period of at least 8 hours.

9.12 **COMPLETENESS OF SUPPLY**

The switchboards offered by the bidder shall be complete in all respects. Any materials necessary which may not have been specifically mentioned but which is usual or necessary for satisfactory and trouble-free operation and maintenance of the switchboards shall be supplied without any extra charge to the employer.

9.13 **SPARES**

The item wise price for the spares recommended for three years operation and maintenance of each switchboard shall be quoted.

9.14 **INTER CHANGEABILITY**

All similar materials and removable parts shall be interchangeable with each other.

All switches, contactors, etc. shall be easily removable as a complete unit from the switchboards and shall be capable of being put in similar position in other switchboards for performing identical functions.

The spares called for in respective sections shall be identical with like parts provided in the main equipments in all respects and shall be capable of replacing the main equipments wherever required to carry out identical functions.

10.0 ACCEPTABILITY OF DIFFERENT EQUIPMENTS & AUXILIARIES

All equipments, cables, wires and accessories offered shall be of best quality and of renowned make for successful and trouble free operation of the switchboards.

Equipments/accessories of substandard quality shall not be accepted by the Employer.

11.0 TESTS

The following tests are to be carried out.

(i) Checking continuity of the wiring.

(ii) Insulation resistance of all wiring circuit with all equipments mounted on the board, before and after application of H.V.

(iii) One minute power frequency voltage withstand test. All equipments and wiring shall withstand a power frequency voltage of 2 KV applied between any circuit and earth.

(iv) Routine test of all equipments, switches and devices according to relevant I.S.S.

(v) Type test reports shall be furnished.

12.0 CLEARANCE

The apparatus forming part of the panel shall have requisite clearances and these shall be maintained during normal service conditions. When arranging the apparatus within the panels, the clearances for them shall be complied with taking into account the relevant service condition. In addition, abnormal conditions such as in short circuit shall not permanently reduce the distances between bus bars.

13.0 NAME PLATE OF D.C. SWITCHBOARDS

Each panel shall be provided with name plates, marked in a durable manner and located in a place such that they are visible and legible when the panel is installed. The following information should be given on the name plate.

(i) The manufacturerôs name and /or trade markô& identification number.
(ii) Rated operational voltage.
(iii) Purchase order number and date.
(iv) Weight.

14.0 DETAILS OF DISTRIBUTION BOARDS.

14.1 **ACDB**:

a) Incomer - 1: 250 Amp MCCB, 50KA, provision of O/C & E/F, UV relay, ON/OFF lamp indication, Auto trip indication, R,Y,B healthy indication, Ammeter & voltmeter with selector switch, Annunciation facia with Acc, Reset and Test P.B.

b) Out going Feeders: 1)63 Amp MCB: 2 Nos,
2) 32 Amp MCB: 5 Nos,
3) 16 Amp MCB: 5 Nos
4) 100 Amp MCCB: 1 No(for transformer oil filtration)
& Spare compartment: 2 Nos.

14.2 **LIGHTING DB** (indoor & outdoor): R, Y, B Healthy Indication, Ammeter and voltmeter with selector switch.

a) Incomer -1: 63 Amp MCB.
b) Out going feeder (for inc 1): 1) 32 Amp MCB: 5 Nos
2) 16 A MCB: 5 Nos

14.3 **50 V DC Indoor Ltg. DB (for emergency purpose)**

a) Incomer : 32 Amp DC MCB from DCDB with auto changeover facility having delay timer with auto/manual selection switch.
b) Outgoing feeder: 16 Amp DC MCB: 4 Nos

14.4 **50 V DCDB**:

a) 48 V DC DB: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.

b) Incomer: 50 Amp DC MCCB:
c) Outgoing feeder: (1) 16 Amp DC MCB: 10 Nos.
(2) 32 Amp DC MCB: 1 No.

TECHNICAL SPECIFICATION

FOR
CONTROL & PROTECTION PANEL
(AT SOURCE SUB STATION)

TABLE OF CONTENTS
OF
CONTROL, RELAY & PROTECTION PANELS

CONTROL, RELAY & PROTECTION PANELS

The control and relay panel offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. Tthe Type Test reports shall be submitted along with the bid.

1.0 TYPE OF PANELS

1.1 Simplex Panel

Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from rear for control panels & front for –relay/**protection** panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.

2.0 CONSTRUCTIONAL FEATURES

2.1. Control and Relay Board shall be of panels of simplex or duplex type design as indicated in bill of quantity. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementaryequipmentrequired for completeness of the protective / control schemes be properly accommodated in the panels without congestion and if necessary, **either more number of panels or** provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. **However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room**.

2.2. Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS: 2147.

2.3. Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than **3 mm** for weight bearing members of the panels such as base frame, front sheet and door frames, and **2.0 mm** for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

2.4. All doors, removable covers **of** panels shall be gasketed all around with synthetic gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

2.5. Design, materials selection and workmanship shall be such as to result in

neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

2.6. Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials that shall be supplied by the contractor, **which** shall be placed between panel & base frame.

2.7. Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

2.8. Relay/protection panels of modern modular construction would also be acceptable.

3.0 MOUNTING

3.1. All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush.

3.2. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

3.3. The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with **blanking plate**.

3.4. The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel.The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel.

3.5. The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

3.6. No equipment shall be mounted on the doors.

3.7. At existing station, **panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement** of equipment (centre lines of switches, push buttons and other equipment) on the front of the panel.

4.0 PANEL INTERNAL WIRING

4.1. Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally.

4.2. All wiring shall be carried out with 1100V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 2.5 mm sq. per lead.
- All current transformer circuits - one 2.5 sq.mm per lead.
- Voltage transformer circuit (for energy meters): Two 2.5 mm sq. per lead.

4.3. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

4.4. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

4.5. Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

4.6. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring.Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

The sizes of wiring in different circuits shall not be less than those specified below :

Table – I

Circuit	Minimum permissible Size of wire.
Metering and relaying circuits connected to Current Transformers.	4.0 mm sq.
Potential circuits for metering and Relaying,	4.0 mm sq.
Other control, visual and audible alarm signaling circuits etc.	2.5 mm sq

The following colour scheme shall be used for the wiring.

Table – II

Circuit where use.	Colour of wire and ferrule.
Red phase of instrument transformer circuit	Red
Yellow phase of instrument transformer	Yellow
Blue phase of instrument transformer circuits	Blue
Neutral connections earthed or not earthed in the instrument transformer circuit	Green
All other wires shall be	Grey

5.0 TERMINAL BLOCKS:

All the terminal blocks to be used in the operating mechanism should be of stud type of Poly-amide material (for non-disconnecting type and for disconnecting type) of make Elmex / Connectwell.

5.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps. continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

5.2. Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

5.3. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

5.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 2.5 mm^2 Copper
- AC/DC Power Supply Circuits: One of 4 mm^2 Copper
- All other circuits: minimum of one of 2.5 mm^2 Copper

5.5. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for

convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7. The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included in the scope of supply.

6.0 PAINTING

Powder coating type

All sheet steel work shall be phosphated in accordance with the IS:6005 Code of practice for phosphating iron and steel.

(1) All unfinished surface of the steel panels and frame work shall be sand blasted to remove rust, scale, foreign, adhering matter of grease.

(2) A suitable rust resisting primer shall be applied on the interior and exterior surfaces of the steel, which shall be followed by application of an under coat suitable to serve as base and binder for the finishing coat. The finishing coat on the exterior of the panels shall be deep gray powder coated. Polished cellulose appearance while on the interior faces the finishing coat shall be of light gray shaded paint sprayed to give a contrasting effect with the cubicle wiring. A small quantity of finishing paint shall be supplied with each consignment of the panels to enable the Employerôs store at site any finish which may get damaged curing the transshipment. The panel boards may alternatively be given a plastic durable covering coat for protection of the finish during the transshipment, which shall be capable of being peeled off after installation.

7.0 MIMIC DIAGRAM

7.1. Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

7.2. Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections. Painted overlaid mimic is also acceptable.

7.3. Mimic bus colour will be decided **during detailed Engineering** by the OPTCL.

TABLE

COLOUR SCHEME FOR MIMIC DIAGRAMS

Equipment	Colour	I.S. Code No.(IS.5)

33 KV	Signal Red	537
11 KV	Brilliant Green	414
415/250V	Black	221
Earth	White	309

7.4. When Semaphore indicators are used for equipment position, they shall be so mounted in the mimic that the equipment in close position shall complete the continuity of mimic.

7.5. Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition

8.0 NAME PLATES AND MARKINGS

8.1. All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/feeder designation.

8.2. All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

8.3. Each instrument and meter shall be prominently marked with the quantity measured e.g. KV, A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

8.4. Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall be black with white engraving lettering.

8.5. Each switch shall bear clear inscription identifying its function e.g. "BREAKER' '52A', "SYNCHRONISING" etc. Similar inscription shall also be provided on each device whose function is not other-wise identified. If any switch device does not bear this inscription separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. "Trip- Neutral-Close", "ON-OFF", "R-Y-B- OFF" etc

8.6. All the panels shall be provided with name plate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

9.0 MISCELLANEOUS ACCESSORIES

9.1. **Plug Point**: 240V, Single phase 50Hz, AC Socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

9.2. **Interior Lighting**: Each panel shall be provided with a fluorescent lighting

fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

9.3. **Switches and Fuses**: Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses. Selection of the main and sub-circuit Fuses rating shall be such as to ensure selective clearance of sub-circuit faults. Voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.

9.4. **Space Heater**: Each panel shall be provided with a thermostatically connected space heater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

10.0 EARTHING

10.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference from earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least **25 X 6** sq.mm copper with threaded holes at a gap of 50 mm with provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

10.2. Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.

10.3. All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than **2.5 sq. mm**. The colour code of earthing wires shall be green.

10.4. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

10.5. VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel.Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

10.6. An electrostatic discharge **arrangement** shall be provided in each panel **so as to discharge human body before he handles the equipments inside the panels**.

11.0 INDICATING INSTRUMENTS & TRANSDUCERS FOR CONTROL PANEL(Multi function meter to be inserted)

All instruments, meters and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All MEGAWATT , MEGAVAR, BUS VOLTAGE AND FREQUENCY indicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery.

However no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronising equipment.

11.1. Indicating Instruments

11.1.1. Unless otherwise specified, all electrical indicating instruments shall be of digital type suitable for flush mounting.

11.1.2. Instruments shall have 4-digit display; display height being not less than 25mm.

11.1.3. Instrument shall confirm to relevant IS and shall have an accuracy class of 1.0 or better. Watt and Var meters shall have an indication of (+) and (-) to indicate EXPORT and IMPORT respectively.

11.1.4. Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25mm (height).

11.2. Transducers

11.2.1. Transducers (for use with Indicating Instruments and Telemetry / Data Communication application) shall in general conform to IEC:688-1

11.2.2. The transducers shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

11.2.3. The input to the transducers will be from sub-station current & potential transformers. The output shall be in milli ampere D.C. proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.

11.2.4. The transducer characteristic shall be linear throughout the measuring range.

11.2.5. The transducer output shall be load independent.

11.2.6. The input & output of the transducer shall be galvanically isolated.

11.2.7. Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs.

11.2.8. The transducers shall be suitably protected against transient high peaks of voltage & current.

11.2.9. The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.

11.2.10. All the transducers shall have an output of 4-20 mA.

11.2.11. The response time of the transducers shall be less than 1 second.

11.2.12. The **accuracy class** of transducers shall be 0.2.

11.2.13. The transducers shall have a low AC ripple on output less than 1%.

11.2.14. The transducer shall have dual output.

12.0 ANNUNCIATION SYSTEM for Control Panel

12.1. Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification.

12.2. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.

12.3. The annunciation facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

12.4. Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity **(350 Lux)**, from the location of the operator's desk.

12.5. All Trip facia shall have **Red** colour and all Non-trip facia shall have **White** colour.

12.6. The audible alarm shall be provided by Buzzer/ Hooter /Bell having different sounds and shall be used as follows.

Hooter	Alarm Annunciation
Bell	Annunciation DC failure
Buzzer	AC supply failure

12.7 Sequence of operation of the annunciator shall be as follows :

Sl. NO.	Alarm	Condition Contact	Visual Annunciation	Audible Annunciation
	Normal	Open	Off	Off
	Abnormal	Close	Flashing	On
	Accept Push Button Pressed	Close Open	Steady On Steady On	Off Off
	Reset Push Button Pressed	Close Open	On Off	Off Off
	Lamp Test Push Button Pressed	Open	Steady On	Off

12.8. Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to annunciation system is restored.

12.9. A separate voltage check relay shall be provided to monitor the failure of supply (240V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds, this relay shall initiate visual and audible annunciation. Visual and audible annunciation for the failure of AC supply to the annunciation system shall be provided and this annunciation shall operate on Annunciation DC and buzzer shall sound.

12.10. The annunciation system described above shall meet the following additional requirements :

a) The annunciation system shall be capable of catering to at least 20 simultaneous signals at a time.

b) One set of the following push buttons shall be provided on each control panel:

- Reset push button for annunciation system
- Accept push button for annunciation system
- Lamp test push button for testing the facia windows

c) One set of the following items shall be provided common for all the control panel (not applicable for extension of substation) :

- Flasher relay for annunciation system
- Push button for Flasher test
- Three Push buttons for test of all audible alarm systems

d) These testing circuits shall be so connected that while testing is being done, it shall not prevent the registering of any new annunciation that may land during the test.

e) The annunciation shall be repetitive type and shall be capable of registering the fleeting signal. Minimum duration of the fleeting signal registered by the system shall be 15 milli seconds.

f) In case of static annunciator scheme, special precaution shall be taken to ensure that spurious alarm condition does not appear due to influence of external electromagnetic/ electrostatic interference on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels and the static annunciator shall meet the high voltage susceptibility test , impulse voltage with stand test , high frequency disturbance testï class III and fast transient disturbance test ï level III as per IEC 60255.

12.11. The annunciation system to be supplied for existing sub-stations shall be engineered as **an extension to the existing scheme**.

13.0 SWITCHES

13.1. Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

13.2 The selection of operating handles for the different types of switches shall be as follows :

Breaker,Isolator control switches	Pistol grip, black
Synchronising switches	Oval,Black, Keyed handle(one common removable handle for a group of switches or locking facility having common key).
synchronising Selector switches switches	Oval or knob, black Instrument Round, knurled, black
Protection Transfer switch	Pistol grip, lockable and black.

13.3. The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively.

13.4.

13.6. Lockable type of switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

13.7. The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts

13.8. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

a. The contact rating of the switches shall be as follows :

Description	**Contact Rating in Amps**	
	24V/220 V DC	**240V AC**
Make and carry Continuously	**10**	**10**
Make and carry	**30**	**30 for 0.5 sec.**
Break for Resistive load	**20**	**7**
Break for Inductive load with L/R = 40m sec.	-	-

14.0 INDICATING LAMPS

14.1. Indicating lamps shall be of cluster LED type suitable for panel mounting with rear terminal connections. Lamps shall be provided with series connected resistors preferably built in the lamp assembly. Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified. The lamp cover shall be preferably of screwed type, unbreakable and moulded from heat resisting material.

14.2. The lamps shall be provided with suitable resistors.

14.3. Lamps and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of the supply.

14.4. The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

Lamps shall have translucent lamp covers to difuse lights coloured red, green, amber, clear white or blue as specified as per the following:

	Function	Quantity	Colour of lens
1.	Circuit Breaker spring charged/normal pressure indication.	1 No.	Blue
2.	Circuit Breaker trip circuit healthy indication.	2 Nos.	White
3.	Circuit Breaker Low Air Pressure indication	1 No.(where necessary	White
4.	Incoming D.C. fail indication.	2 Nos.	White
(i)	A. C. fail indication.	1 No.	White
6.	P. T. supply indication.	3 Nos.(where necessary)	Red/Yellow/ Blue.
7.	Indication lamps for CB closing ,opening Isolator closing and opening		Red and Green
i)	Auto trip	1 No.	Amber
ii)	Protection on Transfer Mode	1 No.	White
iii)	CB on Local/Remote	2 Nos	White

15.0 POSITION INDICATORS (if Applicable)

15.1. Position indicators of "SEMAPHORE" type shall be provided when specified as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear.Their strips shall be of the same colour as the associated mimic.

15.2. Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus bars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure.

15.3. The rating of the indicator shall not exceed 2.5 W.

15.4. The position indicators shall withstand 120% of rated voltage on a continuous basis.

16.0 RELAYS

16.1. All relays shall conform to the requirements of IS: 3231/IEC-60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

16.2. All protective relays shall be of numerical type and communication protocol shall be as per IEC 61850. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these relays.

16.3. All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.

16.4. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for **1 amp CT secondary**. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

16.5. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

16.6. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.

16.7. No control relay, which shall trip the power circuit breaker when the relay is de-energised, shall be employed in the circuits.

16.8. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

16.9. Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:

(a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

(b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.

(c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.

(d) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s),but also the relevant initiation signals to other scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.

(e) Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).

(f) For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal- in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.

(g) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).

16.10. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

16.11. Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the OPTCL.

16.12. All relays and their drawings shall have phase indications as R-Red, Y- yellow, B-blue.

16.13. For **numerical relays**, the scope shall include the following:

a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.

b) The relay shall have suitable communication facility for SCADA connectivity. The relay shall be capable of supporting IEC 61850 protocol.

c) The features like fault recorder and event logging function in the relays shall be supplied.

17.0. For 33 KV (Line)

	Back up: Numerical Directional & Non-directional(site selectable) Over Current and Earth fault Protection. The detailed description of line protections is given here under.
(a)	shall have continuous self monitoring and diagnostic feature. include a directional back up Inverse Definite Minimum Time (IDMT) earth fault relay with normal inverse characteristics as per IEC 60255-3 as a built in feature

18.0. Numerical Back-up Directional Over Current and Earth fault protection scheme.

(a) shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s)

(b) shall include necessary VT fuse failure relays for alarm purposes

(c) **over current elements** shall

- have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
- have a variable setting range of 50-200% of rated current
- have a characteristic angle of 30/45 degree lead
- include hand reset flag indicators or LEDs

(d) **earth fault element** shall

- have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
- have a variable setting range of 20-80% of rated current
- have a characteristic angle of 45/60 degree lag
- include hand reset flag indicators or LEDs

- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay

(e) Shall have over & under voltage protection facility.

(f) Shall have facility for under frequency protection facility (minimum 03 stages)

(g) Shall have facility of LBB protection.

20.0 TRIPPING RELAY

High Speed Tripping Relay shall

(a) be instantaneous (operating time not to exceed 10 milli-seconds).

(b) reset within 20 milli seconds

(c) be D.C. operated

(d) have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.

(e) be provided with operation indicators for each element/coil.

21.0 DC/AC SUPPLY SUPERIVISION RELAY

(a) The relay shall be capable of monitoring the failure of **D.C./A.C** supply to which, it is connected.

(b) It shall have adequate potential free contacts to meet the scheme requirement.

(c) The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

22.0 TIME SYNCHRONISATION EQUPMENT

21.1. The Time synchronisation equipment shall receive the co-ordinated Universal Time (UTC) **transmitted** through Geo Positioning Satellite System (GPS) and synchronise equipments to the Indian Standard Time in a substation.

21.2. Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.

21.3. It shall be compatible for synchronisation of Event Loggers,

Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.

21.4. Equipment shall operate up to the ambient temperature of 50 degree centigrade and 80% humidity.

21.5. The synchronisation equipment shall have 2 micro-second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, &temperature variations, propagation & processing delays etc).

21.6. Equipment shall meet the requirement of IEC 60255 for storage &operatin.

21.7. The system shall be able to track the satellites to ensure no interruption of synchronisation signal.

21.8. The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.

21.9. The equipment offered shall have six (6) output ports. Vario us combinations of output ports shall be selected by the customer, during detailed engineering, from the following :

- Potential free contact (Minimum pulse duration of 50 milli Seconds.)
- IRIG-B
- RS232C
- SNTP Port

21.10. The equipment shall have a periodic time correction facility of one second periodicity.

21.11. Time synchronisation equipment shall be suitable to operate from 48 V DC as available at Substation.

21.12. Equipment shall have real time digital display in hour, minute, second (24 hour mode) & have a separate time display unit to be mounted on the top of control panels having display size of approx. 100 mm height.

23.1. The reports for following type tests shall be submitted during detailed engineering for the Protective relays.

a) Insulation tests as per IEC 60255-5

b) DC Voltage dips and interruptions/Variation as per IEC 6100-4-29.

c) High frequency disturbance test as per IEC 61000-4 16, Class IV (Not applicable for electromechanical relays)

d) Electrostatic discharges as per IEC 61000-4-2, level; 4 (not applicable for Electromechanical relays)

e) Fast transient test as per IEC 61000, Level I**V** (Not applicable for electromechanical relays)

f) Relay characteristics, performance and accuracy test as per IEC 60255

- Steady state Characteristics and operating time
- Dynamic Characteristics and operating time for distance protection relays and current differential protection relays
- Conformance test as per IEC 61850-10.

For Fault recorder, Disturbance recorder; only performance tests are intended under this item.

g) Tests for thermal and mechanical requirements as per IEC 60255-6 h) Tests for rated burden as per IEC 60255-6

i) Contact performance test as per IEC 60255-0-20 (not applicable for Distance to fault locator and Disturbance recorder)

In case there is a change either in version or in model (Except firmware) of the relay, the contractor has to submit the type test reports for the offered revision/model.

24.0 CONFIGURATION OF RELAY AND PROTECTION PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel. However, contractor can optimise the requirement of panels by suitably clubbing the feeder protection and CB relay panels.

CONTROL PANEL: Various types of control panels shall consist of the following

Sl No.	Description	Qty	Description
a.	Multifunction Metr	1	To monitor & display V,I,KW,KVA,KVAR,F,Cosϕ etc
b.	CB Control switch	1 No	for each Circuit breaker
c.	Isolator Control switch	1 No	for each isolator
d.	Semaphore Red indicating lamp	1 no. 1 no.	for each earth switch for each Circuit breaker

e.	Red indicating lamp	1 no.	for each isolator
f.	Green indicating lamp	1 no.	for each Circuit breaker
g.	Green indicating lamp	1 no.	for each isolator
h.	White indicating lamp (DC healthy lamp)	2 nos	for each feeder
i.	Annunciation windows with associated annunciation relays	18 nos	for each feeder
j.	Push button for alarm Accept/reset/lamp test	3 nos	for each control panel
k.	Synchronising Socket	1 no.	for each Circuit Breaker if required
l.	Synchronising selector Switch	1 no.	for each Circuit Breaker switch if required
m.	Protection Transfer Switch with indication lamp(for transfer position)	1 no.	for each breaker in case of DMT /DM*/SMT schemes (Except TBC and BC breaker) - * with by pass isolator
n.	Mimic to represent SLD	Lot	in all control panels
o.	Trip Circuit Healthy with push button	2 Nos	In all the control panel

3. The above list of equipments mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipments for matching the existing control panel shall be supplied.

