

GI pipes of Medium quality conforming to IS 1239 (Part I) and IS 1795 for Mild Steel pipes shall be used for all water supply and plumbing works.

#### **5.9.12 PLUMBING AND SANITARY**

Sanitary fittings, which include water closet (EWC/IWC), wash basins, sink, urinal fitting including flushing tank, and necessary plumbing lines shall be provided for office cum stores building and Security house.

#### **5.9.13 ELECTRIFICATION OF BUILDING**

Electrification of buildings shall be carried out as per IS 732 and other relevant standards. The lighting design of the buildings shall be carried out as per IS 3646. The building shall be provided with adequate quantity of light fittings, 5A/15A 1 phase sockets; Supply air fans, exhaust fans etc., controlled by required ratings of MCCBs and DBs. Operation room cum PLC room must be fitted with suitably sized 100 % standby HVAC system. Battery room also have 100% redundant exhaust fans. Battery room shall be provided with non-corrosive paints, light fitting, wiring and exhaust fans with acid proof tiles. It is encouraged that bidder shall use the latest energy efficient equipment for the electrification and illumination.

#### **5.9.14 TOILET**

Toilet shall be designed for 5 persons; and constructed with following finish

- Floor: Vitrified tiles/ ceramic tiles
- Door window: made out of aluminium sections, 6mm float glass
- Ventilators: Mechanical exhaust facility
- Plumbing fixtures: Repute make
- Sanitary ware: Repute make
- EWC: 390 mm high with health facet, toilet paper roll holder and all fittings
- Urinal (430 x 260 x 350 mm size) with all fittings.
- Wash basin (550 x 400 mm) with all fittings.
- Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
- CP brass towel rail (600 x 20 mm) with C.P. brass brackets
- Soap holder and liquid soap dispenser.
- GI pipes (B class) of reputed makes
- Overhead water tank equivalent of 700 litre capacity

#### **5.9.15 Drainage for Toilets:**

Drainage pipes shall be of PVC (6 kg/cm<sup>2</sup>) Supreme, Prince or equivalent make. Gully trap, inspection chambers, septic tank for 5 person and soak well to be constructed for abovementioned requirement.

#### **5.9.16 WATER SUPPLY & CLEANING**

Suitable arrangement of water shall be ensured to cater the day-to-day requirement of drinking water and other use of Control Room.

#### **5.10 PV ARRAY O&M MAINTENANCE ARRANGEMENT**

Equipment which are required for day to day cleaning of the solar panels and for O&M of the solar plant shall be in the scope of the bidders and accordingly the bidder has to provide all the necessary equipment, accessories, tool & tackles, boat, piping arrangement which as may be required for the same. Bidder shall have to provide a paddle boat and motor boat for each pond for O&M activities with carrying capacity of minimum four persons. However contractor shall arrange sufficient number of boats for installation purpose of floaters separately for each pond.

#### **5.11. APPROACH ROAD FOR SOLAR POWER PLANT**

Suitable approach road from Control Building to Solar Plant to carry safe and easy transportation of equipment and material at the project site shall be made. The road should provide easy and fast approach to each location of the plant. Roads are to be constructed with sufficient width (minimum 3.75m) followed by 0.5m well compacted shoulders on each side. The road must be well compacted as per the relevant IS standards and MORTH updated till date. All peripheral roads and pathways from central road to Inverter room road shall be Concrete road. Also, all cable crossings and other crossings shall be provided with GI/Hume pipes. Bidder please provides concrete road upto each entrance and exists of the Inverter cum control room building.

Bidder shall have to construct suitable approach step / ramp from embankment to inverter cum control room along with road connectivity with 3mtrs wide concrete road.

#### **5.12 WATCHMEN / SECURITY CABIN**

Contractor shall provide prefabricated Watchman's portable cabin at each corner of Ponds (2) and strategic locations surrounding of the plant. The Minimum size of watchmen's (Security Cabin) cabin is 1.2 metre x 1.8 metre size and height of 2.4m with appropriate roof at the top. Location of the watch Cabin (Security Cabin) will be as directed by the Purchaser. The Prefabricated Security Cabin of

size 3 metre x 3 metre at the main entrance gate shall be designed and constructed by the Successful Bidder keeping in view the safety and security of the power plant. All Watchman /Security cabins shall having separate light, fan and 5 pin plug with individual switches.

- **TRANSFORMER YARD**

Transformer Yard shall be constructed adjacent to each Inverter Cum control Room near each pond for installation of Inverter Transformer. Transformer Yard is including transformer foundations, Fire walls, transformer oil collection drain pit (if applicable) and intermediate pits as required, fencing, cable trench etc. Transformer Yard will be paved with reinforced cement concrete. Switchyard area shall be filled with 150 mm thick layer of 20 mm to 40 mm size gravel / ballast over a layer of 100 mm thick lean concrete (M10).

