

xv) Other Common DG Faults

It must support a RS 232 port for PC interface for programming / reconfiguration of the parameters through laptop.

1.4.8 AC Distribution Panel

There shall be AC distribution panel for termination of the load. The SMPS, Air conditioners etc. shall be connected to this AC distribution panel through suitable MCBs. The ratings of the MCBs shall be selected to provide safe and continuous operation of the DCPS system, Air conditioning system etc being supplied under this contract. The Contractor shall submit the details of MCB ratings for Employer's approval.

The AC mains and DG set shall be connected to PIU unit through MCCBs of suitable ratings.

1.4.9 PIU with Dual DG logic

At few of the remote Telecom locations, two DG sets may be required. For those locations, PIU capable of controlling two DGs shall be supplied. In case of power failure, command shall always go to that DG which was in standby mode during previous cycle of Power failure. For the sites operated purely on DG supply, the logic shall be to run the DG Set for a prefixed time with in the range of 0 to 10 hrs. After every set time of DG run the load of the Repeater Shelters need to be shifted to battery bank. DC load need to be fed through battery till time either shelter temperature exceeds the set threshold or battery bank voltage falls below the set threshold. In case of crossing of any of these thresholds, the PIU to give DG start command to second DG set. DG sets supplied under earlier packages having capacity 15kVA or below may also be available at sites.

1.4.10 Constructional Features of Rack

Only a single cabinet shall accommodate all the systems that include phase selector, surge protection devices, static voltage stabilizer, AMF panel and PIU controller, digital displays and meters, wires and cables, associated sub systems etc. The dimensions of the rack shall be such that it shall occupy minimum space inside the shelter.

The enclosure (rack) shall be freestanding type of design and shall have sufficient structural strength to withstand the ultimate mechanical load capacity without any deformity. Cable entry shall be from the bottom/top of the enclosures. The design of the rack (enclosure) shall be modular allowing easy maintenance and installation such that replacement or taking out of one subsystem for repair or maintenance shall not require dismantling of whole system. The rack shall be free of sharp edges or sharp corners. Rack mounting arrangement shall provide easy access from front, rear and top for installation and maintenance.

Where cables pass through metal panels suitable arrangement including bushings shall be provided to protect cables from damage. Bus-bars shall be suitably spaced and insulated to prevent any possibility of short circuit between bus-bar and/ or rack.

With doors in position, all visual alarms and meters shall be clearly visible. In case of hinged doors, meters and alarm indicators are permitted on the door provided the fixtures on the door do not restrict the movement of door in any way.

1.4.10.1 Components

The component parts of the equipment shall be of professional grade from reputed manufacturer to ensure continuous and safe operation of the equipment including its sub systems. The component shall conform to relevant IEC/IS standards and Complete PIU unit shall ensure compliance to safety as per IEC-60950 or any other international standard.

1.4.10.2 Finish and Painting

The finish of Steel/Aluminium structure and panels shall conform to relevant IS specification (or equivalent international specifications). The colour scheme for Rack, Door and Modules shall be decided during detailed engineering.

1.4.10.3 Earthing

The PIU unit including its subsystems shall be properly earthed by connecting it to the earthing system being provided by the Contractor under this Package.

1.4.11 MTBF

The mean time between the faults of the PIU and its subsystems shall be more than 70,000 hrs.

1.4.12 Installation

The transportation of PIU unit and its complete installation at respective sites as per attached appendices shall be carried out by the Contractor. All type of cables or associated accessories shall be supplied and installed by the Contractor. Connection to SEB supplied AC mains and ACDB etc shall also be carried out by the Contractor

1.4.13 Testing

1.4.13.1 Type Testing

PIU shall conform to EMI/EMC requirements as per IEC-870-2-1 standards. It shall also conform the Environmental requirements as per the TEC Standard for Environmental testing i.e. SD: QM-333 Mar 2010 (with amendments, if any) in category B2.

Electrical and mechanical safety and Performance test shall also be carried out on PIU as per specification. The Contractor can also submit the earlier carried out type test reports on the offered system for above tests.

1.4.13.2 Factory Acceptance Testing

The Contractor shall submit the detailed format of factory acceptance testing plan for PIU unit incorporating various tests for testing of all its systems and sub systems and get it approved from the Employer. The FAT shall be conducted on the offered PIU units as per approved FAT tests and procedure.

1.4.13.3 Site Acceptance Test

After successful installation, the site acceptance testing for PIU unit including its subsystems shall be carried out by the Contractor for each site demonstrating all its functions properly. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.

1.5 DC Power Supply system

In order to provide reliable power supply to communication equipment at various locations, 48 V DC Power Supply (DCPS) system is to be provided as a part of this project. This section describes the technical requirement of DC power supply & associated Battery.

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipments. The rating of offered SMPS modules shall meet Employer's requirements of DCPS system as stipulated in the BoQ.

The DC Power supply system shall have a single DCPS system as per conceptual configuration diagram given in Fig.3-1, shall be supplied.

Surge protection devices shall be installed in the DCPS panel to provide adequate protection against current and voltage transients introduced on input mains AC due to load switching and low energy lightning surges.

These protection devices shall be in compliance with IEC 61312, IEC 61024 and VDE 0100-534 for following surges:

It shall be provided with Class 'B' & 'C' type surge protection device. The device must be provided with Class B type lightning current arrester (Switching Type) with a discharge current capacity of at least 50 kA, 10/350 μ s, and Class C type surge arrester (linear device) as per IEC 61643-1. The blind spots shall be avoided in accordance to IEC 61312. The Class 'C' surge protection device should be pluggable type, equipped with features of thermal disconnection, & health indication and potential free contacts for surge arrestors connected between phase & neutral.

The surge protection device shall comply to IEC 61643.

1.5.1 General Technical Requirements for SMPS based DC power supply units

SMPS based DC power supply system is to be used in Auto Float-cum-Boost Charge mode as a regulated DC Power source. DCPS system is to be installed indoors and shall be provided with IP21 panels. The System shall consist of the following:

SMPS modules

- a) Controller module to control and monitor all DCPS modules.

The Panel, Distribution/Switching arrangement shall be provided for the ultimate system capacity. Ultimate System capacity is defined as 150% of the present capacity specified. The ultimate capacity is over and above the requirement of redundancy wherever specified. All factory wiring for the panel shall be for the ultimate capacity so that only plugging-in of SMPS module shall enhance the DC power output.

The size of fuses, MCBs, switch, bus etc shall be suitable for the ultimate capacity.

The SMPS modules of DCPS system shall be suitable for operation from single phase A.C. mains/DG set supply. However, the input AC mains supply to DCPS system shall be 3-phase, 4 wire which shall be evenly distributed among all the offered SMPS modules.

1.5.1.1 Operational/Component Requirements

The basic modules shall operate at specified ratings and conform to requirements stipulated in this specification. The DCPS system shall meet requirement of the latest TEC specification / IEC/BS for other parameters as applicable.

1.5.1.2 Wiring

All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current and voltage during fault and overload. All insulated conductors/cables used shall conform to IS 1554 or equivalent international standard.

1.5.1.3 Bus Bars

High conductivity Cu bus bar shall be provided and shall be sized to take care of the current of ultimate DCPS system capacity for which it is designed. However, it shall not be less than 25mm X 5mm.

1.5.1.4 Earthing

Two earth terminals shall be provided in the frame of the system. The Contractor shall connect these earth terminals to the earth bus. All modules and devices shall be connected to these earth terminals. The hinged door, if provided shall be connected to the panel with braided Cu at two points at least.

1.5.1.5 Marking and Labelling of Cables

The Contractor shall propose a scheme for marking and labelling the inter panel cables by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1 and get it approved from the Employer. A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of the maintenance staff.

1.5.1.6 System and Panel Configuration

The mechanical and electrical requirements of the Panel are described as below:

1.5.1.7 System Configuration

The SMPS modules shall be accommodated in panels. The system shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of DC Power. The system shall be configured for ultimate capacity as brought out in Section 3.1. The Control, Monitoring, Alarm arrangement and DC & AC distribution shall be provided suitably in the panel.

The SMPS modules shall be provided as per the load requirement stipulated in the Appendix, BOQ. The DCPS system shall comprise of N+2 Modules. In case of DCPS system having N=1, the SMPS shall comprise of N+1 modules. Here N refers to number of SMPS modules to meet the load requirements specified in the Appendix, BOQ and battery charging current. The current rating of each module shall be considered as output current of the SMPS module at nominal voltage (48V).

Total current = load current + battery charging current

Where, battery charging current is equal to the 20 % AH of the battery supplied.

$$N = \frac{\text{Total Current}}{\text{Current rating of each SMPS module at 48 V}}$$

The Distribution/switching/Alarm unit shall be provided for the ultimate system capacity. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate capacity so that mere plugging-in of SMPS module shall add to the DC power output.