(I) LINE PROTECTION PANEL

The Line Protection panel for transmission lines shall consist of following protection features/schemes

Sl No.	**Description**	**33 KV**
1	Numerical Directional & Non-directional (Site selectable) Back up Over current and E/F protection scheme with LBB protection Under frequency protection	1 Set
	Over Voltage & under voltage Protection Scheme	

	Fault Recorder	
	Disturbance Recorder*	
	LBB protection	
2	3 Phase Trip Relays	1 Nos
3	Flag relays, carrier receive relays, aux. Relays, timers etc as per scheme requirements	As required
4	Any other Auxiliary relays for AC /DC supervision and etc as per scheme.	As required

25.0 ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule

26.0 TROPICALISATION

Control room will be normally air- conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

**** ALL THE RELAYS SHALL BE OF NUMERICAL VERSION HAVING IEC 61850 PROTOCOL COMPLIANCE.ALL CARE SHALL BE TAKEN IN DESIGNING THE PROTECTION SYSTEM FOR SCADA PROVISION. THERE SHALL BE ADEQUATE NO OF INPUT AND OUT PUT CONTACTS FOR USE. SHALL HAVE SELF SUPERVISING AND INTERNAL FAULT DETECTING/DIAGNOSING FACILTY. SUFFICIENT FAULT /DISTURBANCE RECORDING FACILITIES.**

TECHNICAL SPECIFICATION

FOR

CONTROL & XLPE CABLES

TABLE OF CONTENTS

OF

CONTROL & XLPE CABLES

TECHNICAL SPECIFICATION FOR CONTROL CABLES

1.0 SCOPE

This specification covers the manufacturing testing and performance requirements of control cables for installation on the Distribution System of OPTCL.

The material offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. Tthe Type Test reports shall be submitted along with the bid.

The control cables shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the Engg In charge shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith.

2.0 STANDARDS

Except where modified by this specification, the control cables shall be designed, manufactured and tested in accordance with the latest editions of the following standards.

IEC / ISO	Indian Standard	Title
IEC 811	IS-18-10810:1982	Testing cables
IEC 502	IS-7098:1985 (part 2)	LT and 3.3 - 33kVXLPE cables
IEC 502	IS - 1554:1988 (part 1)	PVC Cables .65/1.lkV
IEC 227	IS - 5819:1970	Short circuit ratings for PVC cables
IEC 228	15-8130:1984	Conductors for insulated cables
IEC 502	IS - 6474: 1984	XLPE Cables
IEC 502		Extruded solid dielectric insulated power cables for rated voltages from 1.1kV to 30kV
IEC 540	IS - 5831: 1984	Test Methods for insulation and sheaths of electric cables and cords
IEC 287		Calculation of the continuous current rating of cables.
IS - 3975: 1979		Mild steel wires, strips and tapes for armouring of cables

The Bidder may propose alternative standards, provided it is demonstrated that they give a degree of quality and performance equivalent to or better than the referenced standards. Acceptability of any alternative standard is at the discretion of the Project Manager. The Bidder shall furnish a copy of the alternative standard proposed along with his bid. If the alternative standard is in a language other than English, an English translation shall be submitted with the standard. In the case of conflict the order of precedence shall be 1) IEC or ISO Standards, 2) Indian Standards, 3) other alternative standards.

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this Specification does not relieve the Contractor of the necessity of providing the goods complying with other relevant standards or recommendations.

3.0 TECHNICAL DETAILS

All control cables to be used in the OPTCL distribution system shall be of the polyvinyl chloride (PVC) insulated with PVC sheathing types.

3.1 1.1KV POLYVINYL CHLORIDE (PVC) INSULATED CABLES

3.2 RATED VOLTAGE AND TEMPERATURE

Control and Panel Wiring Cables (PVC insulated)

The conductor shall be of round stranded plain copper wires complying with IS - 8130:1984/ IEC 228.

The conductors shall be of Flexibility Class 2 as per IS - 8130: 1984.

Conductor screening not required

3.3 Insulation

The insulation shall be of Polyvinyl Chloride (PVC) compound. 'Heat Resisting' Type C for the Control and Panel Wiring cables. Both shall conform to the requirements of IS - 5831: 1984.

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
General Purpose	70°C	160°C
Heat Resisting	85°C	160°C

The PVC insulation shall be applied by extrusion and the average thickness of insulation shall not be less than the specified nominal value and the maximum value not more than 0.1 mm plus 0.1 of nominal and as specified in IS ï 1554 (part 1): 1988.

The insulation shall be applied so that it fits closely on to the conductor and it shall be possible to remove it without damage to the conductor.

Insulation Screening not required

Core Identification and Laying up of Cores

In multi-core cables, the cores shall be laid up together with a suitable lay as recommended in IS - 1554 (Part 1): 1988. The layers shall have successive right and left hand lays with the outermost layer having a right hand lay.

3.4 **Inner Sheath**

The laid up cables shall be covered with an inner sheath made of thermoplastic material (PVC) applied by extrusion.

The thickness of the sheath shall conform to IEC 502/IS - 1554: 1988. Single core cables shall have no inner sheath.

The outer serving shall incorporate an effective anti-termite barrier and shall be capable of withstanding a l0kV DC test voltage for five minutes after installation and annually thereafter.

Cables shall be installed as a single four core cable or three single phase cables plus neutral in a close trefoil formation.

Current ratings shall be calculated in accordance with IEC 287 "Calculation of the continuous current rating of cables with 100% load factor".

3.5 **Conductor Sizes**

The following shall be used for Control and Panel Wiring:

The No. of Cores & Sizes of the Control Cable shall be 3 Core, 4 Core, 5 Core, 10 Core and 12 Core etc. The size of each shall be done by 2.5^2 mm flexible Copper Wires. All panel wiring shall be done by 2.52 mm and 42mm (foe CT, PT, CVT, AC & DC Supply) flexible Copper Wires.

3.6 **Cable Drum Length**

The cable shall be supplied in 500metre lengths or more but with prior approval for the owner.

4.0 CABLE IDENTIFICATION

The manufacturer's and Employer's name or trade mark, the voltage grade, cable designation and year of manufacture shall be indented or embossed along the whole length of the cable. The indentation or embossing shall only do on the outer sheath. The alphanumerical character size shall be not less than 20% of the circumference of the cable and be legible.

5.0 SAMPLING OF CABLES

5.1 **Lot**

In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

5.2 **Scale of Sampling**

Samples shall be taken and tested from each lot to ascertain the conformity of the lot to specification.

5.3 **Sampling Rates**

The number of samples to be selected shall be as follows:

Number of drums in the Lot	Number of Drums to be taken as samples	Permissible number of defective drums
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

The samples shall be taken at random. In order to achieve random selection the procedure for selection detailed in IS - 4905: 1968 shall be followed.

6.0 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

Suitable lengths of test samples shall be taken from each of the selected drums. These samples shall be subjected to each of the acceptance tests. A test sample shall be classed as defective if it fails any of the acceptance tests. If the number of defective samples is less than or equal to the corresponding number given in the lot shall be declared as conforming to the requirements of acceptance test.

7.0 TESTS ON 1.1 KV PVC INSULATED Control & Power Cable.

7.1 **Type Tests**

Certification of type tests already completed by independent test laboratories shall be presented with the bid for each cable type. These tests shall be carried out in accordance with the requirements of IS -8130: 1984/IEC 502, IS - 5831:1984/IEC 540 and IEC 811 unless otherwise specified. Type testing of 33kV, 11kV and 1.1 kV cables shall include the following:

Test	Requirement Reference	Test Method as a Part of IS-10810/IEC 811
(a) Tests on conductor		
Annealing test (copper)	IS-8130: 1984/IEC 502	
Tensile test (aluminium)	IS-8130: 1984/IEC 502	
Wrapping test (aluminium)	IS-8130: 1984/IEC 502	
Resistance test	IS-8130: 1984/IEC 502	
(b) Tests for Armour wires/strips	IS - 3975: 1979/IEC 502	
(c) Tests for thickness of insulation and sheath	IS-5831:1984/IEC 540	
(d) Physical tests for Insulation		
Tensile strength and elongation at break	IS-5831:1984/IEC 540	
Ageing in air oven	IS-5831:1984/IEC 540	
Hot test	IS-5831:1984/IEC 540	
Shrinkage test	IS-5831:1984/IEC 540	
Water absorption (gravimatic)	IS-5831:1984/IEC 540	
(e) Physical tests for outer sheath		
Tensile strength and elongation at break	IS-5831: 1984/IEC 540	
Ageing in air oven	IS-5 831: 1984/IEC 540	
Shrinkage test	IS-5831: 1984/IEC 540	
Hot deformation	IS-5831: 1984/IEC 540	
Loss of mass in air oven	IS-5831: 1984/IEC540	
Heat shock	IS-5831: 1984/IEC540	
Thermal stability	IS-5831: 1984/IEC540	IS-5831: 1984
(f) Partial discharge test (11 and 33kV only)	Section 13.2 of this specification	
(g) Bending test (11 and 33kV only)	Section 13.2 of this specification	
(h) Dielectric power factor test (11 and 33kV only)	Section 13. 4 of this specification	
As a function of voltage		
As a function of temperature		
(j) Insulation resistance test	IS-8130: 1984/IEC502	

(Volume resistivity)

(k) Heating cycle test — Section 13.5 of this specification
(11 and 33kV only)

(l) Impulse withstand test — Section 13.6 of this specification
(11 and 33kV only)

(m) High voltage test — Section 13.7 of this specification

(n) Flammability test — Section 13.8 of this specification

Tests (g), (h), (j), (l) and (m) are only applicable to screened cables.

7.2 **Acceptance Tests**

The following shall constitute acceptance tests:

- Tensile test (aluminium)
- Annealing test (copper)
- Wrapping test
- Conductor resistance test
- Test for thickness of insulation and sheath
- Hot set test for insulation*
- Tensile strength and elongation at break test for insulation and outer sheath
- Partial discharge test (for screened cables only)**
- High voltage test
- Insulation resistance (volume resistivity) test.
- PVC insulation only

** test to be completed on full drum of cable

7.3 **Routine Tests**

Routine tests shall be carried out on all of the cable on a particular order. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502 and IS - 5831:1984/IEC 540 unless otherwise specified.

The following shall constitute routine tests.

- Conductor resistance test
- Partial discharge test (for 11 kV and 33kV screened cables only)*
- High voltage test

* Test to be completed on full drum of cable

7.4 **Optional Test**

Cold impact test for outer sheath (IS - 5831 - 1984), which shall be completed at the discretion of the Project Manager and at the same time as test at low temperature for PVC as stipulated in the section on special tests.

7.5 **Special tests**

Special tests shall be carried out at the Project Manager's discretion on a number of cable samples selected by the Project Manager from the contract consignment. The test shall be carried out on 10% of the production lengths of a production batch of the same cable type, but at least one production length. Special tests shall be carried out in accordance with the requirements of IEC 502 and IEC 540 unless otherwise specified.

The following special tests shall be included:

- Conductor Examination (IEC-228)
- Check of Dimensions
- Test at low temperature for PVC

8.0 DETAILS OF TESTS

8.1 **General**

Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS -10810/IEC 502: 1994 and the additional requirements as detailed in this specification.

8.2 **Partial Discharge Test**

Partial discharge tests shall only be made on cables insulated with XLPE of rated voltages above 1.9/3.3kV.

For multicore cables, the test shall be carried out on all insulated cores, the voltage being applied between each conductor and the metallic screen.

8.3 **Bending Test**

The diameter of the test cylinder shall be 20 (d +D) ± 5% for single core cables and 15 (d+D) ± 5% for multicores, where D is the overall diameter of the completed cable in millimeters and d is the diameter of the conductor. After completing the bending operations, the test samples shall be subjected to partial discharge measurements in accordance with the requirements of this specification.

8.4 **Dielectric Power Factor Test**

Tan δ as a Function of Voltage

For cables of rated voltage 1.1 kV and above

The measured value of tan ŭ at up shall not exceed 0.004 and the increment of tan ŭ between 0.5 up and 2 up shall not be more than 0.002.

8.5 **Heating Cycle Test**

The sample which has been subjected to previous tests shall be laid out on the floor of the test room and subjected to heating cycles by passing alternating current through the conductor until the conductor reaches a steady temperature 10°C above the maximum rated temperature of the insulation in normal operation. After the third cycle the sample shall subjected to a dielectric power factor as a function of voltage and partial discharge test.

8.6 **High Voltage Test**

I. Type/ Acceptance Test

The cable shall withstand, without breakdown, at ambient temperature, an ac voltage equal to 3Uo, when applied to the sample between the conductor and screen/ armour (and between conductors in the case of unscreened cable). The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

If while testing, interruption occurs during the 4 hour period the test shall be prolonged by the same extent. If the interruption period exceeds 30 minutes the test shall be repeated.

II. Routine Test

Single core screened cables, shall withstand, without any failure, the test voltages given in this specification for a period of five minutes between the conductor and metallic screen.
Single core unscreened cables shall be immersed in water at room temperature for one hour and the test voltage then applied for 5 minutes between the conductor and water.

Multicore cables with individually screened cores, the test voltage shall be applied for 5 minutes between each conductor and the metallic screen or covering.

Multicore cables without individually screened cores, the test voltage shall be applied for 5 minutes in succession between each insulated conductor and all the other conductors and metallic coverings, if any.

When a DC voltage is used, the applied voltage shall be 2.4 times the power frequency test voltage. In all instances no breakdown of the insulation shall occur.

8.7 **Flammability Test**

The period for which the cable shall burn after the removal of the flame shall not exceed 60 seconds and the unaffected portion (uncharged) from the lower edge of the top clamp shall be at least 50mm.

9.0 CONTROL / LV WIRING ACCESSORIES

9.1 **Terminations**

Control wire terminations shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire termination. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule. Numbers 6 and 9 shall not be included for ferrules purposes except where underlined and identified as 6 and 9.

LVAC cable terminals shall be provided with adequate size crimp type lugs. The lugs shall be applied with the correct tool, which shall be regularly checked for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the contractor at every cable entry to mechanism boxes, cabinets and kiosks. The Contractor shall be responsible for drilling the cable gland plate to the required size.

PART 3:

10.0 GENERAL PARTICULARS AND GUARANTEES

10.1 **COMPLIANCE WITH SPECIFICATION**

The control cables shall comply in all respects with the requirements of this specification. However, any minor departure from the provisions of the specification shall be disclosed at the time of bidding in the Non Compliance Schedule in this document.

The mass and dimensions of any item of equipment shall not exceed the figures stated in the schedules.

10.2 **COMPLIANCE WITH REGULATIONS**

All the equipment shall comply in all respects with the Indian Regulations and Acts in force.

The equipment and connections shall be designed and arranged to minimize the risk of fire and any damage which might be caused in the event of fire.

10.3 **Non-conforming product**

The Project Manager shall retain responsibility for decisions regarding acceptance, modification or rejection of non-conforming items.

10.3 **Sub-contractors**

The Contractor shall ensure that the Quality Assurance requirements of this specification are followed by any sub-contractors appointed by him under the Contract.

The Contractor shall assess the sub-contractor's Quality Assurance arrangements prior to his appointment to ensure compliance with the appropriate ISO 9000 standard and the specification.

Auditing of the sub-contractor's Quality Assurance arrangements shall be carried out by the Contractor and recorded in such a manner that demonstrates to the Project Manager the extent of the audits and their effectiveness.

10.4 **Inspection and testing**

The authorized representative of OPTCL shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Project Manager without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification.
The equipment shall successfully pass all the type tests, acceptance tests and routine tests referred to in the section on Tests and those listed in the most recent edition of the standards given in this specification.

The Project Manager reserves the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.

Type tests shall be carried out at an independent testing laboratory or be witnessed by a representative of such laboratory or some other representative acceptable to the Project Manager. Routine and acceptance tests shall be carried out by the Contractor at no extra charge at the manufacturer's works.

Type Test certificates shall be submitted with the bid for evaluation. The requirement for additional type tests will be at the discretion of the Project Manager.

The Project Manager may witness routine, acceptance and type tests. In order to facilitate this, the Contractor shall give the Project Manager a minimum of four weeks notice that the material is ready for testing. If the Project Manager does not indicate his intention to participate in the testing, the manufacturer may proceed with the tests and shall furnish the results thereof to the Project Manager.

Full details of the proposed methods of testing, including connection diagrams, shall be submitted to the Project Manager by the Contractor for approval, at least one month before testing.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Contractor, who shall provide the Project Manager with all the test facilities which the latter may require, free of charge. The Project Manager shall have the right to select the samples for test and shall also have the right to assure that the testing apparatus is correct. Measuring apparatus for routine tests shall be calibrated at the expense of the Contractor at an approved laboratory and shall be approved by the Project Manager.

The Contractor shall be responsible for the proper testing of the materials supplied by sub-contractors to the same extent as if the materials were completed or supplied by the Contractor.

Any cost incurred by the Project Manager in connection with inspection and re-testing as a result of failure of the equipment under test or damage during transport or off-loading shall be to the account of the Contractor.

The Contractor shall submit to the Project Manager five signed copies of the test certificates, giving the results of the tests as required. No materials shall be dispatched until the test certificates have been received by the Project Manager and the Contractor has been informed that they are acceptable.

The test certificates must show the actual values obtained from the tests, in the units used in this specification, and not merely confirm that the requirements have been met.

In the case of components for which specific type tests or routine tests are not given in this specification, the Contractor shall include a list of the tests normally required for these components. All materials used in the Contract shall withstand and shall be certified to have satisfactorily passed such tests.

No inspection or lack of inspection or passing by the Project Manager's Representative of equipment or materials whether supplied by the Contractor

or sub-contractor, shall relieve the Contractor from his liability to complete the contract works in accordance with the contract or exonerate him from any of his guarantees.

10.5 **Guarantee**

The Contractor shall guarantee the following:

- Quality and strength of materials used;
- Satisfactory operation during the guarantee period of one year from the date of commissioning, or 18 months from the date of acceptance of the equipment by the Project Manager following delivery, whichever is the earlier.
- Performance figures as supplied by the Bidder in the schedule of guaranteed particulars.

10.6 **PROGRESS REPORTING**

The Contractor shall submit for approval within two weeks of the starting date of the contract, an outline of production, inspection, delivery (and installation) in a chart form. Within a further period of two weeks, the Contractor shall provide a detailed programme of the same information in a form to be agreed by the Project Manager. The design aspect of the progress report shall include a comprehensive statement on drawings, calculations and type test reports submitted for approval.

The position on material procurement shall give the dates and details of orders placed and indicate the delivery dates quoted by the manufacturer. If any delivery date has an adverse effect on the contract programme, the Contractor shall state the remedial action taken to ensure that delays do not occur.

The position on manufacture shall indicate the arrival of raw material and the progress of manufacture. Any events that may adversely affect completion in the manufacturer's works shall also be reported.

All works tests done shall be listed and test results shall be remarked upon. Any test failure shall be highlighted.

The dispatch of each order shall be monitored on the progress report giving the date by which the equipment will be available for transport, the estimated time of arrival on site and the dates actually achieved.

Delays or test failures in any part of the programme which may affect any milestone or final completion dates shall be detailed by the Contractor who shall state the action taken to effect contract completion in accordance with the contract programme.

11.0 SPARE PARTS AND SPECIAL TOOLS

The Contractor shall provide prices for spare conductor, joints and termination equipment.

The Project Manager may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Project Manager may order additional spares at any time during the contract period at the rates stated in the Contract Document.

A spare parts catalogue with price list shall be provided for the various cables, joints and termination equipment and this shall form part of the drawings and literature to be supplied.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the equipment and must be suitably marked and numbered for identification.

Spare parts shall be delivered suitably packed and treated for long periods in storage. Each pack shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts list in the installation and maintenance instructions.

12.0 PACKING AND SHIPPING

12.1 Packing

The cable shall be wound on strong drums or reels capable of withstanding all normal transportation and handling.

Each length of cable shall be durably sealed before shipment to prevent ingress of moisture. The drums, reels or coils shall be lagged or covered with suitable material to provide physical protection for the cable during transit and during storage and handling operations.

In the case of steel drums adequate precautions shall be taken to prevent damage being caused by direct contact between the cable sheath and the steel. These precautions shall be subject to the approval of the Project Manager.

If wooden drums are used then the wood shall be treated to prevent deterioration from attack by termites and fungi.

Each drum or reel shall carry or be marked with the following information:

Ålndividual serial number

ÅEmployer's name
ÅDestination
ÅContract Number
ÅManufacturer's Name
ÅYear of Manufacture
ÅCable Size and Type
ÅLength of Conductor (meters)
ÅNet and Gross Mass of Conductor (kg)
ÅAll necessary slinging and stacking instructions.
ÅDestination;
ÅContractor's name;
ÅName and address of Contractor's agent in Orissa;
ÅCountry of origin;

The direction of rolling as indicated by an arrow shall be marked on a flange.

12.2 **Storage**

The site selected for the storage of cable drums shall be well drained and preferably have a concrete/firm surface which will prevent the drums sinking into the ground or being subjected to excess water thus causing flange rot.

All drums shall be stood on battens, in the upright position, and in such a manner to allow sufficient space between them for adequate air circulation. During storage the drums shall be rotated 90° every three months. In no instances shall the drums be stored "flat" on their flanges or one on top of each other.

12.3 **Shipping**

The Contractor shall be responsible for the shipping of all cables, drums and reels supplied from abroad to the ports of entry and for the transport of all goods to the various specified destinations including customs clearance, offloading, warehousing and insurance.

The Contractor shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport shall conform to these limitations. The Contractor shall also be responsible for verifying the access facilities specified.

The Contractor shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Contractor shall immediately report

to the Project Manager any claims made against the Contractor arising out of alleged damage to a highway or bridge.