- **MODULE WASHING SYSTEM:**

- a) The Contractor shall design and install the effective module cleaning system.
- b) The Bidder shall do the cleaning the photovoltaic modules at least once in every week in order to operate the plant at its guaranteed plant performance i.e. NMGG stipulation. All necessary arrangement for wet cleaning of the solar panels shall be in the scope of the bidders and accordingly the agency has to provide suitable portable manual operated cleaning equipment with all the necessary accessories, tool & tackles, pumps, tankers, brush and small water storage, piping arrangement etc. which as may be required for the same.
- c) PV module cleaning purpose shall be of potable quality and fit for cleaning the modules with TDS generally not more than 75 PPM. However, water with TDS more than 200 PPM shall not be used directly for module cleaning without suitable treatment to control the TDS within acceptable limits. The water must be free from any grit and any physical contaminants that could damage the panel surface. Module cleaning procedure and pressure requirement at discharge point shall be as per the recommendation of PV module manufacturer. However, discharge pressure at outlet shall not be less than 50 kg/cm<sup>2</sup> (5 MPa).

- **Additional requirement:**

- The peripheral road around the inverter cum control room will be of minimum 3.75 m in width and 1M shoulder on each side. The road will of rigid pavement. (Concrete road with reinforcement).

- The cable crossing across the embankment will be of reinforced concrete box culvert with sufficient spacing as per the electrical requirements.
- The cable will be on cable tray when laid over the reservoir embankment slope.
- Cable from toe of embankment to inverter room will be on pedestal/ rack.
- All road crossing for DC cable will be on reinforced concrete box culvert with sufficient spacing from electrical and serviceability considerations. However for HT cable, road bearing shall be used with GI pipes with a minimum thickness of 5mm & depth of 1 mtrs from the top of Road.
- If, any of the existing structure is damaged or required to be dismantled for convenience of the erection, the same has to mend good as per the original.
- Existing drainage system must have to be maintained. If, any cable crossing is required to cross over the existing toe drain of the reservoir, the same has to be properly blocked with RCC wall and drainage to be restored to the original.

## **D. TECHNICAL SPECIFICATION FOR ELECTRICAL**

### **5.13 SPECIFICATIONS FOR SUPPLY MATERIAL**

#### **5.13.1 PV MODULE:**

##### **5.13.1.1 SCOPE**

This section covers activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of solar modules as detailed hereunder.

- a. Solar Mono crystalline modules having capacity minimum 400 Wp shall be used for the project for 5 MW Solar PV Power Plant each at Santaldih Thermal Power Plant, Purulia. However the make, capacity, technical specification and the model no. of each module connected with an individual inverter should be the same.
- b. Total capacity of the Solar PV modules shall be designed to ensure **5 MW AC with minimum 10% overloading on DC capacity** and the net minimum guaranteed generation mentioned in the **clause no. 3.33 of GCC** of this tender document.

The scope of supply shall also include spare modules (at least 100 Nos) required for any normal or breakdown maintenance and special tools & plants

required for erection & maintenance for each project. Corresponding parts of all the equipment & spares shall be of the same specification & workmanship and shall be interchangeable. All the material & workmanship shall be of reputed make as have proven successful in their respective uses in similar services & under similar condition.

#### **5.13.1.2 STANDARDS**

The PV modules must conform to the latest edition of any of the following IEC / equivalent BIS Standards for PV module design qualification and type approval:

<b>Sl. No.</b>	<b>Standards</b>	<b>Description</b>
1	IEC: 61215/IS: 14286	Crystalline silicon terrestrial photovoltaic modules – Design qualification and type approval.
2	IEC: 61730 – Part 1	Photovoltaic (PV) module safety qualification – Requirements for construction.
3	IEC: 61730 – Part 2	Photovoltaic (PV) module safety qualification – Requirements for testing.
4	IEC: 61701/IS: 61701	Salt Mist Corrosion Testing of the module.
5	IEC: 62804	Test method for detection of Potential Induced Degradation of photovoltaic (PV) modules.

The proposed PV Module must have the Test Certificate issued from accredited test laboratories of Ministry of New and Renewable Energy, Government of India under off grid programme.

The test certificates issued from IEC accredited laboratories shall also be acceptable.

The manufacturers should get their samples tested as per the new format/ procedure which are effective from 1<sup>st</sup> April 2013 onwards as per MNRE, Govt. of India Guideline.