1.5.1.8 Constructional Features of Panel

For the enclosures/panel, the front door (if provided) shall not be wider than 80 cm and rear door may be of hinged or removable type with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The enclosures shall not exceed 220 cm in height. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be minimum 1.6 mm. The panels/boards shall be equipped with necessary cable gland plates. The degree of protection of DCPS enclosures shall preferably be IP21.

Conductors in multi conductor cables shall be individually colour coded, and numbered at both ends by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1 within enclosures.

Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch and lighting lamp for panel illumination.

The Panel shall be designed to allow cooling preferably by natural convection. The Contractor shall submit detail design of proposed Panel/enclosure and heat dissipation calculations during detailed engineering. Forced cooling is permitted (DC Fans are permitted in the Panel or SMPS module) for equipment mounted

indoors (buildings/rooms/shelters). Proper filtering shall be provided to control dust ingress. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure.

1.5.1.9 Electrical Requirements:

AC input supply: The nominal input frequency is 50 Hz, which may vary from 47.5-52.5Hz. The input voltage shall be as mentioned below:

Field Site Application – Three phase/4Wire (Nominal 415/240 V): $415 \pm 10\% - 15\%$. However, at site the voltage may vary from 160V to 300V (Ph-N). An Auto-Mains Changeover unit shall be provided for each field site DC power supply system. The Auto-Mains Changeover unit shall accept input from two AC sources and extend any one of the available healthy sources to the DC Power supply system.

The suitable HVD (High Voltage Disconnecter) Protection shall be provided at input of each DCPS system. This HVD protection shall protect the SMPS modules of DCPS system against the sustained over voltage at the input.

A tolerance of $\pm 5V$ may be acceptable for protection & alarm operation.

1.5.1.10 DC output Characteristics of Modules

The module shall be capable of operating in "Auto Float-cum-Boost Charge" mode depending on the condition of the battery sets being sensed by the Control unit.

- (a) The float voltage shall be continuously adjustable & pre-settable at any value in the range of -48 to $-56V$ or as per battery manufacturer recommendations either at the module or may be set from the common controller configuration. Further, the prescribed float voltage setting shall be based on recommendations of the battery supplier.
- (b) In Boost charge mode, DCPS shall supply battery & equipment current till terminal voltage reaches set value, as recommended by the battery supplier & shall change over to constant voltage mode
- (c) The DC output voltage variation shall not be more than 2% for load variation from 25% load to full load.

1.5.1.11 Current Limiting (Voltage Droop)

The current limiting (Voltage Droop) shall be provided in DCPS SMPS modules in float and boost charge modes of operation. The float/boost charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of -44.4 volts to -56 Volts or as per manufacturer's specified catalogue.

The float and boost charge current limit adjustment shall be provided in the DCPS system. The SMPS modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

1.5.1.12 Soft/Slow Start Feature

Soft/Slow start circuitry shall be employed such that SMPS module input current and output voltage shall reach their nominal value within 10 seconds.

The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

1.5.1.13 Voltage Overshoot/Undershoot

The requirements of (a) to (c) given below shall be achieved without a battery connected to the output of SMPS modules.

- (a) The SMPS modules shall be designed to minimize DC output voltage Overshoot/Undershoot such

that when they are switched on the DC output voltage shall be limited to $\pm 5\%$ of the set voltage & return to their steady state within 20 ms for load variation of 25% to 100%.

(b) The DC output voltage overshoot for a step change in AC mains as specified in clause 4.3.12 Electrical Requirements shall not cause shut down of SMPS module and the voltage overshoot shall be limited to $\pm 5\%$ of its set voltage and return to steady state within 20ms.

(c) The modules shall be designed such that a step load change of 25 to 100% and vice versa shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

1.5.1.14 Electrical Noise

The Rectifier (SMPS) Modules shall be provided with suitable filter at output with discharge arrangements on shut down of the modules. The Psophometric Noise (e.m.f weighted at 800Hz) with battery connected across the output should be within 2 mV at full load at nominal input AC supply. For test purposes, this shall be taken as equivalent to 4mV when the battery is not connected and in accordance to ITU-T Rec. O.41.

Voltage at the output of the Rectifier (SMPS) module, without battery connected, shall not exceed 300 mV at the switching frequency measured by an Oscilloscope of 50/60 MHz bandwidth (Typical).

1.5.1.15 Parallel Operation

SMPS modules shall be suitable for operating in parallel with one or more modules of similar type, make and rating, other output conditions remaining within specified limits.

The current sharing shall be within $\pm 10\%$ of the average current per rectifier module individual capacity of each rectifier module in the system (mounted in the same or different Panels) when loaded between 50 to 100% of its rated capacity for all other working conditions.

1.5.1.16

1.5.1.17 Protection

The SMPS module, which has failed (for any reason) shall be automatically isolated from the rest of the modules and an alarm shall be initiated for the failure.

1.5.1.18 DC Over voltage protection

DCPS shall be fitted with an internal over voltage protection circuit.

In case output DC voltage exceeds $-57V$ or as per the recommendations of the manufacturer of batteries, the over voltage protection circuit shall operate & shut off the faulty module. A tolerance of $\pm 0.25V$ is permitted in this case.

Shutting off of faulty SMPS module shall not affect the operation of other SMPS modules operating in the Panel. Operation of over voltage shut down shall be suitably indicated and extended monitoring/control unit. The circuit design shall ensure protection against the discharge of the Battery through the SMPS module in any case. The over voltage protection circuit failure shall not cause any safety hazard.

1.5.1.19 Fuse/Circuit Breakers

Fuses or miniature circuit breakers (MCB) shall be provided for each SMPS module as follows:

1. Live AC input line
2. Control Circuit

All fuses/circuit breaker used shall be suitably fault rated.

1.5.1.20 AC Under/Over Voltage Protection

AC input Under/Over voltage protection shall be provided as per clause 3.1.11 for Electrical Requirements. The DC side of the SMPS should also be provided with surge protection device to protect the SMPS in case of transients being generated by the loads or due to induction in the DC line from the AC line running parallel together. The Surge protection device should be able to discharge a current of at least 10 kA of 8/20 μ s (Class 'C' surge arrestor), pluggable and should have indication to show its health to facilitate the replacement on fault condition.

1.5.1.21 Over Load/Short Circuit Protection

The SMPS shall be protected for Over load/Short circuit as per clause 3.1.13 Current Limiting (Voltage Droop).

1.5.1.22 Alarms and indicating lamps

Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on each SMPS module for detection of SMPS module failure.

1.5.1.23 Termination

Suitable termination arrangements shall be provided in the panel for termination of inter cubicle cables from other equipment such as Employers ACDB, Telecom and other associated equipments and alarm cables.

1.5.1.24 DC Terminations

All terminations including through MCBs shall be through lock and screw type terminations. Load and batteries shall be connected to DCPS through appropriate MCBs. The isolation of any of the battery from the load shall create an alarm. DC distribution shall be provided with adequate no. of feeders with appropriate MCBs (6 Amp thru 32 Amp) for termination of the loads. Actual rating of the MCBs shall be finalized during the detail engineering. The no. of feeders shall be minimum 10 (ten) nos.

DC distribution may be done either on wall mounted panel or on the DCPS panel. The proper rated MCB shall be provided at the combined output of the SMPS modules (if not provided at each SMPS module). All the AC, DC and Control/alarm cabling shall be supplied with the Panel. All DC +ve and -ve leads shall be clearly marked. All conductors shall be properly rated to prevent excessive heating.

1.5.1.25 Earthing Cables

Earthing cables between equipment and grounding bus bars shall be minimum size 70 mm² stranded conductors copper/copper strip, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid. Signal and Safety earthing shall be provided separately.

1.5.1.26 Alarms

Following Visual indications/display such as LEDs, LCDs or a combination of both shall be provided to indicate:

Functional Indications for local monitoring:

- a) Mains available
- b) DCPS/SMPSs in Float charge Mode
- c) DCPS/SMPSs in Boost Charge Mode

Alarm Indication for local monitoring:

- a) Load Voltage High /Low
- b) DCPS module/SMPS fail

- c) Mains out of range
- d) System Over Load
- e) Mains "ON"/Battery Discharge
- f) Battery fail/isolated

All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage, 1% in case of DC current and $\pm 5V$ for AC voltage

Alarm Indication for remote monitoring:

- a) Input AC mains supply fail alarm
- b) Battery low voltage (Pre cut off) alarm
- c) DCPS module fail

Potential free Contacts in two numbers for each of the above remote monitoring alarms (one for remote alarm interfaced through communication equipments and one redundant for local monitoring at suitable location) shall be provided. All these potential free contacts are to be wired and terminated at the suitable location for interfacing purpose.

1.5.1.27 Digital Meters/Display Unit

There shall be provision to monitor the following parameters through digital meters or digital display units:

- (a) Input AC voltage.*
- (b) Out put DC voltage*
- (c) Output DC current of charger*
- (d) Battery current*
- (e) Load current.*

The Digital display of meters or LCD based display unit shall be with minimum $3\frac{1}{2}$ digital display of height 12mm and shall have accuracy 1.5% or better.