All items of equipment shall be securely clamped against movement to ensure safe transit from the manufacturer's facilities to the specified destinations (work sites.)

The Contractor shall advise the storage requirements for any plant and equipment that may be delivered to the Project Manager's stores. The Contractor shall be required to accept responsibility for the advice given in so far as these arrangements may have a bearing on the behaviour of the equipment in subsequent service.

12.4 **Hazardous substances**

The Contractor shall submit safety data sheets in a form to be agreed for all hazardous substances used with the equipment. The Contractor shall give an assurance that there are no other substances classified as hazardous in the equipment supplied. The Contractor shall accept responsibility for the disposal of such hazardous substances, should any be found.

The Contractor shall be responsible for any injuries resulting from hazardous substances due to noncompliance with these requirements.

TECHNICAL SPECIFICATION

FOR

33KV & 11 KV XLPE CABLES

TECHNICAL SPECIFICATION OF 33KV & 11 KV XLPE CABLES

1.0. SCOPE

1.1. It covers manufacture, testing, supply and commissioning of different voltage grade (36kV / 12kV) of 1 or 3 core. Aluminium Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed, armoured, screened Power Cables. .

1.2 **STANDARDS**

Sl. No.	ISS No.	Description
1	7098 (Part II) latest	Specification for cross-linked polyethylene Insulated PVC Sheathed cables for working Voltage of 11kV and 33 kV.
2	8130 ï 1984 latest	Specification for Conductors for insulated electric cables and flexible cords.
3	5830 ï 1984 latest	PVC insulation & sheath of electric cables.
4	3975 ï 1979 latest	Armour for cables
5	10810 ï 1984 latest	Methods for test for cables.
6	10418 ï 1982 latest	Cable Drum for Electric Cables.

1.3 The cable joints, outdoor and indoor termination and their accessories and fittings shall conform to the relevant latest Indian standards in their offers.

2.0 ELECTRICAL CHARACTERISTICS & PERFORMANCE:-

2.1. Description of Cable

a) 33 kV Grade : Standard compacted circular Aluminum (H4 Grade) Conductor, FRLS type, 3-core / 1-core shielded with black extruded semi-conducting compound XLPE insulated, core shielded with black extruded semi conducting compound, black semi-conducting tape and a copper tape, single layer G.I. flat strip armoured and black extruded PVC (Type: ST-2), overall sheathed, conforming generally to IS:7098 (Part ï II).

b) 11 KV Grade 3-cores / 1-core: Same as above but insulation shielding with black semi-conducting tape not necessary. Inner sheath to be wrapped not extruded and strip armoured. The design shall fully conform to IS:7098 (Part ï II)

Sl. No.	Required details	33kV	11kV
1	Size of cable	400/ 300 mm^2	(In BOQ 630mm2 taken) 400/ 300/ 185 mm^2
2	Voltage grade	33 KV	11 KV
3	Maxm. Conductor Temp	90^0 C at maximum continuous current	
4	Short Circuit Current	28.2 kA for 1sec for 300 mm^2 and 37.6 kA for 1 sec for 400 mm^2	
5	Maxm. Permissible emergency overlo temp. at 25% overload to 100 hrs. per year 500 hrs. in life of cable	130^0 C for 1 hour.	
6	Maxm. Permissible short circuit temperature	250^0 C for 1 hour	
	Conductor Material	Material to IS: 8130, H4 Grade Aluminium Conductor, Stranded compacted Circular	
	Conductor Screening	Extruded, cross-linked, sem conducting compound of 1.(mm thickness	Extruded, cross-linked, semi conducting compound of 0.5 m thickness
	Insulation	XLPE of thickness 8.8mm (Nominal)	XLPE of thickness 3.6mm (Nominal)
	Insulation screening	Combination of black extrude semi-conducting tape as the non-metallic part and annealed copper 0.06mm (minimum) thick tape lappir as metallic part for 1 core cable, the non-magnetic metal Armour will act as metallic part insulation screening	It is same but semi-conductin tape is not required.
	Inner Sheathing	Black extruded PVC, Type ST-2 compound	wrapped PVC tape as per IS For 1 core there will be no inner sheath
	Armouring	Single layer of round galvanized steel wires/strip	galvanized steel strips/wire (core) as per IS
	Overall Sheathing	Coloured PVC, type ST-2 compound to IS: 5831, extrude for both 33KV and 11KV thickness shall be as per ISS	
	Approx. length	: 500/ 250 metres with a tolerance of ± 5% cable in a Drum	
	End Sealing (Heat Shrinkable)	H.S. Caps	
	Max Tan-delta at room temp. at nomir phase to neutral voltage (U_0)	0.004	
	Max increment of Tan-delta between 0.5 to 2 U_0 at room temp	0.002	
	Partial discharge value :	20 Pc (Maxm.) at 1.6 Uo.	
	. Impulse Tests :	170 KV for 33 KV and as per ISS for 11 KV	

	H.V. Tests between Conductors& Screen/Armour :	48 KV (rms) for 33 KV for 5 minutes and as per ISS for 11 KV
	Maxm. D.C. Resistance per Km :	As per relevant I.S.S

*** NB the above parameters are applicable for three core and single core cable, if not otherwise specific.**

3.0. CABLE CONSTRUCTION:

3.1. XLPE underground cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere with use of suitable materials for XLPE semi-conducting, insulation and XLPE screen. The inner and outer semi-conducting sheaths and main polyethylene insulation between the sheaths are to be simultaneously extruded during the Triple Extrusion Process of manufacturing and main insulation of the Cable is to be extruded unified. The XLPE Cables in this specification does not have any metal sheath and the short circuit rating of the cable will depend on the conductivity and continuity of the strands of the armour wires, which shall be ensured by guarding against corrosion.

3.2. **CONDUCTOR SCREENING**.

A semi-conducting cross-linked polyethylene (XLPE) screening shall be extruded over the conductor to act as an electrical shield which together with elimination of the so called ñStrand Effectò prevents to great extent air ionization on the surface of the conductor

3.3. **INSULATION**

The main insulation of the Cable shall be extruded unfilled, chemically cross-linked polyethylene (XLPE) inert gas cured satisfying the requirement of ISS: 7098 (Part- II)

3.4. **INSULATING SCREEN:**

3.5. The screen shall be made up as indicated. The metal screen eliminates tangential stress electrostatic field surrounding the conductor and uniform electrical stress in the insulation.

The semi conducting polyethylene (XLPE) screen shall be extruded over the main poly ethylene- insulating wall to prevent partial discharge at the surface of the insulation. The copper tape shall be wrapped over the semi conducting tape or extrusion as mentioned earlier for 3-core / 1-core cables. The metal screen so formed around the cores shall be in

contact with one another as the cores are laid up at triangular configuration. For single core cable, Aluminium wires armoring shall constitute the metallic part of insulation screen. Conductor screening, insulation and insulation screening shall be extruded in triple extrusion processes so as to obtain continuously smooth interfaces.

3.6. The mechanical and chemical properties of the materials for semi conducting screens are much more important than their electrical properties, but for obtaining the high overall degree of electrical properties of an E.H.V. cable, the inner and outer semi conducting, sheaths and the main polyethylene insulation between the sheaths shall be simultaneously extruded during the manufacturing, process known as **"triple extrusion".** The advantages are

i) The partial discharge level at the surface of the insulation is brought to a minimum.

ii) There will be no displacement of the semi conducting screen and insulation during expansion and contraction due to load cycles and bending.

iii) The semi conducting screens are easily removable during joining and termination operations.

Note: Cable manufactured without having "triple extrusion" process will not be considered / accepted. The Contractor shall have to produce necessary documents in respect of process line.

4.0. ARMOUR

The for 3-core / 1-core cable shall be armoured with steel strip in case of 33KV and 11 KV to insure an adequate return path for the flow of fault current and also to provide suitable mechanical protection. Steel wires/aluminum wire / steel strips of required size in requisite number as per clause shall be laid closely in the spiral formation to protect the circumference of the cable fully and to provide adequate cross section area for flow of maximum fault current within limits of specified temperature rise and duration of fault. Direction of the lay of the armour shall be opposite to that of the cable cores in case of single core cable armour should be of magnetic material.

5.0. OUTER SHEATH

A reliable surving shall be necessary for maintaining conductivity of the armour particularly under corrosive condition in the form of jacket. Cable shall be therefore finished with extruded PVC over sheath of thickness as indicated.

The quality of PVC over sheath (jacket) shall be ensured for service reliability against moisture intrusion and shall confirm to type ST-2 of IS : 5831.

The colour of the outer sheath shall be follows:

For 33 KV cable : GREEN

For 11 KV cable : Blue

The sheaths shall be protected against white ants, vermin and termites by suitable, durable and reliable measures.

The suppliers shall suggest suitable materials for use, in the event of damage to the over sheath to prevent the passage of moisture along the cable

6.0. CABLE IDENTIFICATION:

The following shall be embossed on the outer sheath for the identification.

a) Manufacturerôs Name or Trade Mark.
b) Voltage Grade.
c) Nominal section and material of conductors and number of cores.
d) Year of manufacture.
e) Inscription of length of cables at 1.0 mtr interval.
f) Marking ñPowerò shall be embossed throughout the length of the cable at 10 mtr spacing.
h) Type of insulation i.e. XLPE

7.0. CEILING OF CABLE ENDS

The cable ends of the cable in the cable drum for delivery shall be sealed with heat shrinkable caps.

8.0. Tests to be performed as per IS: 7098 (part II)

8.1. Type test all the test mentioned below are to be made as per details given in IS: 10810

Sl. No.	Details of Tests
a)	**Test on conductor** i) Tensile test (For aluminum) ii) Wrapping test for aluminum iii) Resistance test.
b)	**Test for armoring wire strips**
c)	**Test for thickness of insulation and sheath**
d)	**Physical test for insulation** i) Tensile strength and elongation at break ii) Ageing in air oven iii) Hot test iv) Shrinkage test v) Water absorption (Gravimetric)
e)	**Physical tests for outer sheath** i) Tensile strength and elongation at break ii) Ageing in air oven iii) Shrinkage test iv) Hot deformation v) Heat shock vi) Loss of mass in air oven vii) Thermal stability
f)	**Partial discharge test**
g)	**Bending test**
h)	**Dielectric power factor test**
	i) As a function voltage ii) As a function of temperature
i)	Insulation resistance (volume resistivity) test
j)	Heating cycle test
k)	Impulse with stand test
l)	High voltage test
m)	Flammability test

8.2. The following test on screen cable shall be performed successfully on the same test sample of completed cable, not less than 10 m. in length between the test accessories.

a) PD test

b) Bending test followed by PD test

c) Di-electric power factor as function of voltage

d) Di-electric power factor as a function of temperature

e) Heating cycle test followed by Di-electric power factor as a function of voltage and PD test.

f) Impulse with stand test and

g) High voltage test as indicated

If a sample fails in test (g) one more sample shall be taken for this test, preceded by test (b) and (e).

8.3. **Acceptance test:** the following shall constitute acceptance test:

a) Tensile test (For aluminum)
b) Wrapping test for aluminum
c) Conductor resistance test
d) Test for thickness of insulation and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and outer sheath
g) PD test (Screen enables) only on full drum length
h) High voltage test, and
i) Insulation resistance (volume resistivity) test
j) Spark test on extruded un-insulated outer PVC sheath as per provision clause no 3.2 IEC standard (Publication no.229 of 1982.

8.4. **Routine test**:

The routine test shall be carried out on all cables manufacturer in accordance with this specification. The following routine test shall be made on cable length as specified in ISS.

a) Conductor resistance test
b) Partial discharge test on full drum length
c) High voltage test as indicated

8.5. **Test witness**

a) All tests shall be performed in presence of purchaser representatives if so desired by the purchaser.

b) The contractor shall give **at least 15 days advance** notice for

witnessing such tests.

8.6. **Test Certificate**

All test reports like routine & acceptance test reports are to be furnished for record & approval.

9.0. Descriptive literatures test results etc.

The following details for the cable shall be submitted with bid

a) Manufacturers catalogue giving cable construction details and characteristics

b) Manufacturing process for cable highlighting with the steps of control

i. Contamination

ii. Formation of water trees

i. Effects of byproducts of cross linking ii. Stress control etc.

c) Cross section drawing of the cable

d) Cable current ratings for different types of installation inclusive of derating factors due to ambient temperature, grouping etc.

e) Over-load characteristics of the cable without endangering the normal life and electrical quality of the insulation.

f) Complete technical data of the cables.

g) Type test certificate

h) The bidder to fillup the GTP in the table in E-21

TECHNICAL SPECIFICATION
FOR
“V” CROSS ARM, BACK CLAMP & F CLAMP

TABLE OF CONTENTS
OF
ñVòCROSS ARM, BACK CLAMP & F CLAMP

33 KV,11 KV “V” CROSS ARM, BACK CLAMP FOR “V”

CROSS ARM & POLE TOP BRACKET (F CLAMP)

TECHNICAL SPECIFICATIONS

1.0 Qualification Criteria of Manufacturer:-

The prospective bidder may source the above items from manufacturers who must qualify the following requirements:

The manufacturer should have supplied at least 1000 no.s (of each item) to electricity supply utilities / PSUs.

The bidder should enclose Performance Certificates from the above users issued in the name of the manufacturer as proof of successful operation in field.

a) Hot Dip Galvanised Cross arms and Pole Top Brackets for both 33 KV &11kV construction at intermediate and light angle pole shall be fabricated from grade 43A mild steel of channel section and for heavy angle poles, end poles and section poles fabricated from grade 43A mild steel of angle section. The grades of structural steel shall conform to IS ï 226: 1975.

b) The 33 KV & 11 KV óV ôCross arm shall be made out of 100x 50x5.6. mm MS Channel of (9.56 kg/mtr weight) .

The Back Clamp for both 33 KV & 11 KV shall be made out of 75 x 10 MS Flat and shall be suitably designed to fit PSC Pole 9 Mtr x 300 Kg , 8 Mtr x 200 Kg.and 9 mtrx415kg

c)The Pole Top Bracket (F Clamp) shall be made out of75 x 10 MS Flat suitably designed to fit PSC Pole 9 Mtr x 300 Kg ,10X Mtr x 425 Kg.& 9mtrx415 kg for both 33 KV & 11 KV.

Except where otherwise indicated all dimensions are subject to the following tolerances:

dimensions up to and including 50mm:+1mm: and dimensions greater than 50mm: +2%

All steel members and other parts of fabricated material as delivered shall be free of warps, local deformation, unauthorized splices, or unauthorized bends. Bending of flat strap shall be carried out cold. Straightening shall be carried out by pressure and not by hammering.

Straightness is of particular importance if the alignment of bolt holes along a member is referred to its edges.

Holes and other provisions for field assembly shall be properly marked and cross referenced. Where required, either by notations on the drawing or by the necessity of proper identification and fittings for field assembly, the connection shall be match marked. A tolerance of not more than 1mm shall be permitted in the distance between the center lines of bolt holes.

The holes may be either drilled or punched and, unless otherwise stated, shall be not more than 2mm greater in diameter than the bolts. When assembling the components force may be used to bring the bolt holes together (provided neither members nor holes are thereby distorted) but all force must be removed before the bolt is inserted. Otherwise strain shall be deemed to be present and the structure may be rejected even though it may be, in all other respects, in conformity with the specification.

The back of the inner angle irons of lap joints shall be chamfered and the ends of the members cut where necessary and such other measures taken as will ensure that all members can be bolted together without strain or distortion. In particular, steps shall be taken to relieve stress in cold worked steel so as to prevent the onset of embitterment during galvanizing.
Similar parts shall be interchangeable.

Shapes and plates shall be fabricated and assembled in the shop to the greatest extent practicable. Shearing flame cutting and chipping shall be done carefully, neatly and accurately. Holes shall be cut, drilled or punched at right angles to the surface and shall not be made or enlarged by burning. Holes shall be clean-cut without torn or ragged edges, and burrs resulting from drilling or reaming operations shall be removed with the proper tool.

Shapes and plates shall be fabricated to the tolerance that will permit field erection within tolerance, except as otherwise specified. All fabrication shall be carried out in a neat and workmanlike manner so as to facilitate cleaning, painting, galvanizing and inspection and to avoid areas in which water and other matter can lodge.

Contact surfaces at all connections shall be free of loose scale, dirt, burrs, oil and other foreign materials that might prevent solid seating of the parts.

2.0 Fabrication has to be made as per drg. Of ‘ V ‘ X-arm, Back clamp & ‘ F ‘ clamp.

GALVANISING

All type of cross arms back clamps, F clamps & stay clamps shall be hot dip galvanized, are as following:

All galvanizing shall be carried out by the hot dip process, in accordance with Specification IS 2629. However, high tensile steel nuts, bolts and spring washer shall be electro galvanized to Service Condition 4. The zinc coating (610 gms per sq.mt) shall be smooth, continuous and uniform. It shall be free from acid spot and shall not scale, blister or be removable by handling or packing.

There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before picking, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paints, varnish, oil, welding slag and other foreign matter completely removed.
All protuberances which would affect the life of galvanizing shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard IS 2629 and shall not less than 0.61kg/m² with a minimum thickness of 86 microns for items of thickness more than 5mm, 0.46kg/m² (64 microns) for items of thickness between 2mm and 5mm and 0.33kg/m² (47 microns) for items less than 2mm thick.

Parts shall not be galvanized if their shapes are such that the pickling solutions cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanized unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanizing the method used for repair shall be subject to the approval of the Engineer in Charge or that of his representative.
In no case the repair of galvanisation on site will be permitted.

The threads of all galvanized bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Engineer in Charge. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. To avoid the formation of white rust galvanized materials shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to test as per IS-2633.

3.0 33 KV & 11 KV V CROSS ARM

GURANTEED TECHNICAL PARTICULARS

(To be submitted along with offer)

Sl. No.	Description Unit		Bidder's offer	
			33 Kv	11 Kv
1	Type of crossarm			
2	Grade of steel			
3	Steel standard			
4	Fabrication Standard			
5	Dimensions	Mm		
6	Steel section utilized			
7	Steel tensile strength	N/cm^2		
8	Working load	Kg		
9	Details of galvanizing method utilized and standard/specification conforming to?			
10	Weight of cross arm	kg		
11	Whether drawing has been submitted with the bid			

4.0 POLE TOP BRACKETS (F CLAMP)

GURANTEED TECHNICAL PARTICULARS

(To be submitted along with offer)

Sl. No.	Description Unit		Bidder's offer	
			33 Kv	11 Kv
1	Type of crossarm			
2	Grade of steel			
3	Steel standard			
4	Fabrication Standard			
5	Dimensions	Mm		
6	Steel section utilized			
7	Steel tensile strength	N/cm^2		

8	Working load	Kg		
9	Details of galvanizing method utilized and standard/specification conforming to?			
10	Weight of cross arm	kg		
11	Whether drawing has been submitted with the bid			

5.0 BACK CLAMP FOR "V" CROSS ARM

GURANTEED TECHNICAL PARTICULARS

(To be submitted along with offer)

Sl. No.	**Description Unit**		**Bidder's offer**	
			33 Kv	**11 Kv**
1	Type of Clamp			
2	Grade of steel			
3	Steel standard			
4	Fabrication Standard			
5	Dimensions	Mm		
6	Steel section utilized			
7	Steel tensile strength	N/cm^2		
8	Working load	Kg		
9	Details of galvanizing method utilized and standard/specification conforming to?			
10	Weight of back clamp	kg		
11	Whether drawing has been submitted with the bid			

6.0 Fixing of Cross Arms

After the erection of supports and providing guys, the cross-arms are to be mounted on the support with necessary clamps, bolts and nuts. The practice of fixing the cross arms before the pole erection should be followed.

TECHNICAL SPECIFICATION

FOR

HT STAY SETS

TECHNICAL SPECIFICATION FOR HT STAY SETS

PART - A

1.0 Qualification Criteria of Manufacturer:-

The prospective bidder may source Stay Sets from manufacturers only must qualify all the following requirements :

a) Manufacturer must have successfully carried out Type Test of similar item from any NABL Accredited Laboratory within the last 5 years, prior to the date of submission of the bid.

b) The manufacturer should have supplied at least 1000 sets (both HT & LT taken together) to electricity supply utilities / PSUs. The bidder should enclose Performance Certificates from the above users issued in the name of the manufacturer as proof of successful operation in field.

2.0 SCOPE

This specification covers design, manufacture, testing and dispatch of LT Stay Sets of 16 mm and HT stay sets 20 mm dia**.**

3.0 GENERAL REQUIREMENTS

This stay sets (Line Guy set) will consist of the following components:-

3.1 Anchor Rod with one washer and Nut

Overall length of rod should be 1800 mm to be made out of 16 mm dia GI Rod, one end threaded up to 40 mm length with a pitch of 5 threads per cm and provided with one square GI washer of size 40X40x1.6mm and one GI hexagonal nut conforming to IS:1367:1967 & IS:1363:1967. Both washer and nut to suit threaded rod of 16 mm dia. The other end of the rod to be made into a round eye having an inner dia of 40mm with
best quality welding.

3.2 Anchor Plate Size 200 x 200 x6 mm

To be made out of GI plate of 6 mm thickness. The anchor plate should have at its centre 18 mm dia hole.

3.3 Turn Buckle & Eye Bolt with 2 Nuts

To be made of 16 mm dia GI Rod having an overall length of 450mm, one end of the rod to be threaded up to 300 mm length with a pitch of 5 threads per cm and provided with two GI Hexagonal nuts of suitable size conforming toIS:1363:1967 & IS:1367:1967. The other end of rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality welding.

3.4 Bow with Welded Angle

To be made out of 16mm dia GI rod. The finished bow shall have an over all length of 995 mm and eight of 450 mm, the apex or top of the bow shall be bent at an angle of 10 R. The other end shall be welded with proper and good quality welding to a GIangle 180 mm long having a dimension of 50x50x6mm. The angle shall have 3 holes of 18 mm dia each.

3.5 Thimble

To be made on 1.5 mm thick GIsheet into a size of 75x22x40mm and shape as per standard shall be supplied.