#### **5.13.1.3 IDENTIFICATION AND TRACEABILITY**

Each PV module must use a RF identification tag (RFID), which must contain the following information:

- i. Name of the manufacturer of PV Module
- ii. Name of the Manufacturer of Solar cells

- iii. Month and year of the manufacture (separately for solar cells and module)
- iv. Country of origin (separately for solar cells and module)
- v. I-V curve for the module
- vi. Peak Wattage,  $I_m$ ,  $V_m$  and Fill Factor for the module
- vii. Unique Serial No and Model No of the module
- viii. Date and year of obtaining IEC PV module qualification certificate
- ix. Name of the test lab issuing IEC certificate
- x. Other relevant information on traceability of solar cells and module as per ISO 9000 series.

RFID for each solar module shall be provided inside or outside of the module and must be able to withstand environmental conditions and last the lifetime of the solar module as per MNRE norms which is effective from 1<sup>st</sup> April 2013.

#### **5.13.1.4 AUTHORIZED TESTING LABORATORIES/ CENTERS**

PV modules must qualify (test reports/ certificate from IEC/NABL accredited laboratory should be enclosed) as per the relevant IEC standard. Additionally the performance of PV modules at STC conditions must be tested and approved by one of the IEC / NABL Accredited Testing Laboratories including Solar Energy Centre (SEC).

#### **5.13.1.5 PERFORMANCE WARRANTY**

**A. Material Warranty:** The manufacturer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than five (05) years from the date of sale to the original customer (i.e. EPC Contractor).

- i. Defects and/or failures due to manufacturing
- ii. Defects and/or failures due to quality of materials
- iii. Non conformity to specifications due to faulty manufacturing and/or inspection processes.

If the solar Module(s) fails to conform to this warranty, the manufacturer will repair or replace the solar module(s), at the Purchaser's sole option. The contractor shall be responsible to contact with the contractor if any of the above mentioned cases occurred.

**B. Performance Warranty:** The manufacturer should warrant the output of Solar Module(s) for at least 90% of its rated power upto initial 10 years & 80% of its rated power upto 25 years from the completion of trial run at

site/date of final commissioning. The contractor shall collect the Warranty Certificate for performance of the modules from the manufacturer and submit the same to WBPDCCL prior to delivery of the products to the respective sites.

If, Module(s) fail(s) to exhibit such power output in prescribed time span, the Contractor will bound to either deliver additional PV Module(s) to replace the missing power output with no change in area of site used or replace the PV Module(s) with no extra cost claimed at Purchaser's sole option.

Manufacturer of proposed PV modules must have the ISO 9001:2008 or ISO 14001 Certification for their manufacturing unit for their said manufacturing item.

**Note:** Only indigenously manufactured PV modules should be used in Grid Connected Floating Solar PV Power Plants under this scheme. However, other imported components can be used, subject to adequate disclosure and compliance to specified quality norms and standards and approval of the Purchaser.

#### **Monitoring System for PG Test Verification**

The following instrumentation will be used to determine the Solar Plant Performance:

- Power Meter at the delivery point.
- Power Meter for each inverter for reference only.
- One nos. calibrated pyranometer to determine irradiance on the plane of array (with a target measurement uncertainty of  $\pm 2$ ).
- One nos. calibrated pyranometer to determine irradiance on horizontal plane (with a target measurement uncertainty of  $\pm 2$ )

During the comprehensive O&M period after commissioning, NMGG shall be tested on yearly basis according to the sample calculation shown under PG test under **Section IV**.

#### **5.13.1.6 TECHNICAL REQUIREMENTS**

- Modules should be Mono crystalline type having capacity of minimum 400 Wp. Higher capacity Solar PV modules will be preferred. (more than 400 Wp).

- The module frame shall be made of aluminium or corrosion resistant material, which shall be electrically compatible with the structural material used for mounting the modules. Grounding / Earthing provision shall be provided.
- Solar module shall be laminated using lamination technology using established polymer (EVA: Ethylene-vinyl acetate).
- The back sheet used in the crystalline silicon based modules shall be of 3 layered structures. Outer layer of fluoropolymer, middle layer of Polyester (PET) based and Inner layer of fluoropolymer or UV resistant polymer. Back sheet with additional layer of Aluminium also will be considered. The thickness of back sheet should be of minimum 300 microns with water vapour transmission rate less than 3g/m<sup>2</sup>/day. The Back sheet shall have voltage tolerance of more than 1000 V.
- The EVA used for the modules should be of UV resistant in nature. No yellowing of the back sheet with prolonged exposure shall occur.
- The sealant used for edge sealing of PV modules shall have excellent moisture ingress protection with good electrical insulation (Break down voltage >15 kV/mm) and with good adhesion strength.
- The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation shall be compatible with the thermal expansion properties of the Silicon cells and the module framing arrangement/material. The encapsulation arrangement shall ensure complete moisture proofing during the whole life of the solar modules.
- The Module shall be made of high transmittance glass front surface giving high encapsulation gain. The glass used to make the crystalline silicon modules shall be toughened low iron glass with minimum thickness of **3.2 mm**. The solar cell shall have surface anti-reflective coating to help to absorb more sunlight in all weather conditions. The glass used shall have transmittance of above 90% and with bending less than 0.3% to meet the specifications.
- Module rating is considered under standard test conditions, however Solar Modules shall be designed to operate and perform as per installation site condition.