1.5.2 Cabling & Enclosure Requirements

The contractor shall supply, install and commission all power cables, control cables, network interface cables and associated hardware (lugs, glands, cable termination boxes etc.) as required for all equipment. The contractor shall be responsible for Cable laying and termination at both ends of the cable. The Contractor shall also be responsible for termination of feeder cables at contractor's equipment end including supply of suitable lugs, glands, terminal blocks & if necessary cable termination boxes etc. All cabling, wiring, and interconnections shall be installed in accordance with the following requirements.

1.5.2.1 Power Cables

All external power cables shall be stranded Aluminium conductor, armoured XLPE/PVC insulated and sheathed, 1100V grade as per IS 1554 Part-I.

1.5.2.2 Enclosure/Panel Earthing

Each enclosure shall include suitable earth networks within the enclosure. Earth network shall be a copper bus bar, braid or cable inside enclosures.

The safety earth network shall terminate at two/more studs for connecting with the earthing grid. Safety earthing cables between equipment and enclosure grounding bus bars shall be minimum size 6 sq. mm, stranded copper conductors, rated at 300 volts. All hinged doors (if provided) shall be earthed through flexible earthing braid.

For all enclosures requiring AC input power, the green earthing wire from the AC input shall be wired to the

safety earthing stud. The Contractor shall provide all required cabling between enclosures for earthing. The contractor shall connect safety and signal earths (as applicable) of each enclosure to the Employer provided nearest earth grid/earth riser through suitable 50X6 sq. mm. GI strips or suitably sized copper cable.

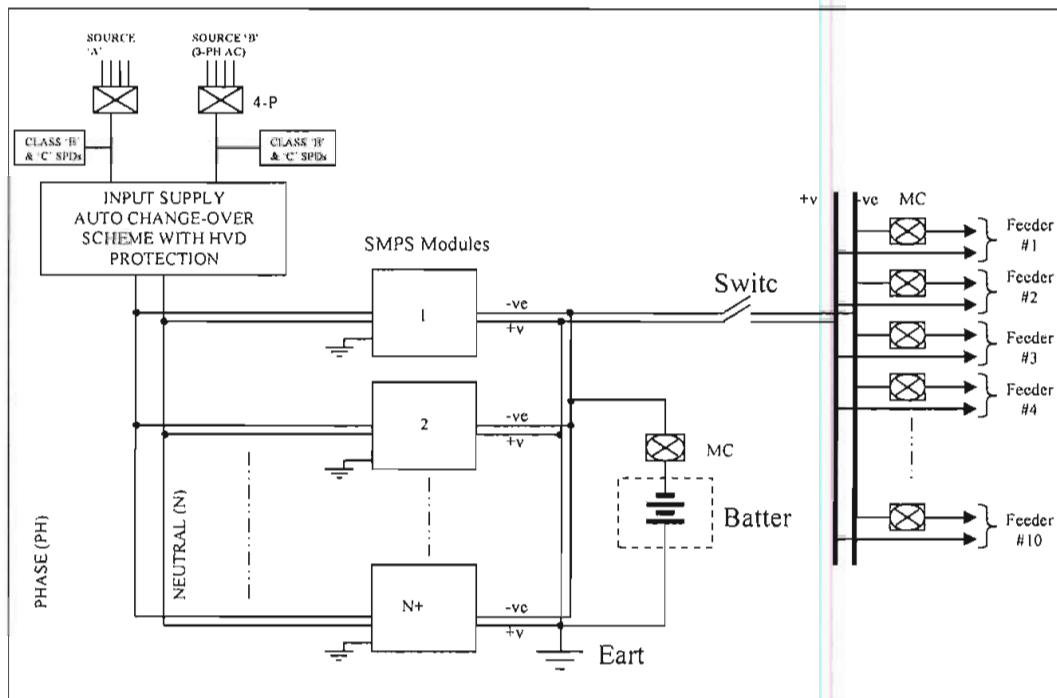
The signal earthing network shall terminate at a separate stud connection, isolated from safety ground. The stud connection shall be sized for an external earthing cable equipped with a suitable lug.

All earthing connections to equipment shall be made directly to each equipment chassis via earthing lug and star washer. Use of the enclosure frame, skins, or chassis mounting hardware for the earthing network is not acceptable.

1.5.3 Temperature Compensation for Battery

There shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the SMPS output voltage to match the battery temperature dependent charge characteristics. The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 72 mV (3mV/cell, 24 cell battery) per degree increase or decrease in temperature over the set voltage or as may be recommended by the VRLA Battery supplier. A tolerance of +/- 5mV may be acceptable over the specified rate of 72 mV/degree C. The output voltage shall decrease till the open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell. The increase in output voltage due to decrease in temperature has been taken care of by the tripping of the unit due to output voltage high (57V) protection. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage. The nominal distance between the battery & DCPS system may be 20 metres. The Contractor shall provide the necessary sensor and cord for the purpose with DCPS system to sense the Battery temperature.

FIG.: CONCEPTUAL CONFIGURATION OF DC POWER SUPPLY (DCPS) SYSTEM (For Field Sites Locations)



1.5.4 Battery Requirements

1.5.4.1 Valve Regulated Lead Acid (VRLA) maintenance free Battery

The contractor shall supply Valve Regulated Lead Acid (VRLA) maintenance free Battery. Each battery set shall have sufficient capacity to maintain output at full rated load as indicated in BOQ in **Appendix**. The battery shall be capable of being recharged to 90% State of Charge (SOC) from the fully discharged condition (1.75V/cell) within 8 hrs. In all cases, the battery is normally not allowed to discharge beyond 80% of rated capacity (80% DOD) at 10 hours rate of discharge.

The supplier, supplying the cells/batteries as per this document shall be responsible to replace/repair free of charge, the battery/cell becoming faulty, owing to defective workmanship or material as per the provisions of the bid document

1.5.4.2 Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28%. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

1.5.4.3 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

1.5.4.4 Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

1.5.4.5 Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

1.5.4.6 Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27°Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 8 hrs. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life. Float voltage of each cell in the string shall be within the average float voltage/cell $\pm 0.05V$ band.

The capacity (corrected at 27°Celsius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

- (a) After Six minutes of discharge : 1.98V/cell
- (b) After Six hours of discharge : 1.92V/cell

- (c) After 8 hours of discharge : 1.85V/cell
- (d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35° Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within $\pm 0.05V$ of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

1.5.4.7 Expected Battery Life

The battery shall be capable of giving more than 1200 charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected operational life of 5 years at normal operating conditions or 1200 charge/discharge cycles (whichever is early).

1.5.4.8 Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply one set of following tools:

- a. Torque wrench.
- b. Tool for opening /closing of pressure regulation valve of battery.

1.5.4.9 Testing requirements

The Contractor shall submit type test reports for the battery for the same make, model & rating as offered as per the IEC 60896 or equivalent IS/EN/BS/TEC standards. In the event, the type test reports for exact rating is not available, the Contractor shall submit type test reports for higher rating Battery.

1.5.4.10 List of Type Tests

The type testing shall be conducted on the following equipment

- (a) DCPS
- (b) Battery System

1.5.4.10.1 Type testing of DCPS

The test reports for Immunity, Emission and safety must be in accordance with relevant IEC/CISPR standards shall be submitted. The Contractor shall submit the DCPS type test reports of earlier conducted tests on the same make, model, type & rating which shall include the following tests listed in Table A.

Table A	
Type Tests on DCPS	
1	Surge immunity (Level 4- as per IEC 61000-4-5)
2	Electrical Fast Transients/Burst (Level 4 – as per IEC 61000-4-4)
3	Electrostatic Discharge (Level 4 – as per IEC 61000-4-2)
4	Radiated Electromagnetic Field (Level 3 – as per IEC 61000-4-3)
5	Conducted disturbances induced by radio-frequency field (Level 3 – as per IEC 61000-4-6)
6	Damped oscillatory magnetic field (Level 3 – as per IEC 61000-4-10)
7	Voltage dips, short interruptions and voltage variations (Level 2 – as per IEC 61000-4-11)
8	Conducted Emission (Level - Class A, Group 1 as per IEC CISPR 11)
9	Radiated Emission (Level - Class A, Group 1 as per IEC CISPR 11)

Table A Type Tests on DCPS	
10	Safety Tests (as per IEC 60950)

15.4.10.2 Testing Requirements of Battery

Table B List of tests for VRLA battery				
Sl. No.	Test	Type Test As per IEC 60896	FAT	SAT
1.	Verification of marking - Visual observation - Dimensional inspection - Polarity checking	√	√	√
2.	Capacity test	√	√	√
3.	Suitability for floating battery operation	√		
4.	Endurance in discharge/charge cycles	√		
5.	Charge Retention	√		
6.	Short-circuit current and internal resistance	√		
7.	Mechanical Tests - Vibration Test (procedure as per IEC 60068-2-6) - Free fall Test (procedure as per IEC 60068-2-32)	√		
NOTE : The batteries shall meet the general requirements as per IEC 60896 or equivalent.				