Average Weight of Finished 16mm Stay Sets shall be at least 7.702 KG (Minimum)

(Excluding Nuts Thimbles and Washer) 8.445 Kg. (Maximum)

3.6 20 mm Dia Stays Sets for 33 Kv,11 KV Lines (Galvanized) HT Stay Set

The Stay Set (Line Guy Set) will consist of the following components:

3.7 Anchor Rod with one Washer and Nut

Overall length of Rod should be 1800mm to be made out of 20 mm dia GI rod oneend threaded up to 40 mm length with a pitch of threads per cm. And provided with one square G.I Washer of Size 50x50x1.6mm and one GIHexagonal nut conforming to IS: 1363:1967 & IS:1367:1967. Both washer and nut to suit the threaded rod of 20mm.The other end of the rod to be made into a round eye having an inner dia of 40mm with best quality of welding. Dimensional and other details are indicated and submitted by bidders for owner's approval before start of manufacturing.

3.8 Anchor Plate Size 300 x 300 x 8 mm

To be made out of G.S. Plate of 8 mm thickness. The anchor plate to have at its centre 22mm dia hole.

3.9 Turn Buckle, Eye Bolt with 2 Nuts.

To be made of 20 mm dia G.I Rod having an overall length of 450 mm. One end of the rod to be threaded up to 300 mm length with a pitch of 4 threads per cm. The 20 mm dia bolt so made shall be provided with two G.I Hexagonal nuts of suitable size conforming to IS: 1363:1967 & IS: 1367:1967.The other end of the rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality of welding. Welding details are to be indicated by the bidder separately for approval.

3.10 Bow with Welded Channel:

To be made out of 16mm diaG.IRod. The finished bow shall have and overall length of 995 mm ad height of 450 mm. The apex or top of the bow shall be

bent at an angle of 10R. he other end shall be welded with proper and good quality welding to a G.I Channel 200 mm long having a dimension of 100x50x4.7 mm. The Channel shall have 2 holes of 18 mm dia and 22 dia hole at its centre as per drawing No.3 enclosed herewith.

3.11 Thimble 2 Nos.

To be made of 1.5 mm thick G.Isheet into a size of 75x22x40mm and shape as per standard.

3.12 Galvanizing

The complete assembly shall be hot dip galvanized.

3.13 Welding

The minimum strength of welding provided on various components of 16mm and 20 mm dia stay sets shall be 3100 kg & 4900 kg respectively. Minimum 6mm filet weld or its equivalent weld area should be deposited in all positions of the job i.e. at any point of the weld length. The welding shall be conforming to relevant IS:823/1964 or its latest amendment.

3.14 Threading

The threads on the Anchor Rods, Eye Bolts and Nuts shall be as per specification IS; 4218:1967 (ISO Metric Screw Threads). The Nuts shall be conforming to the requirements of IS: 1367:1967 and have dimension as per IS 1363:1967. The mechanical property requirement of fasteners shall confirm to the properly clause 4.6 each for anchor rods and Eye bolt and property clause 4 for nuts as per IS: 1367:1967.
Average weight of finished 20 mm Stays Set: 14.523 Kg.(Min) (Excluding Nuts Thimble & Washer) :15.569 Kg.(Max.)

4.0 TESTS

The contractor shall be required to conduct testing of materials at Govt./Recognized testing laboratory during pre-dispatch inspection for Tensile Load of 3100 Kg/4900Kg. applied for one minute on the welding and maintained for one minute for 16 mm and 20mm dia stay sets respectively.

5.0. IDENTIFICATION MARK

All stay sets should carry the identification mark of the Purchaser (OWNER)applicable.

This should be engraved on the body of stay rods to ensure proper identification of the materials. The nuts should be of a size compatible with threaded portion of rods and there should be not play or slippage of nuts.

Welding wherever required should be perfect and should not give way after erection.

6.0

TOLERANCES

The tolerances for various components of the stay sets are indicated below subject to the condition that the average weight of finished stay sets of 16mm dia excluding nuts, thimbles and washers shall not be less than the weight specified above:-

A) **HT STAY SET**

GURANTEED TECHNICAL PARTICULARS

(To be submitted along with Offer)

Sl No.	**Item Description**	**Specified Parameters**				**Bidder's Offer**
		Section Tolerances	**Fabrication Tolerances**	**Material**		
1	Anchor Plate	8mm thick+2.5% - 5%	300x300mm+ 1%	hick GIPlate 8 mm thick	**HT Stay Set**	
2	Anchor Rod	20mm dia +3%- 2%	Length 1800mm +0.5% Round Eye 40mm inside dia + 3%. Threading 40mm +11%-5%	GIRound 20mm dai GIRound 20mm dia	**HT Stay Set**	
3	Turn Buckle Bow	16mm dia +5%- 3%	Length180m m +1% 50x50x6mm Channel length 200mm + 1%	GI Round 16mm dia. GI Angle G I Channel 100x50x4.7m m	**HT Stay Set**	
4	Eye Bolt Rod	20mm dia + 3% - 2%	Length450m m +1% Threading 300mm +1% Round Eye 40 mm inside dia +3%	a GIRound 20mm dia.	**t HT Stay Set**	

STAY WIRE (7/10 SWG)

TECHNICAL SPECIFICATIONS

PART - B

1.0 Qualification Criteria of Manufacturer:-

The prospective bidder may source Stay Wire from manufacturers only who must qualify all the following requirements :

a) The manufacturer must have successfully carried out Type Test of similar item from anyNABL Accredited Laboratory within the last 5 years, prior to the date of submission of the bid.

b) The manufacturer should have supplied at least 1000 Kg (all sizes taken together) to electricitysupply utilities / PSUs. The bidder should enclose Performance Certificates from the above users issued in the name of the manufacturer as proof of successful operation in field.

2.0 Application Standards

Except when they conflict with the specific requirements of this specification, the G.I Stay Stranded Wires shall comply with the specific requirements of IS: 2141-1979. IS: 4826-1979 & IS: 6594-1974 or the latest versions thereof.

3.0 Application and Sizes

The G.I. stranded wires covered in this Specification are intended for use on the overhead power line poles, distribution transformer structures etc.
The G.I stranded wires shall be of 7/10SWG (7/3.15 mm).

4.0 Materials

The wires shall be drawn from steel made by the open hearth basic oxygen or electric furnace process and of such quality that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall be of uniform quality and have the properties and characteristics as specified in this specification. The wires shall not contain sulphur and phosphorus exceeding 0.060% each.

5.0 Tensile Grade

The wires shall be of tensile grade 4, having minimum tensile strength of 700 N/mm^2 conforming to 1S:2141.

6.0 General Requirements

The outer wire of strands shall have a right-hand lay.
The lay length of wire strands shall be 12 to 18 times the strand diameter.

7.0 Minimum Breaking Load

The minimum breaking load of the wires before and after stranding shall be as follows:

No. of Wires & Const.	Wire Dia (mm)	Min. breaking load of the Single wire before stranding (KN)	Min. breaking load of the standard wire (KN)
7 (6/1)	2.5	3.44	21.40
7 (6/1)	3.15	5.46	34.00
7 (6/1)	4.0	8.80	54.9

8.0 Construction

The galvanized stay wire shall be of 7-wire construction. The wires shall be so stranded together that when an evenly distributed pull is applied at the ends of completed strand, each wire shall take an equal share of the pull. Joints are permitted in the individual wires during stranding but such joints shall not be less than 15 metres apart in the finished strands.
The wire shall be circular and free from scale, irregularities, imperfection, flaws, splits and other defects.

9.0 Tolerances

A tolerance of (+) 2.5% on the diameter of wires before stranding shall be permitted.

10.0 Sampling Criteria

The sampling criteria shall be in accordance with IS :2141.

11.0 Tests on Wires before Manufacture

The wires shall be subjected to the following tests in accordance with IS :2141.
Ductility Test Tolerance on Wire Diameter

12.0 Tests on Completed Strand

The completed strand shall be tested for the following tests in accordance withIS:2141. Tensile and Elongation Test: The percentage elongation of the stranded wire shall not be less than 6%.

Chemical analysis Galvanizing Test

The Zinc Coating shall conform to "Heavy Coating" as laid down in 1S:4826

13.0 Marking

Each coil shall carry a metallic tag, securely attached to the inner part of the coil bearing the followinginformation:
a) Manufacturers name or trade mark
b) Lot number and coil number
c) Size
d) Construction
e) Tensile Designation
f) Lay
g) Coating
h) Length
i) Mass
j) ISI certification mark, if any

14.0 Packing

The wires shall be supplied in 75-100 Kg. coils. The packing should be done in accordance with the provisions of IS:6594

15.0 Other Items:

For remaining items of stay sets mentioned in the enclosed drawing, relevant applicable Indian standards shall be applicable.

(B) STAY WIRE (7/10 SWG) (7/10 SWG) & (7/12 SWG)

GURANTEED TECHNICAL PARTICULARS

(To be submitted along with offer)

Sl. No.	GENERAL TECHNICAL PARTICULARS	7/08 SWG	7/10 SWG	7/12 SWG
1	Nominal diameter of wire			
2	Tolerance in diameter			
3	Sectional Area (In Sq. mm.)			
4	Tensile strength			
A	Min. N/mm²			
B	Max. N/mm²			
5	Minimum breaking load (KN)			

6	Type of coating Heavy/Medium/Light			
7	Variety Hard/Soft			
8	Weight of Zinc coating (Gms/Sq. Mtr.) Min.			
9	No. of dips the coating is able to withstand as 18 ± 20ºC			
10	Adhesion Test (Wrap Test at 1 turn per second coilingwhile stress not exceeding % nominal tensile strength)			
A	Min. complete turn of wrap			
B	Dia of mandrel on which wrapped			
11	Bend Test			
A	Angle			
B	Dia round a format to be bent			
12	Freedom from defect			
13	Chemical composition the MS Wire used shall not exceed			
A	Sulphur 0.060%			
B	Phosphorous 0.065%			

TECHNICAL SPECIFICATION

FOR

RS JOIST & PSC POLE

TABLE OF CONTENTS
OF
RS JOIST & PSC POLE

PART – A

TECHNICAL SPECIFICATION OF 11 mtr, R.S Joist Pole

1.0 Scope Of Work:

This specification covers design, manufacture, testing and supply of 150x1 50mm RS Joist 11 Meter long designed for a working load of 34.6kg. The bidder should enclose Performance Certificates from the above users, issued in favour of the Sub Vendor / manufacturer, as proof of successful operation in field.

Sl. No.	Size	Purpose	Supply Qty(Nos)	Locations
1	11 Mtr	DP	4	1. At Ransinghpur grid 2. At IOCL Depot

	150x150mmRS Joist		
	150 x 150 mm R.S. Joist length:-1 1 mtr,34.6kg/mtr total weight 336.6kg	MT	

2	11 Mtr	4-Pole	4	At Janla S/s

Applicable Standards:

This specification covers the manufacturing, testing before dispatch and delivery of aboveR.S Joists

2.0 Standards:

The RS JOISTS shall comply with the requirements of latest issue of IS ï 2062 Gr ï A except where specified otherwise.

3.0 ClamaticConditions :

Please refer chapter E3 of Technical Specification on climatic conditions.

4.0 Rolled Steel Joists

RSJ DESIGNATION	150 x 150 mm ISHB
Length of Joist in Mtr with +100mm/- 0% Tolerance	11mtr
Weight kg/m with±2.5% Tolerance	30.6
Sectional Area (cm^2)	39.00
Depth(D) of Section (mm) with +3.0mm/ -2.0mm Tolerance as per IS 1852-1985	150.00
Width (B)of Flange (mm) with ±2.5mm Tolerance for116 x 100 mm ISMB & ±4.0mm Tolerance for 150 x 150 mm	150.00
Thickness of Flange (Tf) (mm) with±1 .5mm	9.00
Thickness of Web(Tw) (mm) with±1 .0mm	8.40
Corner Radius of fillet or root (R1) (mm)	8.00
Corner Radius of Tow (R2) (mm)	4.00
Moment of Inertia Ixx (cm^4) Iyy (cm^4)	 1540.00 460.00
Radius of Gyration (cm) RxxRyy	6.29 3.44
Flange Slope(a) in Degree	94.0
Tolerance in Dimension	As perIS:1 852

4.1 Dimensions and Properties

4.2 MECHANICAL PROPERTIES:

Tensile Test :	Requirement as perIS:2062/ 1999 Grade-A
Yeild Stress(MPa)	Min250
Tensile Strength(MPa)	Min410
Lo=(5.65ISo)Elongation%	Min23
Bend Test	Shall not Crack

4.3. CHEMICAL PROPERTIES:

Chemical Composition	Requirement as perIS:2062/ 1999 Grade-A	Permissiblevariation over the Specified Limit.Percent.Max
Grade	A	-

Chemical Name	Fe-410W A	-
Carbon(%Max.)	0.23	0.02
Manganese(%Max.)	1.5	0.05
Sulphur(%Max.)	0.050	0.005
Phosphorous(%Max.)	0.050	0.005
Silicon(%Max.)	0.40	0.03
Carbon Equivalent(%Max.)	0.42	-
Deoxidation Mode	Semi-killed or killed	-
Supply condition	As rolled	-

4.4. However, In case of any discrepancy between the above data & the relevant ISS, the values indicated in the IS shall prevail.

4.5. The Acceptance Tests shall be Carried out as per Relevant ISS.

5.0.150x150mm RS Joists:

RS Joists of Specific Weight 30.6kg/mtr with length of each type of pole being 11 mtr pole weighing 336.6Kg for specified number of poles with specified weight in MT as given in the NIT table given above shall have to be supplied as per IS:2062;2006 GradeòAò , IS:808;1989/2001, IS1608:1995 & IS:12779-1989 and their latest amendment if any complying the required Dimension, Weight, Chemical & Mechanical properties confirming to the relevant IS, as per the Tolerrance given Below.

6.0 APPLICABLETOLLERANCES:

1. Length of each pole = + 100mm / - 0 % As per relevant IS: 12779- 1989

(with proportionate change in no of Poles)

2. Specific Weight of RS Joists = ±2.5% As per relevant IS: 1852/1 985

3. Weight for whole lot of supply for all categories = ±3.0% As per relevant IS: 12779-1989 for both type of RS Joists.

7.0. EMBOSSING ON EACH R.S JOIST :

Following distinct non-erasable embossing is to be made on each R.S Joists .a) Name & Logo of the Manufacturer. b) B.I.S Logo(ISI Mark) if applicable. c) Size of the

8.0 Chemical Properties :

Tensile Test :	Requirement as per IS:2062/ 1999 Grade-A	Manufacturer's Data
Yeild Stress(MPa)	Min250	
Tensile Strength(MPa)	Min410	
Lo=(5.65ISo)Elongation%	Min23	
Bend Test	Shall not Crack	

9.0 Mechanical Properties :

Chemical Composition	Requirement as per IS:2062/ 1999 Grade- A	Permissible variation over the Specified Limit,Percent,	Manufacturer's Data
Grade	A	-	
Chemical Name	Fe-410W A	-	
Carbon(%Max.)	0.23	0.02	
Manganese(%Max.)	1.5	0.05	
Sulphur(%Max.)	0.050	0.005	
Phosphorous(%Max.)	0.050	0.005	
Silicon(%Max.)	0.40	0.03	
Carbon Equivalent(%Max.)	0.42	-	
Deoxidation Mode	Semi-killed or killed	-	
Supply condition	As rolled	-	

However, In case of any discrepancy between the above data & the relevant ISS, the values indicated in the IS shall prevail.

The Acceptance Tests shall be Carried out as per Relevant ISS.
The RS Joists shall be manufactured confirming to the relevant IS with Manufacturerôs name/logo & B.I.S Logo if applicable embossed on it.

GUARANTEED TECHNICAL PARTICULARS FOR

(RS JOISTS of sizes 150x150mm)

(To be submitted along with offer)

1.1. Dimensions and Properties :

PARTICULARS	150 x 150 mm ISHB	Manufacturerôs Data
Length of Joist in Mtr with +1 00mm/-0% Tolerance	11 mtr	
Weight kg/m with±2.5% Tolerance	30.6	
Sectional Area (cm^2)	39.00	
Depth(D) of Section (mm) with +3.0mm/ - 2.0mm Tolerance as	150.00	
Width (B)of Flange (mm) with ±2.5mm Tolerance for116 x 100 mmISMB &	150.00	
Thickness of Flange (Tf) (mm) with±1 .5mm Tolerance	9.00	
Thickness of Web(Tw) (mm) with±1 .0mm Tolerance	8.40	
Corner Radius of fillet or root (R1)	8.00	
Corner Radius of Tow (R2) (mm)	4.00	
Moment of Inertia Ixx (cm^4) Iyy (cm^4)	 1540.0 0	
Radius of Gyration (cm) Rxx Ryy	 6.29 3.44	
Modulus of Section Zxx(cm^3) Zyy(cm^3)	 205 60.2	
Flange Slope(a) in Degree	94.0	
Tolerance in Dimension	As per IS:1 852	
Distinct Non-Erasable Embossings to be made on each R.S. Joist	a) Name & Logo of the Manufacturer. b) B.I.S Logo(ISI Mark) if applicable. c) Size	

PART - B

PSC POLE

(10mtr x 400Kg& 10mtr x 300kg)

PART - B

PSC Pole (10mtr x 400Kg)

TECHNICAL SPECIFICATIONS

1.0Qualification Criteria of Sub Vendor / Manufacturer:-

The prospective bidder may source PSC Poles from manufacturers who should have supplied at least the following quantity of PSC Poles to Electricity Supply Utilities / PSUs. The bidder should enclose Performance Certificates from the above users, issued in favour of the Sub Vendor / manufacturer, as proof of successful operation in field.

Sl. No.	Size	Minimum Past Supply Qty
1	10 Mtr. X 300 Kg	200
2	10 Mtr. X 400 Kg	200

2.0 Applicable Standard :

The Poles shall comply with latest standards as under:
REC Specification No. 15/1979, REC Specification No. 24/1983, IS 1678, IS 2905, IS 7321.

3.0 Materials :

a. Cement

Cement to be used in the manufacture of pre-stressed concrete poles shall be ordinary for rapid hardening Portland cement confirming to IS: 269-1976 (Specification for ordinary and low heat Portland cement) or IS: 8041 E-1978 (Specification for rapid hardening Portland cement).

b. Aggregates

Aggregates to be used for the manufacture of pre-stressed concrete poles shall confirm to IS: 383 (Specification for coarse and fine aggregates from natural sources for concrete) .The nominal maximum sizes of aggregates shall in no case exceed 12 mm.

c. Water

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

d. Admixture

Admixture should not contain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel. The admixture shall conform to IS: 9103.

e. Pres-Stressing Steel

Pre-stressing steel wires including those used as un tensioned wires should conform to IS:1785 (Part-I)
(Specification for plain hard-drawn steel wire for pre-stressed concrete, Part-I cold drawn stress
relieved wire).IS: 1785 (Part-II)(Specification for plain hard-drawn steel wire) or IS:6003
(Specification for indented wire for pre-stressed concrete).The type design given in the annexure arefor plain wires of 4 mm diameter with a guaranteed ultimate strength of 160 kg/mm^2. All pre-stressing steel shall be free from splits, harmful scratches, surface flaw, rough, aged and imperfect edges and other defects likely to impair its use in pre-stressed concrete.

f. Concrete Mix

Concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS: 1343-1980 (Code of practice for pre-stressed concrete) and IS: 456 ï 1978
(Code of practice for plain and reinforced concrete) subject to the following special conditions: Minimum works cube strength at 28 days should be at least 420 Kg/cm^2.
The concrete strength at transfer should be at least 210 Kg/cm^2.
The mix should contain at least 380 Kg of cement per cubic meter of concrete.
The mix should contain as low water content as is consistent with adequate workability. It becomes necessary to add water to increase the workability the cement content also should be raised in such a way that the original value of water cement ratio is maintained.

4.0 Design Requirements

The poles shall be designed for the following

requirements:

The poles shall be planted directly in the ground with a planting depth as per IS: 1678. Wherever, planting depth is required to be increased beyond the specified limits or alternative arrangements are required to be made on account of ground conditions e.g. water logging etc., the same shall be in the scope of the bidder at no extra cost to owner. The bidder shall furnish necessary design calculations/details of alternative arrangements in this regard.

The working load on the poles should correspond to those that are likely to come on the pole during their service life.

The factor of safety for all poles 9.0Mts. Shall not be less than 2.0 and for 8.0 M poles, the factor of safety shall not be less than 2.5.
The average permanent load shall be 40% of the working load.
The F.O.S. against first load shall be 1.0.
At average permanent load, permissible tensile stress in concrete shall be 30 kg/cm^2.

At the design value of first crack load, the modulus of rupture shall not exceed 53.0kg/cm^2 for M-40. The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.

The maximum compressive stress in concrete at the time of transfer of pre-stress should not exceed 0.8 times the cube strength.

The concrete strength at transfer shall not be less than half, the 28 days strength ensured in the design, i.e. 420x0.5=210kg/cm^2. For model check calculations on the design of poles, referred to in the annexure, a reference may be made to the REC ñManual on Manufacturing of solid PCC poles, Part-IDesign Aspectsò

5.0 Dimensions and Reinforcements

5.1 The cross-sectional dimensions and the details of pre-stressing wires should conform to the particulars given in the enclosed drawing. The provisions of holes for fixing cross-arms and other fixtures should conform to the REC specification No.15/1979.

All pre-stressing wires and reinforcements shall be accurately fixed as shown in drawings and maintained in position during manufacture. The un-tensioned reinforcement as indicated in the drawings should be held in position by the use of stirrups which should go round all the wires.

All wires shall be accurately stretched with uniform pre-stressed in each wire. Each wire or group of wires shall be anchored positively during casing. Care should be taken to see that the anchorages do not yield before the concrete attains the necessary strength.

5.2 The poles shall then be lifted to the pit with the help of wooden supports. The pole shall then be kept in the vertical position with the help of 25 mm (min.) manila ropes, which will act as the temporary anchor. The verticality of the pole shall be checked by spirit level in both longitudinal &transverse directions. The temporary anchor shall be removed only when **poles set properly in the pit for foundation concreting & backfilling with proper compacting the soil. The backfilling should be done inlayers (maxm. 0.5 mts at a time with sprinkling of water and by using wooden hammer. No stone more than 75 mm should be used during back filling.**

5.3 Suspension type 11/W fittings in all tangent locations and Four pair bolted type tension 11/W fittings should be used in all new 33&11 Kv lines.45 KN & 70 KN normal B&S insulators will be used in suspension & tension locations respectively.

5.4 Concreting of foundation up to a minimum height of 1.8 mtrs from the bottom of the pit with a circular cross-section of radius 0.25 mtrs. (volume of 0.3 cu.mtr. per pole) in the ratio of 1:2:4 shall be done at the following locations: The **depth** has to be increased to 2mtr or as required at site condition if poles more than 11 Mts. are to be used.

i) At all the tapping points and dead end poles.

ii) At all the points as per REC construction dwg. No. A-10 (for the diversion angle of 10-60

degree) or **better there of as per the instruction of Engineer in charge. The decision of Engineer in charge will be final.**

iii) Both side poles at all the crossing for road, Nallaha railway crossings etc.

iv) Where Rail poles, Joist poles, double pole and four pole structures are to be erected.

5.5 Each tower/structures should be earthed by providing 2.5 mts.50x6 GI flat and 40 x 3000 mm heavy gauge ISI mark earthing pipe. The top of the earthing pipe should remain 600 mm below ground level. All railway X-ing locations two nos. earthing should be provided.

In case the required footing resistance is not achieved on measurement, counterpoise earthing has to be provided as per the standard.

6.0 C o v e r The cover of concrete measured from the outside of pre-stressing tendon shall be normally 20 mm.

7.0 Welding and Lapping of Steel

The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, joining or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

8.0 C o m p a c t i n g

Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compacting shall not be permitted.

9.0 C u r i n g

The concrete shall be covered with a layer of sacking, canvass, Hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of pre-stress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit the interval should depend on the atmospheric humidity and temperature. The pre-stressing wires shall be de-tensioned only after the concrete has attained the specified strength at transfer (i.e. 200 or 210 kg/cm^2 as applicable).The cubes cast for the purpose of determining the strength at transfer should be coursed, a sear as possible, under condition similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS: 1 343(code of practice for pre-stressed concrete). The manufacture shall supply, when required by the owner or his representative, result of compressive test conducted in accordance with IS: 456 (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles. If the manufacture so desired, the manufacture shall supply cubes for test purpose and such cubes shall be tested in accordance with IS: 456 (Code of practice for plain and reinforced concrete).

10.0 Lifting Eye-Hooks or Holes

Separate eye-hooks or hoes shall be provided for handling the transport, one each at a distance of 0.15 times the overall length, from either end of the pole. Eye-hooks, if provided, should be properly anchored and should be on the face that has the shorter dimension of the cross-section. Holes, if provided for lifting purpose, should be perpendicular to the broad face of the pole.

11.0 Holes for Cross Arms etc

Sufficient number of holes shall be provided in the poles for attachment of cross arms and other equipments.

12.0 Stacking & Transportation

Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleeper located as 0.15 times the overall length, measured from the end. The timber supported in the stack should be aligned in vertical line.

13.0 Earthing

(a) Earthing shall be provided by having length of 6 SWG GI wire embedded in Concrete during manufacture and the ends of the wires left projecting from the pole to a length of 100mm at 250 mm from top and 1000 mm below ground level.

(b) Earth wire shall not be allowed to come in contract with the pre-stressing wires.

14.0 Earthing of Support

14.1 Each pole shall be earthed with coil type earthing as per REC Construction Standard J-1.

14.2 All DP & Four pole structures & the poles on both sides of railway crossing shall be earthed by providing two nos. **pipeearthing as per Drawing provided by CESU.**

Note: All the poles shall be provided with a RCC block base or MS base plate having dimensions as mentioned at 5.0.2 © as per the site requirement to be decided by Engineer in Charge. The decision of Engineer in Charge will be Final.

B.PSC Pole (10mtr x 400Kg)

GUARANTEED TECHNICAL PARTICULARS

(To be submitted along with offer)

Sl No.	Description	Unit	Bidder's Offer	
			10mtr X 400 Kg	10mtr X 300 Kg
1	Type of pole			
2	Factor of Safety			
3	Overall Length of Pole Meters	meters		
4	Working Load Kg	Kg		
5	Overall Dimensions			
A	Bottom Depth	mm		
B	Top Depth			
C	Breadth			
6	Reinforcement Detail:			
7	Diameter of prestressing wire			
8	No. of Tensioned wires			
9	No. of Untensioned wire			
10	Length of each untensioned wire			
11	Concrete Detail			
A	Cement Type			
B	Grade			
C	Type			
D	Quantity	Cubic meter/pole		
E	Standard confirming to:			
12	Steel Quality	Kg/Pole		
A	Ultimate Tensile Strength (UTS)	Km/Cm2		
B	Weight			

TECHNICAL SPECIFICATION
FOR
RTU FOR SCADA COMPATIBILITY

TABLE OF CONTENTS
OF
RTU FOR SCADA COMPATIBILITY

RTU FOR SCADA COMPATIBILITY

1.0 SCOPE OF SCADA

33/11kV S/S will be unmanned and remote controlled from the Distribution System Operation Control Centre (DSOCC) of each DISCOM with overall supervision monitoring facilities at SLDC, Bhubaneswar. The DSOCC of each DISCOM is located as under:

CESU at Bhubaneswar	**SOUTHCO at Berhampur**
WESCO at Burla	**NESCO at Balasore**

The Remote Terminal Unit (RTU) of each Primary S/S shall be in 2-way communication through **GPRS** with DSOCCs of DISCOMs for control purpose with further integration of existing communication link of DSOCCs with SLDC at Bhubaneswar. It shall be under open protocol (preferably IEC 104 protocol) under overall SCADA system. The SCADA system of DSOCC and SLDC under this scheme shall also be capable of augmentation for integrating existing 570 number of Primary S/Ss as well as for 20% expansions in future years.

It is expected that the 4 DSOCCs along with 5 Primary S/Ss for each DISCOM shall be completed within 6 months from the date of award and 5 Primary S/S of each DISCOM shall be added for control functions from DSOCCs and overall monitoring with SLDC at every 2 months.

Requirement Specification of 33/11 KV Outdoor, Unmanned, Remote Controlled S/Ss.

The capacity of S/S shall be 2X3.15, 2X5 MVA or 2X8 MVA with a provision of 3rd Transformer Bay for future expansion. There will be one incoming 33 KV bays and minimum two outgoing 11 KV bays with a provision of one 33kV spare feeder bay and one spare 11 KV feeder bay for future expansions along with provision of Bus coupler on 11 kV side.

33 KV Auto-Reclosing CB (ARCB) in some case.

The status indications and data for all the CBs, Transformers, Isolators and Metering Units shall be passed on to DSOCC through GPRS via RTU .

In the receiving stations i.e. at DSOCC, the information will be routed through a secured gate way and to be integrated with the SCADA provided by the vender or with any 3rd party SCADA.

All control functions of Circuit Breakers operations including OFF/ON for the transformers, incoming and outgoing feeders operation shall be carried out from DSOCC. The status indication of Isolators and the Metering Data for energy auditing, billing, asset management etc. shall be done at DSOCC.

The Isolators could be kept normally ON position and the ON/OFF operation for maintenance purpose shall be done manually.

The data in a proper format shall be transmitted to SLDC from DSOCCs for monitoring and information purpose.

The SCADA and communication architecture shall be on open protocol, so that the Primary S/Ss along with RTU established by any 3rd Party can be integrated with control functions at DSOCC and monitoring functions of SLDC.

Each Primary S/s shall be associated with erection, testing and commissioning of incoming 33 KV lines of about 30 Kms. and outgoing 11 KV feeders of about 20 Kms.

Each Primary S/s shall also have one 33/0.4 KV, 63/100 KVA Station Transformer.

The vender of the DSOCC will be responsible for operational training to the DISCOM's Operators and will hand-hold the operation control of the unmanned S/S for the project period of 2 years.

Each primary S/S along with construction of associated 33 KV and 11 KV lines shall be on turn-key basis for supply, erection, testing, commissioning and preventive maintenance for a period of 2 years.

As this project is conceived for utility (DISCOM) for system automation purpose, with remote operation of the feeder in the Control Room along with energy management functions for energy audit as well as distribution loss reductions, the vender should be well equipped for taking of the turn key contract along with the supply, erection, testing and commissioning of electrical equipments like CB, Transformer, Line Materials along with sufficient experience in the Energy Management Software, SCADA, RTU function and communication protocol. The manufacturer who have relevant Circuit Breakers, Relays, Meters, RTU with IEC 104 protocol and SCADA – DMS software supporting GPS (for control and monitoring of the Sub-stations from a common Control Room) only eligible to bid. The bidder should have a Project Engineering Centre so that this solution can be provided by them by integrating all equipments in SCADA DMS though open protocol as IEC-104 with adequate site training to the utility officers and staff.

2.0 TECHNICAL REQUIREMENTS OF RTU

2.1 General

The Remote Terminal Unit (RTU) shall be installed at primary substation to acquire data from Multifunction Transducers (MFTs), discrete transducers & status input devices such as CMRs etc. RTU & shall also be used for control of Substation devices from Master station(s). The supplied RTUs shall be interfaced with the substation equipment, communication equipment, power supply distribution boards; for which all the interface cables, TBs, wires, lugs, glands etc. shall be supplied, installed & terminated by the Contractor.

2.1 Design Standards

The RTUs shall be designed in accordance with applicable International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineer (IEEE),unless otherwise specified in this Technical specification. In all cases the provisions of the latest edition or revision of the applicable standards in effect shall apply. The RTU shall be designed around microprocessor technology. For easy maintenance the architecture shall support pluggable modules on backplane. The field wiring shall be terminated such that these are easily detachable from the I/O module.

3.0 RTU Functions

All functional capability described herein shall be provided by the Contractor even if a function is not initially implemented.

As a minimum, the RTU shall be capable of performing the following functions:

(a) Acquiring analog values from Multifunction Transducers Multi function meters or alternatively through transducer- less modules and the status inputs of devices from the substation, processing and transmitting to Master stations.

(b) Receiving and processing digital commands from the master station(s)

(c) Data transmission rates - **300 to 19200 bps** for Serial ports for MODBUS and 10/100 mbps for TCP/IP Ethernet ports

(d) IEC 60870-5-104 protocol to communicate with the Master station(s) ,IEC 60870-5-101 for slave devices. & MODBUS protocol over RS485 interface , to communicate with the MFTs/IEDs.

(e) RTU shall have the capability of automatic start-up and initialisation following restoration of power after an outage without need of manual intervention. All restarts shall be reported to the connected master stations.

(f) Remote database downloading of RTU from master station/SCADA/DMS control centre

(g) Act as data concentrator on IEC60870-5-101/104/MODBUS protocols

(h) Internal battery backup to hold data in SOE buffer memory & also maintaining the time & date.

(i) As the SCADA/DMS system will use public domain such GPRS/CDMA etc, therefore it mandatory to guard the data/ equipment from intrusion/damage/breach of security & shall have SSL/VPN based security.

(j) Shall have SNMP Support Feature:

All support feature as mentioned below will not be used now & may require in future . However, the same shall be tested in routine /Factory Tests. Further, it should be possible to have following capabilities in the RTU by way of addition of required hardware limited to addition of I/O modules & communication card only & using the same firmware at later date:

I) Support for Analog output in form of standard current loops viz 4-20Ma etc

II) Support for IEC 60870-5-103, IEC 61850 protocols & ability to act as a gateway for Numerical relays may have to be interfaced in future with numerical relays with future vision of Smart grid.

III) Have required number of communication ports for simultaneous communication with Master station(s), /MFTs and RTU configuration & maintenance tool.

IV) Communication with at least two master stations simultaneously on IEC 60870-5-104

V) Receiving and processing analog commands from master station(s) and Capability of driving analog output card.

VI) RTU shall be capable of acquiring analog values through transducers having output as 4-20 mA, 0-10 mA, 0-+10 mA or +/- 5 volts etc using analog input modules.

VII) Capability of time synchronisation with GPS receiver which may be required future at the time of SMART GRID.

4.0 Communication ports

The RTUs shall have following communication ports to communicate with master station, existing /MFTs and configuration & maintenance terminal.

_ RTU shall have two TCP/IP Ethernet ports for communication with Master station(s) using IEC 60870-5-104.

_ RTU shall have required number of RS 485 ports for communication with MFTs to be connected in daisy chain using MODBUS protocol . Minimum 15 analog values (including 4 energy values) to be considered per energy meter . The RTU shall be designed to connect maximum 5 MFTs. Further , bidder to demonstrate during testing that all analog values updated within 2 sec. The updation time shall be demonstrated during FAT(routine) & SAT testing . The bidder can offer MFT on IEC 60870-101/104 protocol to communicate with RTU. In addition, if weather transducer & DC transducers are also having RS485 MODBUS port., the same can be also added in the daisy.

_ RTU shall have one port for connecting the portable configuration and maintenance tool for RTU.

_ RTU as a data concentrator, then RTU shall have additional communication ports Ethernet or serial for IEC60870-5-104/101.

_ SSL/VPN ,NERC/CIP compliant

It shall be possible to increase the number of communication ports in the RTU by addition of cards, if required in future. The RTU shall support the use of a different communication data exchange rate (bits per second) and scanning cycle on each port & different database for each master station

5.0 Master Station Communication Protocol

5.1 RTU shall use IEC 60870-5-104 communication protocol for communicating to master station. The RTU communication protocol shall be configured to report analog (except energy values) & status changes by exception to master stations. However, RTU shall support periodic reporting of analog data and periodicity shall be configurable

from 2 sec to 1 hour. Digital status data shall have higher priority than the Analog data. The dead-band for reporting Analog value by exception shall be initially set to 1% (user configurable) of the full scale value. In addition, analog values shall also be reported to Master station by exception on violation of a defined threshold limit. All the analog values and status data shall also be assigned to scan groups for integrity check by Master stations at every 10 minutes configurable up to 60 minutes RTU wise.

RTU shall report energy values to master station periodically. The periodicity shall be configurable from 5 minutes to 24 hours (initially set for 15 minutes)

6.0 Communication Protocol between RTU & MFTs

The RTU shall acquire data from the MFTs using the MODBUS protocol. Inaddition, usage of IEC 60870-5-101/104 protocols is also permitted. The MFT will act as slave to the RTU. The RTU shall transmit these values to the master station in the frame of IEC 60870-5-104/101 protocol. As an alternate approach the

utility/contractor may use RTU as a data concentrator & acquire all the required analog data from DCU installed & connected to energy meters using MODBUS protocol under IT scheme under R-APDRP. However, performance, functional, availability & update time requirement shall be met in this case also. It is the responsibility of utility /contractor to assess this option & only opt in case it is foun feasible,

7.0 Analog Inputs

The real time values like, Active power, Reactive Power, Apparent power three phase Current & Voltage and frequency, power factor & accumulated values of import /export energy values will be acquired RTU from the following in the given manner:

1. MFTs installed in substations

2. RTU shall also take 4-20 mA, 0-20mA, 0- -10mA, 0-+10mA, 0-5V etc as analog inputs to acquire transformer tap position, DC power supply voltage, weather transducer etc.

The RTU analog-to-digital (A/D) converters shall have a digital resolution of at least twelve (12) bits plus sign. The overall accuracy of the analog input system shall be at least □0.2%(i.e. 99.8%) at 25 ºC of full scale . Mean accuracy shall not drift more than 0.002% per degree C within the temperature range of –5 to +55 degree Linearity shall be better than □0.05%. The RTU shall be designed to reject common mode voltages up to 150 Vac (50 Hz). For dc inputs, normal mode noise voltages up to 5 Vac shall be rejected while maintaining the specified accuracy. Each input shall have suitable protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak) and overload.

Loading upto 150% of the input value shall not sustain any failures to the RTU input.

The ability of the RTU to accommodate dc inputs shall include the following signal ranges:

Unipolar Voltage:0-0.5V, 0-1V, 0-5V, 0-10V,

Unipolar Current: 0-1mA, 0-10mA, 0-20mA, 4-20Ma,

Bipolar Voltage: 0.5V, 2.5V, 5V, -20-0-20mA (- to +)

The total burden imposed by the RTU/DC analog input circuit shall not exceed 0.5

volt-ampere for current and voltage inputs. As an option, contractor may also provide transducer less solution to connect direct CT/PT secondaries.

8.0 Status input

RTU shall be capable of accepting isolated dry (potential free) contact status inputs. The RTU shall provide necessary sensing voltage, current, optical isolation and de-bounce filtering independently for each status input. The sensing voltage shall not exceed 48Vdc. The RTU shall be set to capture contact operations of 20 ms or more duration. Operations of less than 20 ms duration shall be considered no change (contact bounce condition). The RTU shall accept two types of status inputs i.e. Single point Status inputs and Double point status inputs. To take care of status contact chattering, a time period for each point and the allowable number of operations per time period shall be defined. If the allowable number of operations exceed within this time period, the status change shall not be accepted as valid Single point status input will be from a normally-open (NO) or normally-closed (NC) contact which is represented by 1-bit in the protocol message. The Double point status input will be from two complementary contacts (one NO and one NC) which is represented by 2-bits in the protocol message. A switching device status is valid only when one contact is closed and the other contact is open. Invalid states shall be reported when both contacts are open or both contacts are closed.

All status inputs shall be scanned by the RTU from the field at 1 millisecond periodicity.

9.0 Sequence of Events (SOE) feature

To analyse the chronology or sequence of events occurring in the power system, time tagging of data is required which shall be achieved through SOE feature of RTU. The RTU shall have an internal clock with the stability of 10ppm or better . The RTU time shall be set from time synchronization messages received from master station using IEC 60870-5- 104 protocol. In addition, the message can be transmitted using NTP/SNTP. SOE time resolution shall be 1ms or better The RTU shall maintain a clock and shall time-stamp the digital status data. Any digital status input data point in the RTU shall be assignable as an SOE point.

Each time a SOE status indication point changes the state, the RTU shall time-tag the change and store in SOE buffer within the RTU. A minimum of 1000 events can be stored in the SOE buffer. SOE shall be transferred to Master Station as per IEC 60870-5-104 protocol. SOE buffer & time shall be maintained by RTU on power supply interruption.

9.1 IED pass through the Master Station user shall be able to perform a virtual connection with any IED connected to the RTU/DC, provided the communication protocol functionality, to support the information transfer from and to the IEDs. For example, the Master Station shall gather on-demand IED data, visualize IED configuration parameters, and IED source code depending upon the IED capabilities. On the other hand, the Master Station shall be able to download to the IEDs configuration

parameters, code changes, etc. depending upon the IED capabilities. This feature is a support function considering in future SMART GRID implementation. The capability can be demonstrated with the upload & download of data from master station with IEDs connected to the RTUs using the support of protocols specified in this chapter.

Numerical relays Analog data viz voltage ,current, sag swell instantaneous, momentary , temporary, over voltage, under voltage , over current , phasor measurement , THD, current TDD & current unbalance ratio etc at numerical relays if installed at bay of S/S

10.0 Control Outputs

The RTU shall provide the capability for a master station to select and change the state of digital output points. These control outputs shall be used to control power system devices such as Circuit breakers relay disable/enable and other two-state devices, which shall be supported by the RTU. A set of control outputs shall be provided for each controllable device. On receipt of command from a master station using the select check-before-execute operate (SCBO) sequence, the appropriate control output shall be operated for a preset time period which is adjustable for each point from 0.1 to 2 seconds.

Each control output shall consist of one set of potential free NO contact. The output contacts shall be rated for atleast 0.2 Amp. at 48 Vdc. These output contact shall be used to drive heavy duty relays. In case Control output module of RTU does not provide potential free control output contact of this rating, then separate control output relays shall be provided by the contractor. These relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils & shall conform to the relevant IEC requirements.

11.0 Heavy duty control output relays

The control output contact from the RTU shall be used for initiating heavy duty relays for trip/close of switching devices and energising relays of OLTC raise lower. The contractor shall provide heavy duty relays. Each control output relays shall consist of atleast 2 NO contacts. The output contacts shall be rated for at least 5 Amps Continuous at 220Vdc and shall provide arc suppression to permit interruptions of an inductive load. Relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils. The relays shall conform to the IEC255-1-00 and IEC 255-5 requirements.

12.0 Control Security and Safety Requirements

The RTU shall include the following security and safety features as a minimum for control outputs:

(a) Select- check-before-operate operate (SCBO) sequence for control output.

(b) No more than one control point shall be select ed/executed at any given time.

(c) The control selection shall be automatically cancelled if after receiving the "control selection" message, the "control execute" command is not received within the set time period.

(d) No control command shall be generated during power up or power down of RTU.

12.1 **Local/Remote selector switch**

A manual Local/Remote selector switch shall be provided for each RTU to disable all control outputs by breaking the power supply connection to the control output s. When in the "Local" position, the Local/Remote switch shall allow testing of all the control outputs of RTU without activating the control outputs to field devices. A status input indication shall be provided for the Local/Remote switch to allow the SCADA system to monitor the position of the switch.

13.0 Dummy breaker latching relay

The Contractor shall provide a latching relay to be used to simulate and test supervisory control from the Master station. The latching relay shall accept the control signals from the RTU to open and close, and shall provide the correct indication response through a single point status input.

14.0 Contact Multiplying Relays (CMRs)

Contact Multiplying Relays (CMRs) are required to multiply the contacts of breaker, isolators and protection relays etc. The contacts of these relays shall be used to provide status inputs to the RTUs.

The relays shall be DC operated, self reset type. The rated voltage for relay operation shall be on 24/48/110/220V DC depending on the station DC supply.

The relay shall be able to operate for +/-20% variation from nominal voltage.

The relay shall have a minimum of two change over contacts, out of which one shall be used for telemetry purposes. The contacts shall be rated to carry minimum current capacity of 5A.

The relay shall conform to following requirement.

a) Power Frequency withstand voltage–2KV for 1 minute as per IEC 255-5.

b) Insulation Resistance of 100M ohms measured using 500V DC megger.

c) 5KV Impulse test as per IEC 255-5

The relays coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-enegizing of the relay coils. The relays shall conform to the IEC 255-1-00 and IEC 255-5 requirements or provisions of latest edition or revision of the applicable standard as per Sec-2 Chapter 1 CLAUSE 1.1 of MTS. The relays must be protected against the effects of humidity, corrosion & provide with a dust tight cover. The connecting terminals shall be screw type & legibly marked. The relays may optionally have a visual operation indicator. The relays are to be mounted in Control & Relay (C&R) panels and therefore shall be equipped with suitable mounting arrangements. In case suitable space is not available in C&R panel the same shall be mounted in RTU panel or suitable panels , which shall be supplied & mounted on the top of the C&R panel by the contractor.