1.5.4.11 Factory Acceptance Tests

1.5.4.11.1 FAT/SAT of DCPS

The factory/site tests to be carried out on DCPS system/module in the factory and site are listed respectively in Table C below.

Table C Lists of tests for FAT/SAT of DCPS			
S.No.	Test	FAT	SAT
Tests on DCPS System			
1.	Mechanical & Visual Check Tests	√	√
2.	Insulation Test.	√	
3.	High Voltage Withstand Test	√	
4.	Switch On Test	√	√
5.	DCPS Low voltage & High voltage limits check Test	√	√
6.	Pre-alarm test for Battery Voltage Low	√	√

Table C			
Lists of tests for FAT/SAT of DCPS			
S.No.	Test	FAT	SAT
7.	Battery Low Voltage Disconnect Level Test	√	√
8.	AC Input Low and High voltage limits check Test	√	
9.	Rectifier Fail Alarm Test	√	√
10.	Voltage Regulation Test	√	
11.	Current Sharing Test	√	
12.	Total Output Power Test	√	√
13.	Hot Plug In Test (if applicable)	√	√
14.	Calibration & Parameter settings	√	√
15.	Automatic Float cum Boost Charge Mode Change Over Test	√	√
16.	Battery Path Current Limiting Test	√	√
17.	Battery Charging and full load Current Test	√	√
18.	Total Harmonic distortion Test	√	
19.	Burn in Test at 50 ° C (for 8 hrs duration)	√	
Tests on SMPS module			
20	Mechanical & Visual Check Test	√	
21	Module-On Test	√	
22	Input low/high voltage cut-off test	√	
23	Voltage Drop Test	√	
24	Voltage Regulation Test	√	
25	Power Output & Current Limit Test	√	
26	DC High Voltage Test	√	
27	O/P Voltage Ripple Test	√	
28	Psophometric Noise Test	√	
29	Efficiency Test	√	
30	Power Factor	√	
31.	Input Current Limit	√	
32.	Input AC Frequency Range Test	√	
33.	Rectifier Dynamic Response	√	
34.	Output Short Circuit Test	√	
35.	Hold up Time Test	√	

-----End of this Section-----

SECTION-III

PROJECT DETAILS & GENERAL SPECIFICATION

SITE INFORMATION

	Particular	Details	
a)	Owner	POWERGRID	
b)	Customer	POWERGRID	
c)	Project Title	765/400kV Switchyard at Medinipur & Jeerat	
d)	Location	Medinipur West Bengal	Jeerat (new) West Bengal
e)	Transport Facilities	Nearest rail head - Medinipur	Nearest rail head - Kolkata
SITE CONDITIONS			
a)	Max. ambient air temp.	50°C	
b)	Min. ambient air temp.	0°C	
c)	Max. design ambient emp.	50°C	
d)	Design reference temp.	50°C	
e)	Average Humidity	Max. 100%	
f)	Special corrosion conditions	No	
g)	Solar Radiation		
h)	Atmospheric UV radiation	High	
i)	Altitude above sea level	Less than 1000meter	
j)	Pollution Severity	High Pollution level	
k)	Seismic Zone	As per the seismic zone defined in the relevant BIS / IEC-62271-300 but not less than 0.3g horizontal	
WIND DATA			
	Wind velocity	50m/s	
	Average No. of thunderstorm days per annum	As per IS	

	Main Electrical Parameters:	
	Fault Levels:	765kV: 50kA for 1 sec 400kV: 63kA for 1 sec 66kV : 25kA for 3 sec
	Creepage Distance	31mm/kV for string insulator hardware and 25mm/kV for Equipment

1.0 GENERAL

This Chapter covers Technical Requirements and requirements of auxiliary items.

- a) Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes unless included in the list of exclusions.
- b) Material and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.
- c) Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.
- d) In case any Deviation Schedule, Bid Proposal Sheet, Schedule of Data Requirements (DRS), test reports or any other document/information are not furnished along-with the bid, the bid is liable to be rejected. Unless brought out clearly, the Bid will be deemed to conform to the specification scrupulously. All deviations from the specification shall be clearly brought out in the respective deviation schedule.
- f) The Bidder shall clearly indicate in the bid, the specific standards in accordance with which the works will be carried out.
- g) The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of art, and in accordance with purpose for which they are intended and ensure satisfactory performance throughout the service life.
- h) All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same materials and workmanship as the corresponding parts of the equipment. Where feasible, common components, units shall be employed in different pieces of equipment in order to optimize the spare part stock-up and utilization.

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

2.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

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

3.0 SUPPORT STRUCTURES (If in the scope of Bidder)

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

4.0 STANDARDS

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

5.0 ENGINEERING DATA AND DRAWINGS

- 5.1 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award. The supplier shall necessarily submit all the drawings/ documents unless anything is waived.
- 5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. POWERGRID has standardized a large number of drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Purchaser will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Purchaser shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.4 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.5 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Purchaser in Writing.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

- | | | |
|-----|--|---|
| i) | Approval/comments/
Purchaser on initial | As per agreed by
schedule submission |
| ii) | Resubmission | Within 3 (three) weeks |

	(whenever required)	from date of comments
iii)	Approval or comments	Within 3 (three) weeks of receipt of resubmission.
iv)	Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre)	2 weeks from the date of approval
v)	Furnishing of distribution copies of test reports	
(a)	Type test reports (one scanned softcopy in pdf format per substation plus one for corporate centre & one hardcopy per substation)	2 weeks from the date of final approval
(b)	Routine Test Reports (one copy for each substation)	-do-
vi)	Furnishing of instruction/ manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)	As per agreed schedule operation
vii)	As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre & per substation)	On completion of entire works

NOTE :

- (1) The supplier may please note that all resubmissions must incorporate all comments given in the earlier submission by BHEL/POWERGRID or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.
- (2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.
- (3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the supplier to BHEL/POWERGRID.
- (5) The manufacturer shall furnish to the Purchaser catalogues of spare parts.
- (6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

6.0 MATERIAL WORKMANSHIP

6.1 General Requirement

- 6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.
- 6.1.2 Incase where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the supplier.
- 6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the BHEL/POWERGRID.
- 6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
- 6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

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- 6.1.6 The supplier shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The supplier shall apply all operational lubricants to the equipment installed by him.
 - 6.1.7 All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help POWERGRID in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.
 - 6.1.8 Corona and radio interference voltage test and seismic withstand test (for 132kV and above voltage level) procedures for equipments shall be in line with the procedure given at Annexure-A and B respectively.

6.2 Provisions For Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

6.2.1 Space Heaters

- 6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. On-off switch and fuse shall be provided.
- 6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.
- 6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

- a) Installed out door: IP- 55
- b) Installed indoor in air conditioned area: IP-31
- c) Installed in covered area: IP-52
- d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.
- e) For LT Switchgear (AC & DC distribution Boards) : IP-52

The degree of protection shall be in accordance with IS:13947 (Part-I) / IEC-60947(Part-I) / IS 12063 / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the supplier unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

- 7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.
- 7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
- 7.3 The supplier shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of

the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The supplier has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.

7.5 The supplier will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the supplier's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the supplier shall adopt suitable quality assurance programme to control such activities at all points necessary. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the supplier shall generally cover the following:

- (a) His organization structure for the management and implementation of the proposed quality assurance programme;
- (b) Documentation control system;
- (c) Qualification data for bidder's key personnel;
- (d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- (e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
- (f) Control of non-conforming items and system for corrective actions;
- (g) Inspection and test procedure both for manufacture and field activities.
- (h) Control of calibration and testing of measuring instruments and field activities;
- (i) System for indication and appraisal of inspection status;
- (j) System for quality audits;
- (k) System for authorising release of manufactured product to the Purchaser.
- (l) System for maintenance of records;
- (m) System for handling storage and delivery; and
- (n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to

each item of equipment furnished and/or services rendered.

POWERGRID/BHEL or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the supplier/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The supplier would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of POWERGRID/BHEL inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

9.2 The reports for all type tests as per technical specification shall be furnished by the supplier alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all project with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the date of bid opening i.e. **23.11.16**. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the date of bid opening, the contractor shall repeat these test(s) at no extra cost to BHEL.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the date of bid opening.

- i) Lightning Impulse Test
- ii) Switching Impulse Test
- iii) Multiple Chopped Impulse Test (For CT)
- iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the date of bid opening i.e. **23.11.16**, the contractor shall repeat these test(s) at no extra cost to the purchaser.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

The supplier shall intimate the BHEL/POWERGRID the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the supplier.

- 9.3 The Purchaser intends to repeat the type tests on Power Transformer and Shunt Reactor except Dynamic short circuit tests on transformers, for which test charges shall be payable as per provision of contract. The price of conducting type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. BHEL/POWERGRID reserves the right to witness any or all the type tests. The BHEL/POWERGRID also reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.

The Purchaser shall bear all expenses for deputation of purchaser's representative(s) for witnessing the type tests under this clause except in the case of re-deputation if any, necessitated due to no fault of the purchaser.

For outdoor receptacles, trefoil clamps, diesel engine, alternator, motors, cable glands, lighting fixtures, ACSR/AAC conductor, IPS aluminum tube and junction boxes, type test reports are not required to be submitted for the makes indicated at Annexure-E /POWERGRID approved list of subvendors. For the new makes(other than those indicated at Annexure-E / POWERGRID approved list of subvendors), type test reports as per relevant standard shall be submitted for POWERGRID's approval.

- 9.4 The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- 9.5 The supplier shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and POWERGRID. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser/inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the

Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.6 The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.7 When the factory tests have been completed at the Contractor's or Sub- Contractor's works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Purchaser /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

9.8 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser /Inspector or to his authorised representative to accomplish testing.

9.9 The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

9.10 The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

9.11 The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Purchaser.

10.0 TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Purchaser and the Contractor for correctness and completeness of

installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by POWERGRID on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.

12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. For items lower than 6mm thickness

requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m minimum.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Glossy white colour inside the equipments /boards/panels/junction boxes is also acceptable. The exterior colour for panels shall bematching with the existing panels in case of extension of a substation. Each coatof primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Purchaser's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line – Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditioning System			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

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- 13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.
- 13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipments shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipments are to be stored indoors only. Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations. During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.
- 13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- 13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- 13.6 Supplier shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- 13.7 The supplier shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by
-

Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.10 The words 'erection' and 'installation' used in the specification are synonymous.

13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated under section "Electrical & Mechanical Auxiliaries" having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

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

Combined variation of voltage and frequency shall be limited to $\pm 10\%$.

16.0 SUPPORT STRUCTURE (If in the scope of supplier)

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter and 5.9 meter from plinth level for 765

kV,420 kV and 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to IS:5561 & NEMA CC1 and shall be made of materials listed below :

- | | | |
|----|--|---|
| a) | For connecting ACSR conductors | Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617 |
| b) | For connecting equipment terminals made of copper with ACSR conductors | Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 of IS:617 with 2mm thick bimetallic liner and all test shall conform to IS:617 |
| c) | For connecting G.I | Galvanised mild steel shield |
| d) | i) Bolts, nuts & Plain, washers | i) Electrogalvanised for sizes below M12, for others hot dip galvanised. |
| | ii) Spring washers items 'a' to 'c' | ii) Electro-galvanised mild for steel suitable for atleast service condition-3 as per IS:1573 |

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.

17.4 Low voltage connectors, grounding connectors and accessories for grounding allequipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities.

All sharp edges and corners shall be blurred and rounded off.

- 17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.
- 17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.
- 17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 17.10 Clamps and connectors shall be designed to be corona controlled.

17.11 Tests

- 17.11.1 Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).
- i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)
 - ii) Short time current test
 - iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)
 - iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

- 18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:
- 18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.
- 18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

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- 18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.
- 18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, IS:11149 and IS:3400. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.
- 18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.
- 18.7 A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.
- 18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .
For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.
- 18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.
- 18.10 Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.
- 18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/earthing by pasting the same on the inside of the door.
- 18.12 a) The following routine tests alongwith the routine tests as per IS:5039 shall also be conducted:
i) Check for wiring
ii) Visual and dimension check
b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.
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19.0 Deleted.

20.0 TERMINAL BLOCKS AND WIRING

- 20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.
- 20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago or equivalent make.
- 20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.
- 20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.
- 20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.
- 20.6 The terminal blocks shall be of extensible design.
- 20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.
- 20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.
- | | | |
|----|------------------------------------|--|
| a) | All circuits except CT/PT circuits | Minimum of two of 2.5 sq copper flexible. |
| b) | All CT/PT circuits | Minimum of 4 nos. of 2.5 sq copper flexible. |
- 20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.
- 20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.
- 20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.
- 20.13 The supplier shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For

equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge overvoltages either transferred through the equipment or due to transients induced from the EHV circuits.

- 20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

21.0 LAMPS & SOCKETS

21.1 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.3 Switches and Fuses:

- 21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

- 21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

- 22.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC- 60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS:5621. The support insulators shall be manufactured and tested as per IS:2544/IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable. The bidder may also offer composite hollow insulators, conforming to IEC-61462.
- 22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- 22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.
- 22.4 Support insulators/bushings/hollow column insulators shall be designed to

have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS:2544 & IS : 5621.

23.0 MOTORS

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

23.1 Enclosures

- a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691.
- b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
- c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.
- d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

- a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.
- b) Motor shall be capable at giving rated output without reduction in

the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

23.3 Starting Requirements:

- a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.
- b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325.
- d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.
- e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

- a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325 (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.
- b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
- c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

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- (a) Insulation resistance.
 - (b) Phase sequence and proper direction of rotation.
 - (c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.
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ANNEXURE-A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

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

2. Test Levels:

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

3. Test Methods for RIV:

- 3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.
- 3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.
- 3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.
- 3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

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- 3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.
- 3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

For recording purpose, modern devices utilizing UV recording methods such as image intensifier may also be used.

- 4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.
- 4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a

voltage which results in corona.

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

5. Test Records:

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

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

ANNEXURE-B

SEISMIC WITHSTAND TEST PROCEDURE

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

The Bidder shall arrange to transport the structure from his Contractor's premises/POWERGRID sites for the purpose of seismic withstand test only. The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Purchaser. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the POWERGRID.

SECTION 4

ENCLOSURES TO SPECIFICATIONS

ANNEXURE 1	CHECK LIST FOR INFORMATION TO BE FURNISHED WITH THE OFFER
ANNEXURE 2	SCHEDULE OF DEVIATION

CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER

BIDDER SHALL PUT A TICK '✓' IF THE INFORMATION IS ENCLOSED WITH THE OFFER, PUT A CROSS 'X' IF THE INFORMATION IS NOT ENCLOSED OR WRITE 'NOT APPLICABLE' IF THE QUERY/ SCHEDULE IS NOT RELEVANT AND RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

BIDDER:

OFFER REFERENCE:

1. Technical offer with detailed schedules of equipment/ material and spares _____
2. Schedule of Deviations listing deviations, if any, clause-wise with respect to technical specification _____
3. List of past supplies complete with Purchase Order & Project name, quantity, order reference, etc., where identical equipment have been supplied. _____
4. Manufacturer's Quality Plans for approval _____
5. Field Quality Plan for approval _____
6. General Arrangement drawings with dimensions and weights and foundation/ fixing details _____
7. Drawing/ data submission Schedule _____
8. Type test reports. The type test reports shall be accompanied with a list listing all the relevant clauses of the applicable standard and the corresponding type test report. The manufacturer shall also furnish a certificate certifying that the test reports have been carried out on equipment identical in all respects to the one offered. In case the reports are for a different equipment and the applicability of the report is permitted as per applicable standards, the justification shall be enclosed to the list of type test reports. _____
9. Bar Chart showing time schedule showing time required for design, manufacture, test and inspection, transport, erection, site testing and commissioning _____
10. Makes of all important components, like motors, operating switches, fuses, etc. _____
11. Any additional information called for in any part of the technical specification. _____

Date:

Signature of the authorized representative of Bidder

Company Seal

SCHEDULE OF DEVIATIONS

Certified that the following are only deviations from the specification (for the equipment and systems being offered)

S.No.	Page No.	Clause No.	Deviation	Reason / Justification
-------	----------	------------	-----------	------------------------

Date :

Signature :

Name:

Designation :

Technical Specifications for Phasor Measurement Unit (PMU)

Technical Specifications for Phasor Measurement Unit



SECTION 1: PHASOR MEASUREMENT UNIT (PMU) REQUIREMENTS 3

1.0	GENERAL REQUIREMENTS.....	3	
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Section 1: Phasor Measurement Unit (PMU) Requirements

1.0 General requirements

The offered PMUs shall be complete in all respect including GPS receiver. The PMU shall be integrated with Phasor Data Concentrators (PDCs) installed at Control centers of SLDC/RLDC and NTAMC (National Transmission Asset Management Center) /NLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard. The scope of Integration shall be upto the supplied PMUs and associated substation switches only.

The supplied PMUs shall be mounted in the C&R/SAS panels being supplied by the Contractor for respective substation package and interface cabling requirements shall be as applicable for relay.