14.1 **Time facility**

The internal RTU time base shall have a stability of 10 ppm. The RTU shall be synchronised through synchronisation message from master station at every 15 minutes (configurable from 15 minutes to 24hrs) over IEC 60870-5-104/101/NTP/SNTP. The RTU shall also carry out time stamping of the events which are not received as time stamped from connected IEDs/ FPIs etc.

15.0 Diagnostic Software

Diagnostic Software shall be provided to continuously monitor operation of the RTU and report RTU hardware errors to the connected master stations. The software shall check for memory, processor, and input/output ports errors and failures of other functional areas defined in the specification of the RTU.

The RTU will be powered from a 48 V DC power supply system. The RTU shall not place additional ground on the input power source.

The characteristics of the input DC power supply shall be

(a) Nominal voltage of 48 Vdc with variation between 40.8 and 57.6 Vdc.(i.e. 48(+20%/-15%)

(b) Maximum AC component of frequency equal to or greater than 100 Hz and 0.012 times the rated voltage peak-to-peak.

The RTU shall have adequate protection against reversed polarity, over current and under voltage conditions, to prevent the RTU internal logic from being damaged and becoming unstable causing mal-operation. The specification for DCPS is given in respective section of MTS.

15.1 **Environmental Requirements**

The RTU will be installed in control room buildings with no temperature or humidity control. The RTUs shall be capable of operating in ambient temperature from 0 to +55 degree C with rate of temperature change of 20 degree C/hour and relative humidity less than 95%, non-condensing. For RTUs to be installed in the hilly region with the history of snowfall, the lower ambient temperature limit shall be -5 degree C.

15.2 **RTU Size and Expandability**

RTU shall be equipped for the point counts defined in the BOQ (Basic+20% spare (wired & hardware). It shall be possible to expand the RTU capability for additional 100 % of the basic point counts by way of addition of hardware such as modules, racks, panels, , however, RTU software and database shall be sized to accommodate such growth without requiring software or database regeneration.

15.3 **RTU Panels**

At least 50% of the space inside each enclosure shall be unused (spare) space that shall be reserved for future use. The Contractor shall provide required panels conforming to IEC 529 for housing the RTU modules/racks, relays etc. and other required hardware. The panels shall meet the following requirements:

(a) shall be free-standing, floor mounted and height shall not exceed 2200 mm.

All doors and removable panels shall be fitted with long life rubber beading.

All non load bearing panels/doors shall be fabricated from minimum 1.6 mm thickness steel sheet and all load bearing panels, frames, top & bottom panels shall be fabricated from minimum 2.0 mm thickness steel sheet

(b) shall have maintenance access to the hardware and wiring through lockable full height doors.

(c) shall have the provisions for bottom cable entry

(d) The safety ground shall be isolated from the signal ground and shall be connected to the ground network. Safety ground shall be a copper bus bar.

The contractor shall connect the panel's safety ground of to the owner's grounding network. Signal ground shall be connected to the communication equipment signal ground.

(e) All panels shall be supplied with 230 Vac, 50 Hz, single-phase switch and 15/5A duplex socket arrangement for maintenance.

(f) All panels shall be provided with an internal maintenance lamp, space heaters and gaskets.

(g) All panels shall be indoor, dust-proof with rodent protection, and meet IP41 class of protection.

(h) There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.

(i) Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.

(j) All materials used in the enclosures including cable insulation or sheathing,wire troughs, terminal blocks, and enclosure trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions.

15.4 **Wiring/Cabling requirements**

The RTU panels shall gather all signals from and to the devices located in Control & Relay panels in the substation control room. All wires that carry low-level signals shall be adequately protected and separated as far as possible from power wiring. All wires shall be identified either by using ferrules or by colour coding. In addition, cables shall be provided with cable numbers at both ends, attached to the cable itself at the floor plate where it enters the cubicles. Shielded cables shall be used for external Cabling from the RTU panels. The external cables (except communication cables) shall have the following characteristics:

a) All cables shall have stranded copper conductor.

b) Minimum core cross-section of 2.5 mm2 for PT cables, 4 mm2 for CT cables, if applicable and 2.5 mm2 for Control outputs and 1.5mm2 for Status inputs

c) Rated voltage Uo/U of 0.6/1.1KV

d) External sheathing of cable shall have oxygen index not less than 29 & temperature index not less than 250. Cable sheath shall meet fire resistance test as per IS 1554 Part- I.

e) Shielding, longitudinally laid with overlap.

f) Dielectric withstand 2.5 kV at 50 Hz for 5 minutes

g) External marking with manufacture's name, type, core quantity, crosssection, and year of manufacture.

Armoured. Cables shall be used in the area where cable will pass through open area which may experience loading.

The Communication cable shall be of shielded twisted pairs and of minimum 0.22sq mm size.

15.5 **Terminal Blocks (TBs)**

Terminal blocks shall be having provision for disconnection (isolation), with fulldepth insulating barriers made from moulded self-extinguishing material. Terminal blocks shall be appropriately sized and rated for the electrical capacity of the circuit and wire used. No more than two wires shall be connected to any terminal. Required number of TBs shall be provided for common shield termination for each cable. All terminal blocks shall be suitably arranged for easy identification of its usages such as CT circuits, PT circuits, analog inputs, status inputs, control outputs,auxiliary power supply circuits, communication signals etc. TBs for CT circuits shall have feature for CT shorting (on CT side) & disconnection (from load side) to facilitate testing by current injection. Similarly, TBs for PT circuit shall have feature for disconnection to facilitate voltage injection for testing.

16.0 RTU Architecture

Bidder has the option to offer RTUs having following architectural design:

a) Centralized RTU design where all I/O modules are housed in RTU panels and communicating with master station through communication port.

b) Distributed RTU design where distributed I/O modules/processor with I/O modules are housed in respective bay panels/RTU panel. All these distributed I/O modules / I/O modules with processor shall be connected to a central processor for further communication with master station. The bidder shall asses the requirement of RTU panels for such design and supply panels accordingly . In both cases the RTU requirements as envisaged in this specification shall be

followed.

17.0 LOCAL DATA MONITORING SYSTEM (LDMS)

The LDMS is a client workstation of main SCADA/ DMS control centre connected on 2Mbps or 64kbps leased line for local monitoring of SCADA/DMS system . The hardware & software specification, features shall be same as of remote VDU defined for SCADA/DMS system.

18.0 RTU CONFIGURATION

18.1	RTU	RTU panel should use advanced 32-bit main microprocessor along with co-processors. The power supply & main processor should be redundant. Internal battery backup to hold data in SOE buffer memory & also The co processors are responsible to communicate with IEDs on RS485 connectivity . RTU should have provision for communicating with MFTs in MODBUS protocol over RS485 interface . The co processors should have the licenses of IEC103, MODBUS RTU MASTER & PLC. Main Processor should have at least two nos of ports that will be connected to LANSwitch(TobeprovidedbyOPTCL)forcommunication with Master Control Centre. These are responsible for communication between the RTU with MCC. The protocol for two way communication between RTU & MCC should be IEC 104. Data transmission rates - 300 to 19200 bps for Serial ports for MODBUS.and 10/100 mbps for TCP/IP Ethernet ports.
18.2	Digital inputs	RTU Panel should have provisions for interfacing multiples of Digital inputs as per filed requirements. All Inputs should be suitable for 48V DC. They will be connected through potential free contact with field inputs like CB,Isolator open/close.
18.3	Digital outputs	RTU Panel should have provisions for multiples pf Digital outputs as per field requirement. Output to be connected to CMRs of 48 V DC mounted in RTU Panel. Its potential free contact will be connected in the field for remote operation of breakers/isolator.
18.4	Analog Inputs	RTU panel should have provisions for interfacing with analog inputs. Analog signals are to be configurable either 0-10 V DC or 4-20 mA as required.

18.5	Control voltage	Control Voltage to be provided to RTU panel will be 48V DC.
18.6	Air-conditioning	RTU Panel should have air conditioner and the panel should be double door front open able.
18.7	Front door	The RTU hardware mounted in the panel should be visible from glass door/window without opening the panel door.

19.0 SCADA INTERFACE PHILOSOPHY

19.1	Status/Alarm signals to RTU	RTU will read all the signals coming from(IEDs MFMs, MFTs,Numerical relays, Transformer REGDA relays, Battery Charger) as Soft signals on standard protocols.
19.2	Commands from RTU	RTU will execute commands from SCADA as soft commands through numerical relays on standard protocol.
19.3	Numerical relay integration	Numerical relays should be IEC 103 compatible. All the hardware required to extend the relay signals to the RTU shall be supplied along with the switchboards. All hardware or protocol converters required for compatibility with SCADA shall be in bidder's scope.
19.4	Signals and Commands	Following signals are to taken from the various devices to the RTU. This list is indicative and signals should not be limited to this. Additional signals can be taken based on requirement.

19.4.1	Soft signals from numerical relays to RTU (Status/Alarms)	On line Currents / Voltage/Power/Pf Relay General Trip signalRelay Internal Fault Post Fault currents (R,Yand Bphase separately) Unbalance Current (In case of Neutral displacement relay of capacitor feeders) Breaker closed Breaker Opened LOCAL/SCADA enabled. Isolator Close and open Earth Switch close and open Auto Trip I Trip circuit healthy Breaker in Test / Service (for indoor breakers only) SF6 Gas pressure low & lockout Spring charged All relay alarms when tripped on specific fault. VT fuse Failure Differential relay operated REF / back up earth fault relay operated Distance relay operated WTI Alarm

	Design	aa. MOG bb. OSR Main Tank cc. PRD Trip dd. OLTC OSR ee. Main DC Fail ff. Under/Over voltage relay operated gg. Neutral displacement relay operated(for capacitor banks) hh. All relay internal fault
19.4.2	Soft Commands from RTU to numerical relays	Breaker close Breaker Open Isolator close Isolator open
19.4.3	Status/Alarm signals from battery charger controller to RTU	Battery/Charger Load current Battery/Charger Load Voltage Battery charger main fail Battery charger failure DC system earth fault
19.4.4	Status/Alarm signals from Transformer monitoring relay to RTU	Transformer Tap Position Transformer WTI
19.4.5	Soft commands from RTU to Transformer monitoring relay	X'mer Tap Raise X'mer Tap Lower
19.5	Communication hardware	All hardware like Star coupler, FO glass/plastic, cables, RS 485 Belden class cables and protocol converters required for interfacing IEDs like protection relays, multifunction meters, transformer monitoring relays, battery charger controllers etc. to RTU should be included in scope of supply.
19.6	Configuration Software and Tools	All software and configuration tools required for configuration of RTU and Network, should be included in scope of supply.
19.7	Marshalling panel	The Marshalling box to be supplied by the vendor, if required.

19.8	Interface work details	Installation, testing and commissioning of RTU and Marshalling Panel. Laying & termination of control cable Laying and termination of communication cable through PVC conduit pipe Installation testing commissioning of protocol converter, connection converter, star coupler

20.0 PRESENT ARRANGEMENT:

Only RTUs and be installed. Local displays to be made in PCs from RTUs.

TECHNICAL SPECIFICATION

FOR

ALL ALUMINIUM ALLOY CONDUCTOR (AAAC)

TABLE OF CONTENTS

OF

ALL ALUMINIUM ALLOY CONDUCTOR

TECHNICAL SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTOR

1.0 SCOPE

This specification covers design, Engineering, Manufacture, Testing, Inspection before despath, forwarding, packing, transportation to sites, Insurance (both during transit & storage), storage, erection, supervision testing & commissioning of all sizes of All Aluminum Alloy Conductors of the Aluminum–Magnesium-Silicon type for use in the distribution overhead power lines.

The conductor offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. Tthe Type Test reports shall be submitted along with the bid.

The AAA Conductor shall conform in all respects to highest standards of engineering, design, workmanship complying this specification and the latest revisions of relevant standards at the time of offer and the Purchaser shall have the power to reject any work or materials, which, in his judgement, is not in full accordance therewith.

2.0 STANDARDS

Except where modified by the specification, the Aluminum Alloy Conductor shall be designed, manufactured and tested in accordance with latest editions of the following standards:

Sl.No	International Standard	IS	Description
1	IEC :1089		Round wire concentric lay overhead electrical standard Conductor
2		IS 398	Aluminum Alloy Stranded Conductors
3		IS 9997	Aluminum Alloy redraw rods for electrical purposes
4	IEC 502 : 1994		Extruded solid dielectric insulated power cables for rated voltages 1.0 kV up to 30 kV
5	IEC 104		Aluminum Magnesium Silicon alloy wire for overhead line conductors
6		IS 1778	Reels and drums of bare conductor.

7	BS : 6485-1971		PVC covered conductors for overhead power lines.

3.0 GENERAL

The wires shall be of heat treated aluminium, magnesium silicon alloy containing approximately silcon-0.5 to 0.9 %, magnesium-0.6 % to 0.9%, Fe-0.5% (maximum) , Copper- 0.1% (max), Mn- 0.03%, Cr-0.03%, Zn-0.1%, B-0.06%, and having the mechanical and electrical properties specified in the table and be smooth and free from all imperfections, such as, spills, splits and scratches.

Neutral grease shall be applied between the layers of wires. The drop point temperature of the grease shall not be less than 120^0C.

31 Mechanical and Electrical Characteristics of Aluminium Alloy Wires used in the Construction of Stranded Aluminium Alloy Conductors

Nominal Diameter	Minimum Diameter	Max. Diameter	Cross Sectional Area	Mass	Minimum Breaking Load		Maximum Resistance at 20^0 C
					Before stranding	After stranding	
1	2	3	4	5	6	7	8
mm	mm	mm	mm^2	Kg/km	KN	KN	ohms/km
3.15 *	3.12	3.18	7.793	21.04	2.41	2.29	4.290
4.26 *	4.22	4.30	14.25	38.48	4.40	4.18	2.345

Maximum resistance values given in column 8 have been calculated from the maximum values of the resistively as specified and the cross sectional area based on the minimum diameter.

The minimum breaking load is calculated on nominal diameter at ultimate tensile strength of 0.3 09 KN / mm^2 for wire before stranding and 95% of the ultimate tensile strength after stranding.

4.0 PHYSICAL CONSTANTS FOR ALUMINIUM ALLOY WIRES

41 Resistively:

For the purpose of this specification, the standard value of resistively of aluminum alloy wire which shall be used for calculation is to be taken as 0.0325 ohm-mm^2/m at 20^0 C. the maximum value of resistively of any single wire shall not, however, exceed 0.0328 ohm-mm^2/m at 20^0 C

4.2 Density:

At a temperature of 20^0 C, the density of aluminum alloy wire is to be taken as 2700 kg/m^3.

4.3 Temperature Coefficient of Linear Expansion:

The temperature coefficient of linear expansion of aluminium alloy wire is to be taken as 23 x 10^{-6} /^{0}C

4.4 Constant – Mass Temperature Coefficient

At a Temperature of 20^0 C, the constant – mass temperature coefficient of resistance of aluminium alloy wires, measured between two potential points rigidly fixed to the wire, is taken as 0.00360/^{0} C

5.0 STANDARD SIZES

5.1 Nominal Sizes of Wires

The aluminium alloy wires for standard constructions covered by this specification shall have the diameters as specified in the table and a tolerance of ±1% shall be permitted on the nominal diameter.

5.2 Standard Conductors

The sizes, resistance and masses (excluding the mass of grease) of stranded aluminium alloy conductors shall be as given in table. The preferred sizes are highlighted in the table.

5.3 Mechanical and Electrical Characteristics of Aluminium Alloy Stranded Conductors

Sl. No.	Actual Area	Stranding and Wire Dia	Approx. Overall Dia	Approx. Mass	Calculated Maximum Resistance at 20^0 C	Approx Calculated Breaking
1	2	3	4	5	6	7
	Mm^2	mm	mm	kg/km	ohms/km	KN
2	100	7/4.26	12.78	272.86	0.3390	29.26
3	148	19/3.15	15.75	406.91	0.2290	43.50

5.3.1 Increase in Length due to Stranding

When straightened out, each wire in any particular layer of a stranded conductor, except the central wire, is longer than the stranded conductor by an amount depending on the lay ratio of that layer.

5.3.2 Resistance and Mass of Conductor

The resistance of any length of stranded conductor is the resistance of the same length of any one wire multiplied by a constant as set out in the table below.

The mass of each wire in any particular layer of the stranded conductor, except the central wire, will be greater than that of an equal length of straight wire by an amount depending on the lay ratio of that layer. The total mass of any length of an aluminium stranded conductor is, therefore, obtained by multiplying the mass of an equal length of straight wire by an appropriate constant as mentioned below. In calculating the stranding constants as mentioned in the table below, the mean lay ratio, that is the arithmetic mean of the relevant minimum and maximum values in table for lay ratio has been assumed for each layer.

5.3.3 Calculated Breaking Load of Conductor

For a conductor containing **not more than** 37 wires, 95% of the sum of strength of the individual wires calculated from the values of the minimum breaking load given in this specification.

For a conductor containing **more than** 37 wires, 90% of the sum of the strengths of the individual wire calculated from the values of the minimum breaking load given in this specification.

5.3.4 Calculated Area and Maximum Resistance of Conductor

The actual area of a stranded conductor has been taken as the sum of the cross-sectional areas of the individual wires of nominal diameter.

Maximum resistance values of stranded conductor have been calculated on the basis of maximum resistively and the cross-sectional area based on the minimum diameter of wires.

5.4 Stranding Constants

Number of Wires in Conductor	**Stranding Constants**	
	Mass	Electrical Resistance
(1)	(2)	(3)
7	7.091	0.1447
19	19.34	0.05357

6.0 JOINTS IN WIRES

6.1 Conductor containing seven wires

There shall be no joint in any wire of a stranded conductor containing seven wires, except those made in the base rod or wire before final drawing.

6.2 Conductors containing more than seven wires

In stranded conductors containing more than seven wires, joints in individual wires are permitted in any layer except the outermost layer (in addition to those made in the base rod or wire before final drawing) but no two such joints shall be less than 15 m apart in the complete stranded conductor. Such joints shall be made by cold pressure butt welding. They are not required to fulfill the mechanical requirements for un-jointed wires.

7.0 STRANDING

The wire used in the construction of a stranded conductor shall, before and after stranding, satisfy all the relevant requirements of this standard.

The lay ratio of the different layers shall be within the limits given in the table for lay ratio.

In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being righ-handed. The wires in each layer shall be evenly and closely stranded.

In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

7.1 Lay Ratios for Aluminium Alloy Stranded Conductors

Number of Wires in Conductor	LAY RATIOS							
	3/6 Wire Layer		12 Wire Layer		18 Wire Layer		24 Wire Layer	
	Min	Max	Min	Max	Min	Max	Min	Max
7	10	14	---	---	---	---	---	---
19	10	16	10	14	---	---	---	---

NOTE: For the purpose of calculation the mean lay ratio shall be taken as the arithmetic mean of the relevant minimum and maximum values given in this table

8.0 LENGTHS AND VARIATIONS IN LENGTHS:

Unless otherwise agreed between the Owner and the Contractor, stranded aluminium alloy conductors shall be supplied in the manufacturer's usual production lengths to be indicated in the bid Schedule. The Owner reserves the right to specify particular lengths of conductor such that certain drum lengths will be shorter than others. There will in both cases be a permitted variation of –0 + 5% in the length of any one conductor length.

9.0 TESTS

9.1 Type Tests

The following tests should have been carried out as per relevant ISS

9.1.1 Ultimate Tensile Strength Test

This test is intended to confirm not only the breaking strength of the finished conductor but also that the conductor has been uniformly stranded.

A conductor sample of minimum 5mtr. length fitted with compression dead end clamps at either end shall be mounted in a suitable tensile test machine. Circles perpendicular to the axis of the conductor shall be marked at two places on its surface. Tension on the conductor sample shall be increased at a steady rate upto 50% of the minimum UTS specified and held for one minute. The circles drawn shall not be distorted due to relative movement of the individual strands. Thereafter the load shall be increased at a steady rate to the specified minimum UTS and held at that load for one minute. The conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

9.1.2 D.C Resistance Test

On a conductor sample of minimum 5mtr. length two contact clamps shall be fitted with a predetermined bolt torque. The resistance between the clamps shall be measured using a Kelvin double bridge by initially placing the clamps at zero separation and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0 C, which shall conform to the requirements of this specification.

9.2 Routine Tests

9.2.1 Measurement of Physical Dimensions:

The samples should meet the desired dimensional requirements before conducting following Routine Tests as per relevant ISS.

9.2.2 Selection of Test Samples

Samples for the tests specified in this specification shall be taken by the manufacturer before stranding, from not less than 10% of the individual lengths of aluminium alloy wire included in any one final heat-treatment batch and which will be included in any one consignment of the stranded conductors to be supplied.

Samples shall then be obtained by cutting 1.2 meters from the outer end of the finished conductor from not more than 10% of the finished reels or drums.

Tests for electrical and mechanical properties of aluminium alloy wire shall ordinarily be made before stranding since wires unlaid from conductors may have different physical properties from those of the wire prior to stranding because of the deformation brought about by stranding and by straightening for test.

Spools offered for inspection shall be divided into equal lots, the number of lots being equal to the number of samples to be selected, a fraction of a lot being counted as s complete lot. One sample spool shall be selected at random from each lot.

The following test shall be carried out once on samples of completed line conductor during each production run of up to 500 kms of the conductor from each manufacturing facility .

9.3 Breaking Load Test

The breaking load of one specimen, cut from each of the samples taken shall be determined by means of a suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm / min and not greater than 100mm /min.

9.4 Elongation Test

The elongation of one specimen cut from each of the samples taken shall be determined as follows :

The specimen shall be straightened by hand and an original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied as described above and the elongation shall be measured after the fractured ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm of either mark, and the required elongation is not obtained, the test shall be disregarded and another test should be made.

When tested before and after stranding, the elongation shall not be less than 4% on a gauge length of 200 mm

9.5 D.C Resistance Test

The electrical resistance test of one specimen cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value at 20^0 C by means of the formula

$R_{20} = R_T [1/(1+\alpha(T-20)]$

Where R_{20} = Resistance corrected at 20^oC

R_T = Resistance measured at T^0C

A = Constant – Mass temperature coefficient of resistance, 0.0036, and

T = ambient temperature during measurement

The resistance corrected at 20^0 C shall not be more than the maximum values specified .

9.6 Chemical Analysis of Aluminium Alloy

Samples taken from the alloy coils / strands shall be chemically / spectrographically analysed. The results shall conform to the requirements stated in this specification. The Contractor shall make available material analyses, control documents and certificates from each batch as and when required by the **<OPTCL>**.

Test should be conducted at the independent test house by the purchaser in the case of absence of facility at manufacturer. However the cost of such testing shall be borne by the manufacturer/Contractor.

9.7 Dimensional and Lay Length Check

The individual strands of the conductors shall be dimensionally checked and the lay lengths checked to ensure that they conform to the requirements of this specification.

Ten percent drums from each lot shall be rewound in the presence of the purchaser or his representative to allow visual checking of the conductor for joints, scratches or other surface imperfections and to ensure that the conductor generally conforms to the requirements this specification. The length of conductor would on the drum shall be re-measured by means of an approved counter / meter during the rewinding process.

9.8 Visual and dimensional Checks on the Conductor Drums.

9.8.1 The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification and of IS 1778: Specification for reels and drums of bare conductors. For wooden drums, a suitable barrel batten strength test procedure is required . The Bidder

shall state in his bid the tests to be carried out on the drums and shall include those tests in the Quality Assurance Programme.

9.8.2 Acceptance Tests :

The following acceptance tests as per IS-398 (PartIV)/1994 with latest amendments if any, shall be carried out on all samples

i. Measurement of lay ratio

ii. Measuerement of diameters of individual wire

iii. Meae of resistance of individual wire

iv. Breaking load test of individual wire

v. Elongation test of individual wire

vi. Torsional test of individual wire

10.0 REJECTION AND RETESTS

10.1 Type Tests

Should the conductor fail any of the type tests specified above, the purchaser will not accept any conductor manufactured from the material, nor conductor made by the manufacturing methods used for the conductor which failed the test.

The manufacturer shall propose suitable modifications to his materials and techniques in order that he can produce conductor which will satisfactorily pass the type test requirements.

10.2 Routine Tests

Should any one of the test pieces first selected fail the requirements of the tests, two further samples from the same batch shall be selected for testing, one of which shall be from the length from which the original test sample was taken unless that length has been withdrawn by the manufacturer.

Should the test pieces from both these additional samples satisfy the requirements of the tests, the batch represented by these samples shall be deemed to comply with the standard. Should the test pieces from either of the two additional samples fail, the batch represented shall be deemed not to comply with the standard.

If checked on individual strand diameters, conductor lay lengths and conductor surface condition indicate non-compliance with the requirements of the specification, the particular drum will be rejected. Inspection will then be carried out on two further drums within the same batch. If the conductor on either of the drums is non-complaint, the complete batch will be rejected.

10.3 **Delivery Extension due to Rejection of Conductor**

The rejection of conductor due to its failure to pass either type or routine tests shall not permit the Contractor to apply for any extension to the time period within which he has contracted to complete the Project.

The Technical Particulars of the conductor is furnished below. The bidder is to confirm it in Chapter E-21

11.0 TECHNICAL PARTICULARS FOR 100 / 148 mm2 AAAC

Sl. No.	Particulars	100mm^2 AAAC	148mm^2
1	Nominal Aluminium Alloy area of conductor in mm^2	100	148
2	No. of strands	7	19
3	Wire dia in mm.:		
	Nominal	4.26	3.15
	Minimum	4.22	3.12
	Maximum	4.30	3.18
4	Approximate overall dia of the conductor in mm.	12.78	15.75
5	Cross-sectional area of:		
	Individual wire in mm^2	14.25	7.793
	Stranded conductor in mm^2	99.81	148
6	Approximate mass of :		
	Individual wire in Kg/Km	38.48	21.04
	Stranded Conductor in Kg/Km	272.86	406.91
7	Minimum breaking load in KN		
	Individual wire	4.18	2.289
	Conductor (U.T.S.)	29.26	43.50

8	Calculated maximum DC resistance at 20 ^{0}C in Ohm/ Km		
	Individual wire	2.345	4.351
	Conductor	0.339	0.229
9	Lay ratio for 7 wire conductor	Min : 10, Maxm : 14	Min : 10, Maxm : 16
10	Direction of Lay	Right handed	Right handed
11	Modulus of Elasticity (Kg/ cm^2)	0.63 24 x 10^6	0.63 24 x 10^6
12	Co-efficient of linear expansion per ^{0} C	23.0 x 10	23.0 x 10
13	Standard length (Mtr.)	2000 ± 5%	2000 ± 5%
14	Size of drum in mm.	To be offered by the bidder	To be offered by the bidder
15	No. of lengths in one drum	To be offered by the bidder	To be offered by the bidder
16	No. of cold pressure butt welding	8 (Eight)	8 (Eight)

TECHNICAL SPECIFICATION
FOR

INSULATOR (DISC)

TABLE OF CONTENTS
OF
DISC. INSULATOR

DISC INSULATORS

1.0 SCOPE.

This specification provides for design, manufacture, engineering, inspection and testing before dispatch packing and delivery FOR (destination) for Indian manufacturers of disc. Insulators & Post Insulators as per technical requirements furnished in this specification.

These insulators are to be used in suspension and tension insulators strings for the suspension and anchoring of the bus-bar conductors.

Following is the list of documents constituting this package.

(i) Technical specification.

(ii) Technical data sheet.

(iii) Drawings of insulators

All the above volumes along with amendments there of shall be read and interpreted together. However, in case of a contradiction between the "Technical Specification" and any other volume, the provisions of this volume will prevail.

The insulators offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

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

2.0 STANDARDS:

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

Sl. No.	Indian Standard	Title.	International Standard
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 274 IEC 383
4.	IS: 2071 Part-(I), Part-(II) Part-(III)	Method of High Voltage Testing.	
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part – I	General Requirement and Tests.	BS: 3288
	Part – II	Dimensional Requirements.	IEC: 120
	Part – III	Locking devices.	IEC: 372
7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272

10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R 262-1969 & R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	
13.	IS: 8263	Methods of RIV Test of HV insulators.	IEC 437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse test on HV insulators.	IEC: 506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 575
16.	IEC	Long Rod Insulators	IEC-433

2.2 The standards mentioned above are available from:

Reference.	Abbreviation.	Name & Address:
BS		British Standards, British Standards Institution, 101, Pentonvile Road, N-19 ND,U
IEC / CISPR		International Electro technical commission Electro Technique International. 1, Rue de verembe Geneva SWITZERLAND.
IS		Bureau of Indian Standards, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-110001, ORISSA

ISO		International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej-12 DK-2900 Helleprup DENMARK.
NEMA		National Electric Manufacturers Association 1`55, East 44th. Street New York, NY 10017 USA

3.0 **PRINCIPAL PARAMETERS.**

3.1 **DETAILS OF DISC INSULATORS**:

The Insulator strings shall consist of standard discs for use in three phases, 50 Hz 33/11KV S/s & Lines in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type, radio interference and have characteristics as shown in Table-I and all ferrous parts shall be hot dip galvanized as per the latest edition of IS 2629. The zinc to be used for making sleeves shall be 99.95 % pure.

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

Table I

Sl. No	Type of String.	Size of disc. Insulator (mm)	Minimum creepage distance of each disc(mm)	No. of standard discs 11KV	No. of standard discs 33KV	Electro-mechanical strength of insulator string fittings (KN)
1.	Single suspension	255x145	430	Refers Notes.	1x3	45
2.	Double	-do-	-do-		2x3	2x45

	suspension					
3.	Single Tension	255x145	-do-	1x2	1x4	70
4.	Double Tension	-do-	-do-	2x2	2x4	2x70

Notes:- Post Insulator pin type to be provided in 11kV Suspension Point.The technical Spec. for the same is indicated elesewhere in the technical specification for the project

3.2 **SPECIFICATION DRAWINGS**:

The specification in respect of the disc insulators are described. These specification for information and guidance of the Bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and in line with the specification.

4.0 **GENERAL TECHNICAL REQUIREMENTS**:

4.1 **Porcelain:**

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

The insulator shall be made of highest grade, dense, homogeneous, wet-process porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, laminations, projecting points foreign particles and other defects, except those within the limits of standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

4.2 **Porcelain glaze**:

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

5.0 METAL PARTS:

(i) Cap and Ball Pins:

Ball pins shall be made with drop forged steel caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together welded, shrink fitted or by any other process from more than one piece of materials. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade composition and mechanical properties of steel used for caps and pins. The cap and pin shall be of such design that it will not yield or distort under the specified mechanical load in such a manner as to change the relative spacing of the insulators or add other stresses to the shells. The insulator caps shall be of the socket type provided with nonferrous metal or stainless steel cotter pins and shall provide positive locking of the coupling.

(ii) Security Clips:

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

6.0 FILLER MATERIAL:

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

7.0 MATERIALS DESIGN AND WORKMANSHIP:

7.1 GENERAL:

All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing/ quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.

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

7.2 INSULATOR SHELL:

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

7.3 METAL PARTS:

1) The pin and cap shall be designed to transmit the mechanical stress to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the

insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.

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

7.4 GALVANIZING:

All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

7.5 CEMENTING:

The insulator design shall. Be such that the insulating medium shall not directly engaged with hard metal. The surface of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials. High quality Portland cement shall be used for cementing the porcelain to the cap & pin.

7.6 SECURITY CLIPS (LOCKING DEVICES)

The security clips to be used as locking device for ball and socket coupling shall be ‘R’ shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall resilient corrosion resistant and of sufficient mechanical strength.

There shall be no possibility of the locking device to be displaced or be capable of rotation, which placed in position, and under no circumstances shall it allow separation of insulator units and fittings. 'W' type security clips are also acceptable. The hole for the security clip shall be counter sunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked positions shall not be less than 50 N (5 kg.) or more than 500 N (50 kgs.).

7.7 MARKING:

Each insulator shall have the rated combined mechanical and electrical strength marked clearly on the porcelain surface. Each insulator shall also bear symbols identifying the manufacturer, month, and year of manufacture. Marking on porcelain shall be printed, not impressed, and shall be applied before firing.

7.8 BALL AND SOCKET DESIGNATION:

The dimensions of the ball and sockets for 45 KN and 70 KN discs shall be of 16 mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-II).

8.0 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

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

a) Diameter of Disc (mm)

	Standard	Maximum	Minimum
45 KN Disc	255	266	244
70 KN Disc	255	266	244

b) Ball to Ball spacing

Between Discs (mm)

	Standard	Maximum	Minimum
45 KN Disc	145	149	141
70 KN Disc	145	149	141

9.0 INTERCHANGEABILITY:

The insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian Standards.

10.0 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

1) Ball pin shake.
2) Cementing defects near the pin like small blow holes, small hair cracks lumps etc.
3) Sand fall defects on the surface of the insulator.

11.0 INSULATOR STRINGS:

11.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 33 KV 50 Hz effectively earthed systems in an atmosphere with pollution level as indicated in project synopsis. Suspension insulator strings for use with suspension/tangent supports are to be fitted with discs 45 KN EMS rating while tension insulator strings for use with Anchor / Tension towers are to be fitted with discs of 70 KN KN EMS level rating.

11.2 STRING SIZE:

The sizes of the disc insulator, the number to be used in different types of strings, their electro-mechanical strength and minimum nominal creep age distance shall be as given in this specification.

11.3 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian Standards.

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

12.0 DIMENSIONAL TOLERANCE OF INSULATORS DISCS

It shall be ensured that the dimensions of the long rod insulators are within the limits as per relevant IEC/ISS.

13.0 TESTS (FOR DISC INSULATORS) :

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

13.1 TYPE TEST:

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

13.2 ACCEPTANCE TESTS:

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

13.3 ROUTINE TESTS:

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

13.4 TESTS DURING MANUFACTURE:

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

13.5 TEST VALUE:

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

13.6 TEST PROCEDURE AND SAMPLING NORMS:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or the Internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and normal according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms land procedure for the same shall be as mutually agreed to between the supplier and the purchaser in the quality assurance programme.

13.7 TYPE, ROUTINE & ACCEPTANCE TESTS:

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

1.	**On complete insulator string with hardware fittings**	**Standards**
a)	Power frequency voltage withstand test with corona control rings and under wet condition.	BS:137(Part-I)
b)	Impulse voltage withstand test under dry condition.	IEC: 383
c)	Mechanical strength test.	As per this specification.
2.	**On Insulators:**	
a)	Verification of dimensions.	IS: 731
b)	Thermal mechanical performance test:	IEC:575
c)	Power frequency voltage withstand and flashover (I) dry (ii) wet.	BS: 173
d)	Impulse voltage withstand flashover test (dry)	: IEC: 383
e)	Visible discharge test (dry)	: IS:731
	All the type tests given under clause No.5.14 above shall be conducted on single suspension and Double Tension insulator string along with hardware fittings.	
3.	**ACCEPTANCE TESTS:**	
	For insulator:	
a)	Visual examination	: IS:731
b)	Verification of dimensions.	: IS:731
c)	Temperature cycle test.	: IS:731
d)	Galvanizing test.	: IS:731
e)	Mechanical performance test.	: IEC:575
f)	Test on locking device for ball and socket coupling.	: IEC:372

g)	Eccentricity test.	As per this specification.
h)	Electro-mechanical strength test.	:
i)	Puncture test.	: IS:731
j)	Porosity test.	: IS:731

4. ROUTINE TESTS:

For insulators:

a)	Visual inspection.	: IS:731
b)	Mechanical routine test.	:
c)	Electrical routine test.	: IEC:383

5. TEST DURING MANUFACTURE:

Chemical analysis, hardness test and magnetic particle inspection for forgings.	: As per this specification.

13.8 ADDITIONAL TESTS:

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

13.9 CO-ORDINATION FOR TESTING:

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

NOTE:

In respect of electrical tests on a complete string consisting of insulators and hardware guarantee of values of responsibility of testing shall be with

hardware manufacturer of RIV corona and voltage distribution test and with insulator manufacturer for all other tests.

14.0 TEST CHARGES AND TEST SCHEDULE:

14.1 TYPE TEST:

The insulator offered shall be fully type tested as per this specification. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory. The bidder shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years.

14.2 ACCEPTANCE AND ROUTINE TEST:

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

14.2.2 Immediately after finalisation of the programme of type/ acceptance/ routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

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

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

14.3 VOLTAGE DISTRIBUTION TEST:

a) The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage and proportionate correction be applied as to give a total of 100% distribution.

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

14.4 VIBRATION TEST:

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

after the vibration test. The disc insulators shall be subjected to the following tests as per relevant standards.

	Test.	Percentage of disc to be tested
a)	Temperature cycle test followed by	60
	Mechanical performance test.	40
b)	Puncture test (for porcelain insulator only)	

15.0 INSPECTION:

i. Purchaser and its representative shall at all times be entitled to have access to the works and to all places of manufacturer where insulators are manufactured and the supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of materials, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.

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

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

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

16.0 IDENTIFICATION MARKING:

(a) Each unit of insulator shall be legibly and indelibly marked with the trade mark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by ‘KN’ to facilitate easy identification and proper use.

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

17.0 CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING.

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

18.0 TEST 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 purchaser in quality assurance programme.

19.0 TEST ON CASTING:

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

20.0 HYDRAULIC INTERNAL PRESSURE TEST ON SHELLS:

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

21.0 THERMAL MECHANICAL PERFORMANCE TEST:

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

22.0 ECCENTRICITY TEST:

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

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

23.0 CRACK DETECTION TEST:

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

TECHNICAL SPECIFICATION
FOR

POST INSULATOR (PIN TYPE & STATION TYPE)

TABLE OF CONTENTS
OF
POST INSULATOR (PIN TYPE & STATION TYPE)

POST INSULATOR (PIN TYPE & STATION TYPE)

1.0 STANDARDS

Post insulator (Pin Type & Station Type) shall conform in general to IS 2544, IEC 168 and IEC 815.

Technical Parameters

Sl No.	Parameters	33kV	11kV
1	Type	Confirming to IEC 273 (solid core)	Confirming to IEC 273 (solid core)
2	Voltage class (kV)	36	12
3	Dry and wet one minute withstand voltage (kV rms)	70	28
4	Dry lightning impulse withstand voltage (kV p)	170	75
5	Wet switching surge withstand voltage (kV p)	NA	NA
6	Max. RIV at corona extinction voltage (micro volts)	NA	NA
7	Corona extinction voltage (kV rms)		
9	Total minimum cantilever strength (kg)	Not < 300	Not < 300
10	Minimum torsion moment	As per IEC 273	As per IEC 273
11	Total height of insulator (mm)	508	254
12	Minimum PCD (mm) top/bottom	76	57
13	No. of bolts top/bottom	4/ 8	4/ 8
14	Diameter of bolt holes (mm) top/bottom	M12	M12
15	Pollution level as per IEC 815	Heavy	Heavy
16	Minimum total creepage distance (mm)	1050	450

Sl No 12 & 13 , is not applicable for Pin type Post Insulator.The size of the pin shall given as per IS & should be of galvanized with necessary nuts & washers.

2.0 Constructional features

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 and be designed to with stand any shocks to which they may bed subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might after the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.

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.

When operated 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.

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.

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2633, and IS: 4579. The zinc used for galvanizing 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 while deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions. Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells 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.

3.0 TEST DETAILS

The following Type, acceptance and routine tests shall be carried out and results given along with certification as appropriate in the Technical Data Schedule and Test Certificates Schedule of this specification**.**

3.1 TYPE TESTS:

The post insulators shall be subjected to the following type test :

- Visible discharge test
- Impulse voltage withstand test
- Dry power frequency voltage withstand test
- Wet power frequency voltage withstand test
- Mechanical strength test for post insulators as per IEC 168 / IS: 2544.

3.2 Acceptance Tests

The test samples having withstood the routine tests shall be subjected to the following tests according to the sampling procedure of IEC 383 clause 23:

- Verification of dimensions
- Temperature cycle test
- Mechanical strength test for post insulators as per IEC 168/ IS 2544
- Porosity test on post insulators
- Puncture test
- Test for galvanization of ferrous parts

3.3 Routine Tests

- Visual examination
- Power frequency voltage dry test
- Tests to prove mechanical strength.

TECHNICAL SPECIFICATION

FOR

POLYMER INSULATOR

TABLE OF CONTENTS
OF
POLYMER INSULATOR

TECHNICAL SPECIFICATION FOR 33/11 KV POLYMER INSULATORS

1.0 SCOPE :-

I. This specification covers design, manufacture, testing, inspection, packing and supply of composite insulators for use in the 33/11 KV overhead transmission lines and substations situated in any part of Odisha State.

II. Long rod insulators for AAAC/ACSR conductors in tension application at dead end/angle/cut point. The insulators shall be of ball and socket type or tongue & Clevis type as desired by the purchaser.

III. Line post insulators or pin insulators for straight line locations

2.0 CLIMATIC CONDITIONS

Please refer chapter E3 of Technical Specification on climatic conditions.

3.0 STANDARDS

3.1 Following Indian/ International Standards, which shall mean latest revision, with amendments /changes adopted and published, unless specifically stated otherwise in the Specification, shall be referred while accessing conformity of insulators with these specifications.

3.2 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 or better 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.

Indian Standard	Title	International Standard
--	Definition, test methods and acceptance criteria for composite insulators for A.C. overhead lines above 1000 V	IEC : 61109
IS : 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V	IEC : 60883
IS : 2071	Methods of High Voltage Testing	IEC : 60060-1
IS : 2486	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000 V General requirements and tests dimensional	IEC : 60120 IEC : 60732

	Thermal mechanical performance test and mechanical performance test on string insulators units	IEC : 60575
IS: 13134	Guide for the selection of insulators in respect of polluted conditions.	IEC : 60815
	Characteristics of string insulator units of the long rod type.	IEC : 60433
	Hydrophobicity Classification Guide	STRI guide 1.92/1
	Radio interference characteristics of overhead power lines and high voltage equipments	CISPR:18-2 Part-2
IS : 8263	Methods of RI Test of HV Insulators	IEC-60437
	Standards for insulators - Composite-Distribution Dead-end	ANSI C29.13-2000
IS : 4759	Hot dip zinc coatings on structural steel Et other allied products	ISO : 1459 ISO : 1461
IS : 2629	Recommended practice for Hot Dip Galvanization for iron and steel.	ISO : 1461 (E)
IS : 6745	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles.	ISO : 1460
IS : 3203	Methods of testing of local thickness of electroplated coatings.	ISO :2178
IS : 2633	Testing of uniformity of coasting of zinc coated articles.	
	Standard specification for glass fiber strands.	ASTM D 578-05
	Standard test method for compositional analysis by Thermogravimetry.	ASTM E 1131-03
IS : 4699	Specification for refined secondary Zinc.	

4.0 GENERAL REQUIREMENTS

4.1 The Composite insulators will be used on lines on which the conductor will be AAAC/ACSR of size up to 100 Sq.mm. The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.

4.2 Insulator shall be suitable for 3Q 50 Hz effectively earthed 11KV Overhead distribution system in a moderately/heavily polluted atmosphere. Long road insulators shall be of ball Et socket type as specified.

4.3 Bidder must be an indigenous manufacturer and supplier of composite insulators of rating 11 KV or above OR must have developed proven in house technology and manufacturing process for composite insulators of above rating OR possess technical collaboration/association with a manufacturer of composite insulators of rating 11 KV or above. The Bidder shall furnish necessary evidence in support of the above along with the bid, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the owner.

4.4 Insulator shall be suitable for both the pin and strain type of load Et shall be of Ball Et Socket type for long Rod Type. The diameter of Composite Insulator shall be less than 200mm. The center-to-center distance between Ball & socket shall be max. 300mm. for 11KV composite insulator.

4.5 Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC60815/IS: 13134.

4.6. Dimensional Tolerance of Composite Insulators.

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with IEC 61109.

± (0.04d+1.5) mm when d 300 mm
± (0.025d+6) mm when d > 300mm

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

However, no negative tolerance shall be applicable to creepage distance. 4 4.7 Interchangeability

The composite insulators including the end fitting connection shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant IEC/IS standards 11 kV/33 kV Composite Insulator (B & S Type) only.

4.8 Corona and RI Performance

All surfaces shall be clean, smooth without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal part shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operations conditions.

4.9 Maintenance :

The composite insulators offered shall be suitable for use of hotline maintenance technique so that usual hot line operation can be carried out with ease, speed and safety.

5.0 TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS:

5.1 Composite Insulators shall be designed to meet the light quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.

(a). Core- the internal insulating part
(b). Housing - the external insulating part.
(c). Metal and fittings - for attaching to hardware to support conductor.