1.1 PMU Requirements

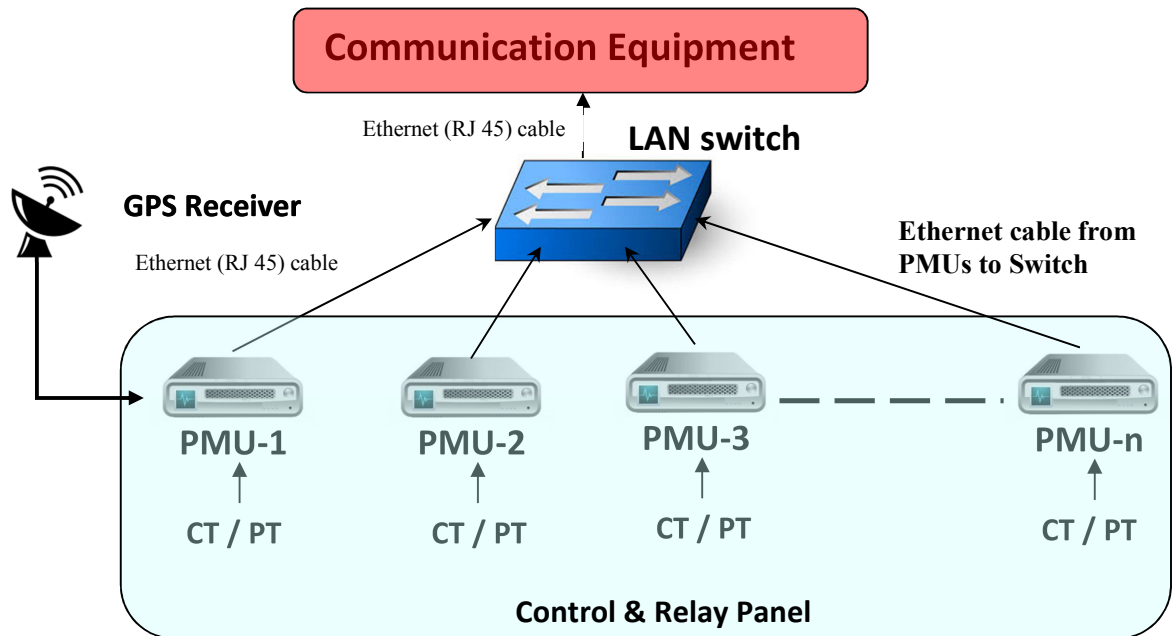
1.1.1 PMU Functional Requirements

The supplied PMUs shall be compliant to M class requirements of IEEE C37.118 Standards (latest version released in 2014).

The PMUs shall communicate with PDC at Control center over the communication link provided by the Employer. For this, PMU shall be provided with One Ethernet port of 10/100 Base Tx and one optical fiber port of 100 Mbps for streaming the data in UDP/IP multicast in IEEE C37.118 format. The supplied PMUs shall be suitable to operate on unearthed 220 V DC or 110V DC or 48V DC (+10%, -15%) power supply as available in the substation.

The PMU shall support data 'Reporting Rates' of 25, and 50 frames per seconds for 50 Hz System. The actual rate to be used shall be user selectable. All the PMU hardware and software shall be sized considering 50 frames per second. The typical network architecture of PMUs at substation is given at Fig 1.1 & Fig 1.2 below. The Data Requirement Sheets (DRS) of PMUs and associated items are mentioned at **Annexure-I**.

At Sub Station Control Room



**PMU installed at Sub-Station Control Room
(with Centralized C&R Panels)**

Fig 1.1: Typical Network Architecture at Sub Station Control Room

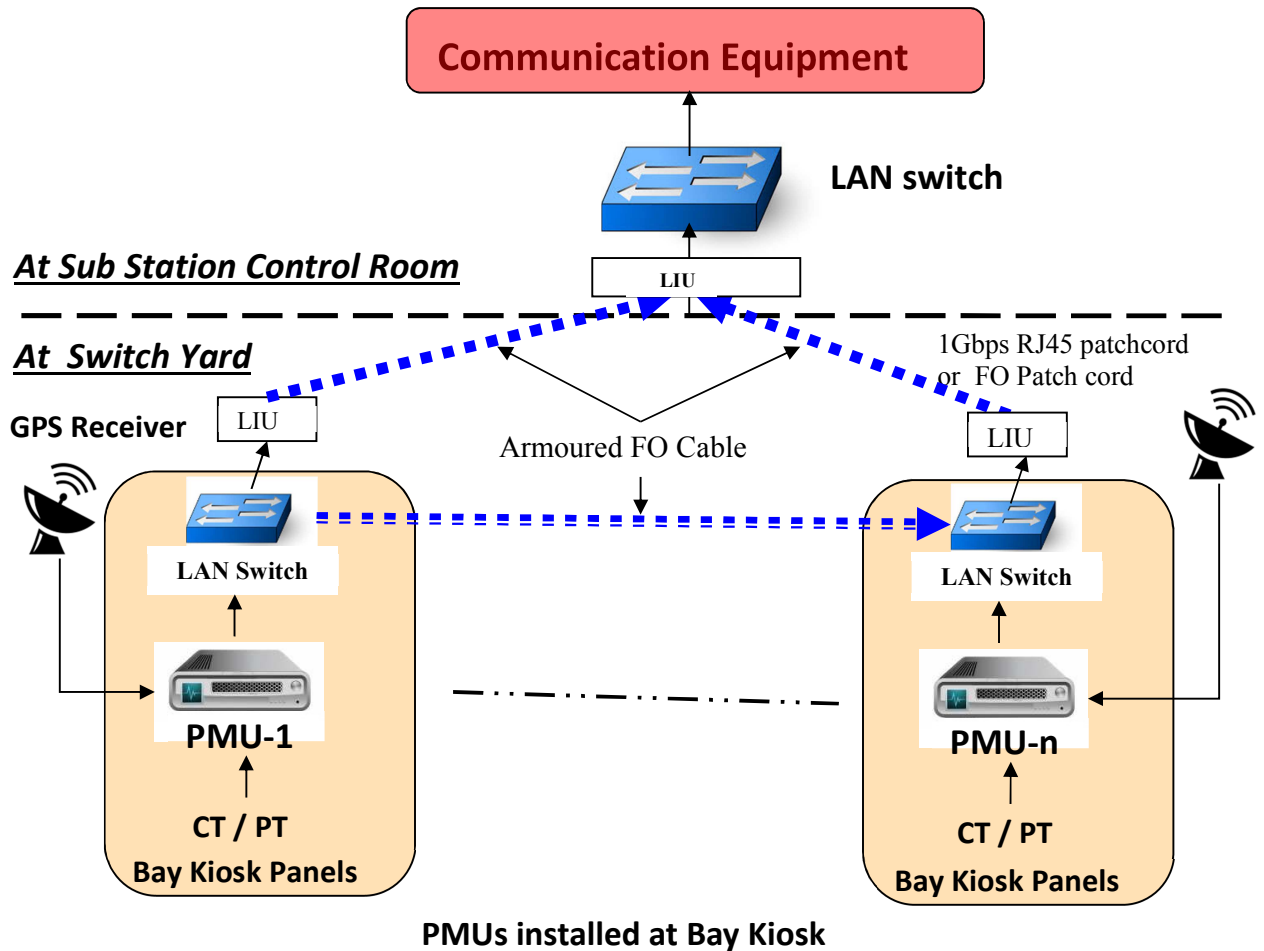


Fig 1.2: Typical Network Architecture at Sub Stations having Bay Kiosks at Switch Yard.

PMUs shall be provided to measure Voltage and Current Phasors of feeders and transformers specified in the BoQ. PMU shall also measure status of master protection and circuit breakers for units, feeders and transformers as per SLD. The PMUs shall be able to measure/calculate following:

- 3-phase voltage Phasors,
- 3-phase current Phasors,
- positive sequence voltage,
- positive sequence current,
- Breaker Status
- Main Protection Status
- Frequency,

- Rate of Change of Frequency (ROCOF) $-df/dt$,

Provision shall be made for user selection of measured value.

A time synchronization system (GPS receiver) shall be provided with PMU. The PMU shall have internal clock, which shall be synchronized with GPS clock. Upon loss of signal from the GPS source, the PMU shall detect a loss-of-signal and generate an alarm which will be transferred to PDC. Upon loss of signal, the PMU time facility shall revert to an internal time base. The internal clock shall have minimum stability of 1 ppm.

There shall be provision for HMI (Human Machine Interface) in PMU for configuration. The HMI shall also display the real time measured values. Alternatively Portable configuration device for PMUs can be provided for configuring the PMUs. Testing & configuration accessories such as test switch, connector, software, hardware etc., which are required for testing and configuration changes locally, shall be supplied.

The PMUs shall have continuous self-monitoring ,diagnostic feature and capable to identify & communicate problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC.

The Data Requirement Sheets (DRS) of PMU are mentioned at **Annexure-I**.

1.2 GPS based Time Facility

The PMU requires time reference to UTC. A GPS based time facility to synchronize PMU clock with Coordinated Universal Time (UTC), shall be provided except in case of in-built GPS in each PMU. The GPS receivers to be offered shall meet the supplied PMUs interface and accuracy requirements.

The time receiver shall include propagation delay compensation and shall also include an offset to permit correction to local time to achieve time accuracy of at least ± 0.2 microseconds (μs). Within one minutes of reacquisition of signal, the time shall return to within 0.2 micro-second of UTC. Proper correction of leap second shall be provided. The signal sent to PMU from the GPS receiver shall be UTC or provide information to the PMU to correct the time to UTC by using the IRIG-B time profile as per IEEE Standard C37.118. The supplied GPS shall be IEEE1588v2.0 (PTP) compliant.