5.2 CORE

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP shall be manufactured through Pultrusion process. The FRP rod shall be void free.

5.3 HOUSING (Sheath)

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy compound of a thickness of 3 mm minimum. It shall be one-piece housing using injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences, external pollution and humidity. Housing shall conform to the requirement of IEC 61109/92-93 with latest amendments.

It shall be extruded or directly molded on core and shall have chemical bonding with the FRP rod. The strength of the bond shall be greater than the tearing strength of the polymer. Sheath material in the bulk as well as in the sealing/bonding area shall be free from voids.

Manufacturer should furnish a description of its quality assurance programme including fabrication; testing and inspection for any material (i.e rubber). Components (i.e rod) or hardware (i.e. end filings). The manufacturer has had fabricated by others should also be included.

Manufacturing methods and material composition documentation will be a part of Technical Bid to be submitted along with offer.

5.4 WEATHERSHEDS

The composite polymer Weathersheds made of silicone elastometric compound or silicon alloy shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections. The weathersheds should have silicon content of minimum 43% by weight. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

5.5 METAL AND FITTINGS :

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron or forged steel, Metal end fittings shall be suitable for Ball and socket type hardware of respective specified mechanical load and shall be hot dip galvanized in accordance with IS 2629. The material used in fittings shall be corrosion resistant.

Metal end fittings shall be uniform and without sharp edges or corners and shall be free of cracks, flakes, silvers, slag, blow-holes shrinkages defects and localized porosity.

They shall be connected to the rod by means of a controlled compression technique. As the main duty of the end fittings is the transfer of

mechanical loads to the core the fittings should be property attached to the core by a coaxial or hexagonal compression process and should not damage the individual fibers or crack the core.

The gap between fittings and sheath shall be sealed by flexible silicone elastometric compound or silicone alloy compound sealant, system of attached of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof.

The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC: 60120/IS:2486 - Part-II/1989.

Nominal dimensions of the pin, ball and socket interior shall be in accordance with the standard shown at Sr. No.4.0. No joints in ball and socket or pin will be allowed. Outer portion of ball or socket should be Zinc Sleeved with minimum 99.95% purity of electrolytic high grade Zinc.

The finished surface shall be smooth and shall have a good performance. The surface shall not crack or get chipped due to ageing effect under normal and abnormal service conditions or while handling during transit or erection.

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

Bottom end metal fitting (Shank) of Pin Insulator should be forged steel as per IS 2002/92. Length of thread on shank should be 100 mm and Shank diameter is 20 mm. Minimum Collar diameter should be 40 mm and its minimum thickness should be of 5 mm. Nuts as per IS 1363 (P-III) and 4 mm thick Spring Washer shall be as per IS 3063 with latest amendments if any, Nuts and spring washer shall be hot dip galvanized (For Pin insulators.)

6.0 WORKMANSHIP

6.1 All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Bidders shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.

6.2 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.

6.3 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.

6.4 The core shall be sound and free of cracks and voids that may adversely affect the insulators.

6.5 Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.

6.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth without projecting points of irregularities, which may cause coronoa. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformity.

6.7 All ferrous part shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/Sq.mm or 87 um thickness and shall be in accordance with the requirement of IS 4759. The zinc used for galvanizing shall be of purity 99.5% as per IS: 4699. The zinc coating shall be uniform adherent, smooth, reasonable bright continuous and free from imperfections such as flux, ash rust stains. Bulky white deposits and blisters. The galvanized metal part shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

7.0 TESTS AND STANDARDS :

Insulators offered shall be manufactured with the same configuration Et raw materials as used in the insulators for which design Et type test reports are submitted. The manufacturer shall submit a certificate for the same. The design Et type test reports submitted shall not be more than 5 years old.

(A) <u>DESIGN TEST</u>:

For composite insulators, it is essential to carry out design test as per clause 4.1 of IEC 61109/92-93 with latest amendments. The design test are intended to verify the suitability of the design, materials and method manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which the represented by the one tested and having the following characteristics.

Same materials for the core and sheds and same manufacturing method.

> Same material of the fittings, the same design, the same method of attachment.
> Same or greater layer thickness of the shed material over the core (including a sheath where used):
> Same or smaller ratio of the highest system voltage to insulation length;
> Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings.
> Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances.

Manufacturer should submit test reports for design tests as per IEC - 61109 (Clause- 5) along with the bid. Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract.

UV test : The test shall be carried out in line with Clause of ANSI

C29.13

(B) TYPE TEST:

The type tests are intended to verify the main characteristics of a composite insulator. The type tests shall be applied to composite insulators, the class of which has passed the design tests.

Following type test shall be conducted on a suitable number of individual insulator units, components, materials or complete strings.

Sr. No.	Description of type test	Test procedure/standard
1	Dry lightning impulse withstand voltage test.	As per IEC 61109 (Clause 6.1)
2	Wet power frequency test	As per IEC 61109 (Clause 6.2)
3	Mechanical load-time test	As per IEC 61109 (Clause 6.4)
4	Radio interference test	As per IEC 61109 (Clause 6.5) revised
5	Recovery of Hydrophobicity test	Annexure-B This test may be repeated every 3 years by the
6	Chemical composition test for silicon content	Annexure-B Or any other test method acceptable to the owner.
7	Brittle fracture resistance test	Annexure : B

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

(C)ACCEPTANCE TEST

The test samples after having withstood the type test shall be subject to the following acceptance test-

TEST :

Sr.No.	Description	Standard
1	Verification of dimensions	Clause 7.2 IEC : 61109
2	Verification of the locking system (if applicable)	Clause 7.3 IEC : 61109
3	Galvanizing Test	IS : 2633 /IS : 6745
4	Verification of the specified mechanical load	Clause 7.4 IEC : 61109

(D)ROUTINE

Sr.No	Description	Standa
1	Identification of marking	As per IEC : 61109 Clause
2	Visual inspection.	As per IEC : 61109 Clause 8.2
3	Mechanical routine test	As per IEC : 61109 Clause

Every polymeric insulator shall withstand mechanical routine test at ambient temperature tensile load at RTL corresponding to at least 50% of the SML for at least 10 sec.

(E) TEST DURING MANUFACTURE:

Following tests shall also be carried out on all components as applicable :

(a) Chemical analysis of zinc used for galvanizing.
(b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
(c) Chemical analysis, hardness tests and magnetic particle inspection for forgings.

(F) ADDITIONAL TESTS:

The Purchaser reserves the right of getting done any other test(s) of reasonable nature carried out at Purchaser's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications. In such case all the expenses will be to Suppliers account.

8.0 TEST CERTIFICATE :

The tenderer shall furnish detailed type test reports of the offered composite Insulators as per clause 8.2 of the Technical Specifications from the NABL laboratory to prove that the composite Insulators offered meet the requirements of the specification. These type Tests should have been carried out within five years prior to the date of opening of this tender.

(i) The offered composite Insulators are already fully type tested at approved Laboratory within five years prior to the date of opening of this tender.

(ii) There is no change in the design of type-tested composite Insulators and those offers against this tender.

9.0 TESTING FACILITIES :

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

(a) The bidders must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine and acceptance Tests. These facilities should be available to MGVCL's Engineers if deputed or carry out or witness the tests in the manufacturer works. If any test cannot be carried out at the manufacturer's work, the reasons should be clearly stated in the tender.

(b) The insulators shall be tested in accordance with the procedure detailed in IEC 61109/92-93 with latest amendments.

(c) Calibration Reports from Government approved testing laboratory of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burelle, thermometer, barometer etc.

(d) Finished insulator shall be checked for dimension verification and surface finish separately.

Manufacturers of foreign origin shall, in addition to the above, also have arrangements in India, either at works of their authorized representative/ licenses or in the NABL laboratory for conducting sampling test in accordance with IEC 81109/92-93 with latest amendments.

10.0 DRAWINGS :

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

10.2 The Bidder shall furnish along with the bid the outline drawing (3 copies) of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not be limited to the following information.

(a) Long rod diameter with manufacturing tolerances.
(b) Minimum Creepage distance with positive tolerance.
(c) Protected creepage distance.
(d) Eccentricity of the long rod
    (i) Axial run out.
    (ii) Radial run out
(e) Unit mechanical and electrical characteristics.

(f) Size and weight of ball and socket/ tongue Et Clevis.
(g) Weight of composite long rod units.
(h) Materials
    (i) Identification mark.
    (ii) Manufacturer's catalogue number

10.3 After placement of awards, the Supplier shall submit full dimensioned manufacturing insulator drawings containing all the details 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 10 more copies of the drawing to the owner for further distribution and field use.

10.4 After placement of order, the Supplier shall also submit fully dimensioned insulator crate drawing for different type of insulators for approval of the owner.

11.0 RETEST AND REJECTION :

11.1 Sample Procedure for testing of insulators shall be as per clause 7.1 to 7.6 of IEC 61109 for Acceptance Et Routine Tests.

For the sampling tests, two samples are used, E1 and E2. The sizes of these samples are indicated in the table below.

Lot Size (N)	Sample Size	
	E1	E2
N < 300	Subject to agreement	
300 < N < 2000	4	3
2000 < N < 5000	8	4
5000 < N < 10000	12	6

If more than 10000 insulators are concerned, they shall be divided into an optimum number of lots comprising between 2000 and 10000 insulators. The results of the tests shall be evaluated separately for each lot. The insulators shall be selected by the purchaser's representative from the lost at random.

The samples shall be subjected to the applicable sampling tests.

The sampling tests are:

Verification of dimensions - (E1+E2)

Verification of the locking system - (E2)

Verification of tightness of the interface between end fittings Et - (E2)

Insulators housing

Verification of the specified mechanical load SML - (E1)

Galvanizing test - (E2)

In the event of a failure of the sample to satisfy a test, the retesting procedure shall be as follows:

If only one insulator or metal part fails to comply with the sampling tests, a new sample equal to twice the quantity originally submitted to the tests shall be subjected to retesting. The retesting shall comprise the test in which failure occurs. If two or insulator or metal parts fail to comply with any of the sampling tests or if any failure occurs during the retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with these defects. The sorted lot then be resubmitted for testing. The number then selected shall be three times the first chosen quantity for tests.

If any insulators fail during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

11.2 Verification of dimensions (E1 + E2)

The dimensions given in the drawings shall be verified. The tolerances given in the drawing are valid. If no tolerances are given in the drawings the values mentioned in this specification shall hold good.

11.3 Verification of the locking system (E2)
This test applied only to the insulators equipped with socket coupling as specified by IEC-120 and is performed according to IEC 383.

11.4 Verification of tightness of the interface between end fittings and insulator housing (E2).
One insulator selected randomly from the sample E2, shall be subjected to crack indication by due penetration, in accordance with ISO 3452, on the housing in the zone embracing the complete length of the interface between the housing and metal fitting and metal and including an additional area, sufficiently extended beyond the end of the metal part.

The indication shall be performed in the following way.

> The surface shall be properly pre-cleaned with the cleaner;
> The penetrant, which shall act during 20 minutes, shall be applied on the cleaned surface.
> With in 5 minutes after the application of the penetrant, the insulator shall be subjected, at the ambient temperature, to a tensile load of 70% of the SML, applied between the metal fittings; the tensile load shall be increased rapidly but smoothly from zero upto 70% f the SML, and then maintained at this value for 1 minute;
> The surface shall be cleaned with the excess penetrant removed, and dried; > The developer shall be applied if necessary;
> The surface shall be inspected.

Some housing materials may be penetrated by the penetrant, In such cases evidence shall be provided to validate the interpretation of the results. After the 1 min, test at 70% of the SML, if any crack occur, the housing and, if necessary, the metal fittings and the core shall be cut, perpendicularly to the crack in the middle of the widest of the indicated cracks, into two halves. The surface of the two halves shall then be investigated for the depth of the cracks.

11.5 Verification of the specified mechanical load SML.
The insulators of the sample E1 shall be subjected at ambient temperature to a tensile load, applied between the couplings. The tensile load shall be increased rapidly but smoothly from zero to approximately 75% of the SML, and then be gradually increased to the SML in a time between 30 sec to 90 sec.

If 100% of the SML is reached in less than 90 s, the load (100% of the SML) shall be maintained for the remainder of the 90 s. (This test is considered to be equivalent to a 1 min withstand test at the SML).

This insulators have passed the test at 13.4 Et 13.5 above if ;

> No failure (breakage or complete pull out of the core, or fracture of the metal fitting) occurs either during the 1 min. 70% withstand test (a) or during the 1 min. 100% withstand test (b).

> No cracks are indicated after the dye penetration method described in 13.4 above.
> The investigation of the halves described in 13.4 above shows clearly that the cracks do not reach the core.

11.6 Galvanizing Test :
This test shall be performed according to IS : 2633/IS : 6745 on galvanized parts.

12.0 MARKINGS :

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

(a) Name or trademark of the manufacture.
(b) Voltage Et Type
(c) Month and Year of manufacturing.
(d) Min.failing load/guaranteed mechanical strength in kilo Newton followed by the word ' kN' to facilitate easy identification.
(e) Country of Manufacturer.
(f) Name of DISCOM

13.0 PACKING :

13.1 All insulators shall be packed in strong corrugated box of min.7 ply duly paletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 Kg. to avoid handling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.

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

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

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/corrugated box shall have all the markings stenciled on it in indelible ink.

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

14.0 INSPECTION :

14.1 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.

14.2 The material for fi nal inspection shall be off ered by the Supplier only under packed condition. The Owner shall select samples at random from the packed lot for carrying out acceptance tests. The lot offered for inspection shall be homogeneous and shall contain insulators manufactured in 3-4 consecutive weeks.

14.3 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.
14.4 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 later case also the material shall be dispatched only after satisfactory testing specifi ed herein has been completed.

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

15.0 GUARANTEE :

(i) The stores covered by this specification should be guaranteed for satisfactory operation and against defects in design, materials and workmanship for a period of at least 36 [thirty six] months from the last date of delivery/demonstration . The above guarantee certificate shall be furnished in triplicate to the purchaser for his approval. Any defect noticed during this period should be rectified/replaced by the supplier free of cost to the purchaser provided such defects are due to faulty design, bad workmanship or bad materials used, within one month upon written notice from the purchaser. The guarantee period for the rectified/replaced equipment shall be further guaranteed for 36 months(thirty six) from the date of rectification/replaced.

(ii) Equipment/material failed or found defective during the guarantee period shall have to be guaranteed after repair/replacement for a further period of **36(thirty six)** months from the date of commissioning from the date of receipt at the store/site after such repair/replacement. Date of delivery as used in this clause shall mean the date on which the materials are received in OPTCL'S stores/site in full & good condition which are released for Despatch by the purchaser after due inspection

Annexure - A

The standards mentioned in this specification are available from

Reference Abbreviation	Name and Address
IEC/CISPR	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND
BIS/IS	Bureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK
NEMA/ANSI	National Electric Manufacture Association, 155, East 44th Street. New York, NY-10017 U.S.A
ASTM	American Society for Testing and Materials, 1916 Race St. Phelledelphia,PA19103 U.S.A
STRI guide	STRI, Sweden. Website : www.stri.se

Annexure-B

Tests on Insulator units

1. RIV Test (Dry)

The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10 kV & 30 kV for 11 kV & 33 kV class insulators respectively under dry condition. The test procedure shall be in accordance with IS:8263 /IEC: 437/CISPR 18-2 .

2. Brittle Fracture Resistance Test

Brittle fracture test shall be carried out on naked rod along with end fittings by applying “1n HNO3 acid” (63 g conc. HNO3 added to 937 g water) to the rod. The rod should be held at 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

3 Recovery of Hydrophobicity & Corona test

The test shall be carried out on 4mm thick samples of 5cm x 7cm.

i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRI guide for Hydrophobicity classification. Dry the sample surface.

ii) The sample shall subjected to mechanical stress by bending the sample over aground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. Tentative arrangement shall be as shown in Annexure - E. The test shall be done for 100 hrs.

iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 2 above. Note HC classification. Repeat the cycle for 1000 hrs. or until an HC of 6 or 7 is obtained. Dry the sample surface.

iv) Allow the sample to recover and repeat hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48hours, depending on the material and the intensity of the corona treatment.

4 Chemical composition test for Silicon content

The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X-ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI or any other NABL accredited laboratory.

ANNEXURE : C

Guaranteed Technical Particulars of 11 kv Insulator (B Et S Type)

Name of the Manufacturer :

BIDDER HAS TO CONFIRM FOLLOWING IMPORTANT REQUIREMENT:

Sr.	Description	Min. requirement for 1.1 kV 45 KN	Min. requirement for 33 kV 70 KN	As per firm offer
1.	Type of Insulator	Polymeric	Polymeric Composite	
2.	Standard according to which the insulators manufactured and tested.	IEC 61109	IEC 61109	
3.	Name of material used in manufacture of the insulator with class/grade)	SILICON Wacker-Germany Dow	SILICON Wacker-Germany Dow Corning USA	
(a)	Material of core(FRP rod) (I)E-glass of ECR-glass.	ECR or BORRON FREE	ECR or BORRON FREE	
(b)	Material of housing Et weathersheds (silicon content by weight)	SILICON RUBBER 43 %	SILICON RUBBER 43 %	
(c)	Material of end fittings	SGI	SGI	
(d)	Sealing compound for end fittings	RTV SILICON	RTV SILICON	
4.	Colour	GREY	GREY	
5.	Electrical characteristics			
(a)	Nominal system voltage	11 KV	33 KV	
(b)	Highest system voltage	12 KV	36 KV	
(c)	Dry Power frequency withstand voltage	70 KV	105 KV	
(d)	Wet Power frequency withstand voltage	50 KV	75 KV	
(e)	Dry flashover voltage	77 KV	125 KV	
(f)	Wet flash over voltage	55 KV	85 KV	
(g)	Dry lighting impulse withstand voltage (a) Positive (b) Negative	 129 KV 135 KV	 170 KV 170 KV	
(h)	Dry lighting impulse flashover voltage a) Positive b) Negative.	 135 KV 141 KV	 180 KV 180 KV	
(i)	RIV at 1 MHz when energized at 10 kV/30kV (rms) under dry condition.	20	40	

Sr.No.	Description	Min. requirement	Min. requirement	As per firm offer
(j)	Creepage distance (Min.)	320 MM	900 MM	
6. (a)	Mechanical characteristics Minimum failing load.	45 KN	70KN / 90KN	
7.	Dimensions of insulator			
(i)	Weight	1.25	1.6	
(ii)	Dia of FRP rod	16 MM	16 MM	
(iii)	Length of FRP rod	240 MM	440 MM	
(iv)	Dia of weathersheds	90±1 MM	100 MM	
(v)	Thickness of housing	3 MM	3 MM	
(vi)	Dry arc distance Dimensioned drawings of insulator (including weight with tolerances in weight)	160±5 MM	382 MM	
8.	Method of fixing of sheds to housing (specify). Single mould or Modular construction (injection moulding/compression	Injection moulding	Injection moulding	
9.	No of weathersheds	3	8	
10.	Type of sheds			
i)	Aerodynamic	Aerodynamic	Aerodynamic	
ii)	With underribds			
11.	Type of packing	Wooden Box	Wooden Box	
12.	Any other particulars which the bidder may like to give.			
13	The insulators shall have "W" type phosphors Bronze security clips for ball sockets portion of insulators confirming	YES	YES	

Signature :

Name :

Designation :
Place :

ANNEXURE : D

Guaranteed Technical Particulars of 11 KV Pin Insulator.

Name of the Manufacturer : .

BIDDER HAS TO CONFIRM FOLLOWING IMPORTANT REQUIREMENT:

Sr.No.	Description	Min. requirement for11 kV Pin Insulator	As per firm offer
1.	Type of Insulator	Polymeric	Polymeric Composite
2.	Standard according to which the insulators manufactured and tested.	IEC 61109	IEC 61109
3.	Name of material used in manufacture of the insulator with class/grade)	SILICON Wacker-Germany Dow	SILICON Wacker-Germany Dow
(a)	Material of core(FRP rod) (j) E-glass of ECR-glass.	ECR or BORRON	ECR or BORRON
(b)	Material of housing Et weather sheds (silicon content by weight)	SILICON RUBBER 43 %	SILICON RUBBER 43 %
(c)	Material of end fittings	SGI	SGI
(d)	Sealing compound for end	RTV SILICON	RTV SILICON
4.	Colour	GREY	GREY
5.	Electrical characteristics		
(a)	Nominal system voltage	11 KV	33 KV
(b)	Highest system voltage	12 KV	36 KV
(c)	Dry Power frequency withstand voltage	70 KV	105 KV
(d)	Wet Power frequency withstand voltage	50 KV	75 KV
(e)	Dry flashover voltage	77 KV	125 KV
(f)	Wet flash over voltage	55 KV	85 KV
(g)	Dry lighting impulse withstand voltage c) Positive d) Negative	 129 KV 135 KV	 170 KV 170 KV
(h)	Dry lighting impulse flashover voltage c) Positive d) Negative.	 135 KV 141 KV	 180 KV 180 KV
(i)	RIV at 1 MHz when energized at 10 kV/30kV (rms) under dry condition.	20 (T.C.Encl.)	40

Sr.No.	Description	Unit	Min. requirement for11 kV Pin Insulator	As per firm offer
(j)	Creepage distance (Min.)		340 MM	900 MM
6. (a)	Mechanical characteristics : Minimum bending load		5 KN Bending	70 KN / 90 KN failing
7.	Dimensions of insulator			
(i)	Weight	Kg.	1.35 KG(Approx	1.6 KG(Ap
	Dia of FRP rod	mm	21.7 MM	16 MM
	Length. of	Mm	200 ±5 MM	440 ±5 MM
	Dia of weather sheds	mm	100 MM	100 MM
	Thickness of housing	mm	3 MM	3 MM
(vi)	Dry arc distance Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed	mm	120±5 MM	382±5 MM
8.	Method of fixing of sheds to housing (specify). Single mould or Modular construction (injection moulding/		Injection moulding	Injection moulding
9.	No of weather sheds		3	3
10.	Type of sheds			
	Aerodynamic		Aerodynamic	Aerodynami
	With underribds			
11.	Type of packing		Wooden Box	Wooden
12.	Any other particulars which the bidder may like to give.			

Signature :

Name:

Designation :

ANNEXURE- E

TECHNICAL DEVIATION :

Bidder has to mention below deviation if any, quoting relevant clause of specification.