The supplied GPS shall have “one IRIG-port plus 1 PPS port” and one Ethernet port as minimum.

In some of the locations, GPS shall be installed in switchyard along with PMU. GPS must be suitable to work in such Electrical environment.

1.3 Industrial Grade Layer-3 LAN Switch

The PMUs at Substations/Power Plants shall be connected to the communication equipment through an industrial grade Layer-3 LAN switch. The industrial grade LAN switch shall interface PMUs on one side and communication equipment on the other side. The LAN switch shall operate on 220V DC or 110 V DC or 48V (+10%, -15%) DC supply voltage of station.

1.4 Armoured Fibre Optic cables

Fibre optic cables within the control room shall be of armoured type for protection against rodents and physical stresses. Fibre optic cables, required to be laid in the switchyard shall also be of armored type. The characteristics of the fibre optic shall be as per the IEC 60870-5-103 standard. The fibre optic cables shall be run in GI conduit pipes while passing through cable trenches / cable racks outside the control room building. The fibre optic cables inside the panel shall be neatly laid and tied. Data Requirement Sheets (DRS) of armoured FO cables are given in **Annexure-I**.

1.5 Cabling & Interconnections

All cabling between component units of the PMU, PMU to GPS along with antenna and to the Employer control and relay panels (located in the substation control room) shall be supplied and installed by the Contractor and shall be shown on Contractor supplied drawings. Plug-type connectors with captive fasteners or compression type connectors shall be used for all internal interconnections. The connectors shall be polarized to prevent improper assembly. Each end of interconnection cables shall be identified by a marker which includes the cable number and the identifying number and location of each of the cable's terminations. This information shall match with the Contractor's drawings.

Adequate space and hardware shall be provided for routing of the field wiring within the enclosures. Contractor wiring within enclosures shall be neatly arranged and shall not be directly fastened to the enclosure frame. All internal interconnection wiring and cables shall be routed separately from field wiring to the PMU terminals & power wiring. All wiring shall use copper conductors and have flame retardant insulation. Conductors in multi-conductor cables shall be individually colour coded.

The use of non-flammable, self-extinguishing, plastic wire troughs is permissible. Metal clamps must have insulating inserts between the clamps and the wiring. Wiring between stationary and movable components, such as wiring across door hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wiring.

The bidder shall be responsible for laying and termination of all cables required under the project which includes interconnections among bidder supplied equipment and their interconnection with employer's panels. Testing and commissioning of these interconnections shall also be done by the bidder.

1.6 Wiring/Cabling requirements

Shielded (screened) cables shall be used for external Cabling from the PMU/ SIC panels. These 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 sq.mm for PT cables, 4 sq.mm for CT cables and 2.5 sq.mm for Power & Control outputs and 1.5 sq.mm for Digital Status inputs, transducer mA current output
- c) Rated voltage U_0/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, cross-section, and year of manufacture.

The Communication cable shall be of shielded, twisted pairs and of minimum 0.22sq mm size Copper cable or Fibre optic cable.

1.7 PMU TESTING

(a) Type Testing

The list of Type tests applicable on the PMU is mentioned in **Table-1** & type test requirements are mentioned in **Table-2**. The contractor may optionally submit type test reports for all the tests conducted at accredited laboratory for review & approval by Employer. However, in the event, the type test reports are not meeting the specification requirement, Employer may ask for the type testing above tests (EMI/EMC, Environmental & Functional tests) as required at no additional cost.

(b) Routine Testing

Each complete unit shall undergo routine testing. The list of Routine tests to be performed in the factory is mentioned in **Table-1**. Few samples of PMUs from each Package shall be tested at the PMU Test Lab being set up in India by POWERGRID before taking up mass production.

(c) Field Tests

The Contractor shall carry out the field-testing of PMUs after installation and integration with C&R panels. The list of field tests is mentioned in **Table-1**.

Table-1: List of Tests on PMU:

**Technical Specifications
for Phasor Measurement Unit**



Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
FUNCTIONAL TESTS FOR PMU				
1.	Check for BOQ, Technical details, Construction & Wiring as per PMU drawings		√	√
2.	Check for PMU database & configuration settings		√	√
3.	Check the operation of all Analog inputs, Digital and Status input points of PMU		√	√
4.	Check operation of all communication ports of PMU	√	√	√
5.	Check for communication between PMU and PDC	√		√
6.	Test for PMU time synchronization from GPS	√		√
7.	Test Power Supply Voltage Margin, Ripple Levels and Short Circuit Protection	√		
8.	Test for PMU operation with DC power supply voltage variation	√		
9.	Check for auto restoration of PMU on DC power recovery after its failure	√	√	√
10.	Test for PMU diagnostic feature	√		
11.	Accuracy tests as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard	√		
12.	Test for PMU internal Clock stability	√		
13.	End to end test (between PMU&PDC) for all I/O points			√
14.	Testing and Configuration of PMU from HMI or Portable Configuration tool	√	√	√
EMI/EMC IMMUNITY TESTS FOR PMU				
15.	Surge Immunity Test as per IEC 61000-4-5 & IEC 60255-22-5	√		
16.	Electrical Fast Transient Burst Test as per IEC 61000-4-4 & IEC 60255-22-4	√		
17.	Damped Oscillatory Wave Test as per IEC 61000-4-18 & IEC 60255-22-1	√		
18.	Electrostatic Discharge test as per IEC 61000-4-2 & IEC 60255-22-2	√		
19.	Radiated Electromagnetic Field Test as per IEC 61000-4-3 & IEC 60255-22-3	√		
20.	Damped Oscillatory magnetic Field Test as per IEC 61000-4-10	√		
21.	Power Frequency magnetic Field Test as per IEC 61000-4-8	√		
INSULATION TEST FOR PMU				
22.	Power frequency voltage withstand Test as per IEC 60255-22-5	√		
23.	1.2/50 μ s Impulse voltage withstand Test as per IEC 60255-22-5	√		

**Technical Specifications
for Phasor Measurement Unit**



24.	Insulation resistance test	√		
ENVIRONMENTAL TEST FOR PMU				
25.	Dry heat test as per IEC60068-2-2 / 2-3	√		
26.	Damp heat test as per IEC60068-2-78	√		
27.	Cold Test as per IEC60068-2-1	√		

Note: Test levels for above type tests are elaborated in Table 2

Table-2: PMU Type Test Requirements

Test Nos	Test Name	EUT Status	Test Level	Power Supply Points		I/O Points	Passing Criteria
				CM	DM	CM	
1	Surge Immunity Test	ON	Level 3	2 kV	1 kV	2 kV	A
2	Electrical Fast Transient Burst Test	ON	Level 3	2 KV	-	1 kV	A
3	Damped Oscillatory Wave Test	ON	Level 3	2.5 kV	1 kV	2.5 kV	A
4	Electrostatic Discharge Test	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode			A
5	Radiated Electromagnetic Field Test	ON	Level 3	10 V/m electric field strength			A
6	Damped Oscillatory Magnetic Field Test	ON	Level 3	10 A/m at 1MHz of magnetic field strength			A
7	Power frequency magnetic field	ON	Level 3	30 A/m of magnetic field strength (Continuous duration sine wave)			A
8	Power frequency voltage withstand	OFF	-	1 kV rms for 1 minute			No break down or flashover shall occur
9	1.2/50μs impulse voltage withstand	OFF	-	2 kVp			No break down or flashover shall occur
10	DC Voltage Dips & Interruptions / Variation as per IEC 61000-4-29	ON	-	-			-

Technical Specifications for Phasor Measurement Unit



11	Insulation Resistance Test	OFF	-	Measure Insulation resistance using 500 VDC Megger before & after Power Freq& Impulse voltage withstand tests	As per manufacturer standard
12	Dry heat test	ON	-	Continuous operation at 55 ⁰ C for 16 hrs	0
13	Damp heat test	ON	-	at 95% RH and 40 ⁰ C for 16 hrs	0
14	Cold test	ON	-	Continuous operation at 0 ⁰ C for 96 hrs	0

Note:-

1. EUT - Equipment Under Test
2. CM - Common Mode; DM - Differential mode
3. I/O points do not include Communication ports
4. Passing Criteria
 - 0 - no failure: normal performance within the specified limits
 - A: minor failure: temporary degradation or loss of function or performance which is self- recoverable
5. Functional test as per the sl. nos. 1-14 of Table-1 shall also be done during type testing.

Annexure-I: BOQ for PMUs and associated items

BOQ for PMUs and associated Substation items			
S. No	Name of the item	Unit	Substation Name
			No of 400kV transmission lines – “x”
	Hardware		
1	PMU	No.	X
2	Time System (GPS Receiver)	Nos.	X
3	Substation Grade Layer-3 LAN Switches with minimum 4 x 10/100 Mbps Ethernet ports and 2 x 1 Gbps Ethernet ports	Nos.	X+1
4	Armoured Fibre Optic Cable and associated termination	Lot	1
	Services		
5	Integration - PMU with PDC at RLDC and SLDC	Lot	X

Note: ‘X’ is the no. of 400kV and above transmission lines of substations under the respective package.

In case of substations with conventional Control & relay panels.

- The no of PMUs shall be decided as per no of 400kV transmission line feeders under the scope of respective package.
- One GPS receiver shall be supplied for every 4 PMUs.
- No of LAN switches (no of ports in the LAN switch) shall be decided based on no of PMUs in a given Substation with C&R panels.

Annexure-II: Data Requirement Sheets (DRS) of PMU and associated items

1. Phasor Measurement Unit (PMU) :

The supplied Phasor Measurement Units (PMUs) shall be compliant to IEEE 37.118 Standard (latest version released in 2014):

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
1.	Device	Phasor Measurement Unit (PMU)	
2.	Manufacturer		
3.	Model No.		
4.	Country of origin		
	Inputs		
5.	Minimum Analog Channel	6	
6.	Minimum Digital Channels	6	
7.	CT core	Capable for Metering Core	
8.	Auxiliary Power Supply Source	220 V DC or 110V DC or 48V DC (+10%, -15%) power supply source	
9.	Communication ports	One Ethernet port of 10/100 Base Tx and one optical fiber port of 100 Mbps	
10.	Interface ports for Time synchronization	IRIG-B interface port for either a standard or high-accuracy demodulated IRIG-B time-synchronization input signal or Ethernet port on IEEE 1588v2.0 (PTP)	
11.	Communication Protocols	Both Multicast and Unicast	
	Measurement Output		
12.	Performance Class	M class	
13.	Test Compliance as per IEEE 37.118	Bidder to fill the values as per test conducted in the lab for each individual values both in steady state and Dynamic State as per IEEE C37.118 Standard	
14.	Environmental Condition During testing	Bidder to fill the environmental condition during testing for each test.	

Technical Specifications for Phasor Measurement Unit



15.	Reporting rates (Frame per second)	25 and communication port wise	
	Environmental condition		
16.	Temperature	-10 to 50 degree Celsius	
17.	Humidity	10% to 95%	
18.	Configuration tool		
19.	HMI facility	Yes	
20.	Remote configuration Change	Yes	

2. GPS based time facility

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Country of origin		
4.	Time stability of internal time base	Minimum 1 ppm	
5.	Propagation delay compensation	Yes	
6.	Include an offset to permit correction to local time	Yes	
7.	Reverting to internal time base upon loss of signal from UTC source	Yes	
8.	Resynchronization Delay	Not more than 5 minutes.	
9.	Accuracy of resynchronization	< 1.5 Micro Sec	
10.	Interfaces	Minimum one Ethernet port and One IRIG-B port & 1 PPS port.	

3. Industrial grade Layer-3 LAN Switch (Substation LAN Switch)

S.No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		

Technical Specifications for Phasor Measurement Unit



3.	Country of origin		
4.	Performance	Minimum 5 Gbps Switching Capacity	
5.	Functions	Data Exchange between PMU and PDC	
6.	Layer-2 & Layer-3 features required	Static Routing for IPv4 and IPv6	
		RIP for IPv4 (RIPv1/v2) and IPv6 (RIPng)	
		OSPF for IPv4 (OSPFv2) and IPv6 (OSPFv3)	
		Border Gateway Protocol 4 with support for IPv6 addressing wherever applicable.	
		Policy-based routing	
		IPv6 tunneling to allow IPv6 packets to traverse IPv4-only networks by encapsulating the IPv6 packet into a standard IPv4 packet.	
		Dynamic Host Configuration Protocol (DHCP) client, Relay and server.	
		Support for Multicast VLAN	
		Support for Jumbo frames	
		Should provide for 32K MAC Address Table	
		Should have facilities such as IPv6 to IPv4 tunneling, DHCPv6, ICMPv6	
7.	Features to support	Support IEEE 802.3u: Auto-negotiation on TP, IEEE 802.3x, 802.1p: flow control and prioritization, IEEE 802.1Q: VLANs, maximum 32 VLANs, IEEE 802.1d, 802.1w: Spanning Tree, Rapid Spanning Tree including RSTP 2004 extensions providing sub-second hop on rings, IEEE 802.1p: DiffServ, traffic prioritization for routed IP flows/ports Shall support Multicast and Unicast. Shall be PTP enabled as per IEEE1588v2.0 (Power Profile)	
8.	Network management	- Console port for configuration of software features - Shall able to manage the switch through Command-line interface; Web browser; SNMP etc.,	
9.	Security	a. Access Control Lists for both IPv4 and IPv6 for filtering traffic to prevent unauthorized users from accessing the network	
		b. Port-based rate limiting and access control list (ACL) based rate limiting	
		c. IEEE 802.1x to provide port-based user authentication with multiple 802.1x authentication sessions per port	
		d. Media access control (MAC) authentication to provide simple authentication based on a user's MAC address	
		e. Dynamic Host Configuration Protocol (DHCP) snooping to prevent unauthorized DHCP servers	

Technical Specifications for Phasor Measurement Unit



		f. Port security and port isolation	
10.	Speed configurability at each port	WAN ports optional 64kbps to 2Mbps	
11.	Interface ports	As per BoQ The BOQ requirement is the minimum in every switch at Substations. The no. of ports in LAN switches at Substations shall be optimised as per the Phasors list given at Appendix-H of Part-B and additional 50% expansion ports shall also be provided in the LAN switch.	
12.	Mounting	Rack mountable	
13.	Environmental Compliance	IEC61850-3 and IEEE1613 (Electric Utility Substation), EMS-IEC61000, EMI: FCC part15 A	
14.	Operating temp	- 10 to 75°C, no fans	

4. Armored FO Cables

S. No	Description of the Features	Minimum requirements	Offered by the Bidder
1	Manufacturer	Powergrid Approved Vendor	
2	Application	Between kiosks & Control Room	
2	Cable Type	4F Multimode Cable 62.5/125 um	
3	Armoured/Un-Armoured	Armoured	
4	Wavelength	850nm/1300nm	
5	Attenuation	< 3.5 dB/km @850nm, <1.0 dB/km @1300nm	
6	Band Width	>= 200 MHz/km @850nm, >=500 MHz/km @1300nm	
7	No. of Fibers	24*	
8	Colour for Fiber	Blue , Orange, Green, White	
9	Cladding Diameter	125um ± 2	
10	Core Diameter	62.5 um ± 3	
11	Cable Diameter	Vendor Specific	

**Technical Specifications
for Phasor Measurement Unit**



12	Numeric Aperture	0.275+/- 0.015	
13	Bending Radius	20xD where D is diameter of cable	
14	Armored Type	ECCS Tape (Electromagnetically Coated Corrugated Steel Tape)	
15	Operating Temperature	-20°C to +70°C	

Note: * 24 fibers to cater the need of PMU as well as for other substation applications

TECHNICAL REQUIREMENT OF PQR

Name of Project:- 765/400kV Jeerat & Medinipur Substation

Name Of Item :- TELECOMMUNICATION EQUIPMENT

Sr. No	Description	Supporting Document to be attached	Reference No. of supporting documents																
A)	Cl. No. 1.3 of Section-I of TS																		
01	The manufacturer(s) a who has been manufacturing SDH equipment for the last three (3) years.	a) Bidder to provide confirmation of fulfilling Technical Requirements mentioned in Cl. No. 1.3 of Section-1 of TS. b) Purchase Orders The details are to be submitted in following format, <table><thead><tr><th>Sr. No</th><th>ITEMS SUPPLIED TO</th><th>ORDER REFERENCE No. & DATE</th><th>ITEMS</th><th>QUANTITY</th><th>ORDER FULLY EXECUTED. YES/NO</th><th>STATUS, IF ORDER UNDER EXECUTION</th><th>REMARK</th></tr></thead><tbody><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table> c) Dispatch Instructions/ Material Receipt at site certificate/ Lorry Receipt details etc	Sr. No	ITEMS SUPPLIED TO	ORDER REFERENCE No. & DATE	ITEMS	QUANTITY	ORDER FULLY EXECUTED. YES/NO	STATUS, IF ORDER UNDER EXECUTION	REMARK									a) b) c) d)
Sr. No	ITEMS SUPPLIED TO	ORDER REFERENCE No. & DATE	ITEMS	QUANTITY	ORDER FULLY EXECUTED. YES/NO	STATUS, IF ORDER UNDER EXECUTION	REMARK												
02	The supplied SDH equipment manufactured by such manufacturer (s) shall have been in satisfactory operation in 110kV or higher voltage power substations for the last (2) years as on the date of opening of Bids	e) Letter/ Certificate/ MOM from customer/ end user for satisfactory operation	e)																

Note: 1) Satisfactory operation means certificate issued by the Employer/ Utility certifying the operation without any adverse remark

2) Bidder to meet both A) 01 & A) 02 above to qualify against Sr. No.1.3 of Section-1 of TS

3/15/18

11/11/2015