- The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary by more than 2 % (two percent) from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
- All materials used shall be having a proven history of reliable, light weight and stable operation in external outdoor applications and shall have service life of 25 years.
- The modules should be 100% PID (Potential Induced Degradation) tolerant and should comply with IEC 62804.
- Solar PV Module design shall conform to following requirement:
  - Weather proof DC rated MC connector and a lead cable coming out as a part of the module, making connections easier and secure, not allowing for any loose connections.
  - Resistant of water, abrasion, hail impact, humidity & other environment factor for the worst situation at site.
  - The PV Junction Box shall confirm IP 65 and shall have sufficient bypass diodes to avoid shadowing effects.
- Modules shall perform satisfactorily in relative humidity up to 95% and temperature between -10°C and 85°C (module temperature).
- The PAN file of the solar module should be validated by Third party.
- The developer shall arrange for the details of the materials along with specifications sheets of from the manufacturers of the various components used in solar modules along with those used in the modules sent for certification. The Bill of materials (BOM) used for modules shall not differ in any case from the ones submitted for certification of modules.
- The I-V characteristics of all modules as per specifications to be used in the systems are required to be submitted at the time of supply.
- SPV module shall have module safety class-II and should be highly reliable, light weight and must have a service life of more than 25 years.

#### **5.13.1.7 SPECIFICATION OF THE PV MODULES**

Desired specification of the PV Module shall be as mentioned hereunder:

SI. No.	Item	Description
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1	Type	Crystalline Silicon - Mono
2	Efficiency of module	Minimum 17 % at STC
3	Cell efficiency	Minimum 19 % at STC
4	Fill Factor	Minimum 80 %
5	No. of cells per module	atleast 72
6	Module Frame	Non-corrosive and electrolytically compatible with the structural material, preferably anodized Aluminium.
7	Termination box	Thermo-plastic, IP 65, UV resistant
8	Blocking diodes	Schottky type
9	Bypass Diode	Yes, as required
10	Power Rating	The nominal power of a single PV module shall be minimum 400 Wp
11	Power tolerance	upto +5 %
12	Temperature co-efficient of power	Less than - 0.50% / °C
13	Glass	High transmittance glass with Anti Reflective Coating (ARC)
14	RF Identification tag for each solar module	Shall be provided inside or outside the module and must be able to withstand environmental conditions and last the lifetime of the solar module as per MNRE Norms.

#### **5.13.1.8 APPROVAL**

- The Detailed Design Report Submitted by the contractor to WBPDC must contain but not limited to the following details of the solar modules:
  - Detailed specification
  - Necessary Drawings
  - Type Test Report and Necessary Certificates etc.
- Inspection of Electro Luminescence (EL) & Potential Induced Degradation (PID) tests during manufacturing of solar PV modules may be carried out by WBPDC.

- Joint inspections and testing will be done by WBPDC and the authorized representatives of the contractor at the manufacturer's workshop on regular basis for quality assurance and testing. Acceptance Tests as per relevant Indian Standard shall be carried out at the module manufacturer's workshop. Following tests as per relevant Indian Standard shall be carried out on certain number of modules from a lot (decided by WBPDC) as acceptance tests of Solar PV Modules:
  - Visual Inspection
  - Thermal cycling test
  - Damp heat test
  - Performance Test of the modules at STC and NOCT with Sun Simulator of Class B or better as per Indian Standard
  - Performance Test of the modules at low irradiance (200 W/m<sup>2</sup>) with Sun Simulator of Class B or better as per Indian Standard
  - Dielectric withstand test
  - Continuity and leakage current test
  - Insulation Resistant test
  - Wet leakage current test
  - Potential induced degradation test
  - Mechanical load test
  - Solar cells: Cell tester.
  - EVA: Gel content test and pressure cooker test.
  - Glass: Fragmentation test
  - Frame: Frame anodizing test
  - Junction box: IP 65 test.
  - Ribbon: Elongation test and camber test.
  - RTV Silicone sealant: Adhesiveness test.
  - Electroluminescence test to detect micro cracks.
  - Ammonia test for anti-corrosion
  - Any other test as desired by WBPDC

Arrangements for the aforesaid testing and inspection at manufacturer's end are to be provided by the contractor.

- Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:
  - Guarantees
  - Instructions for installation and operation manual
  - Test reports for routine tests and acceptance tests etc.

- The contractor shall deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCCL.
- WBPDCCL may select certain number of modules delivered at site by the contractor on random basis for conducting performance test of those modules from any accredited test laboratory of MNRE/NABL. If there are any discrepancy found in the test results and the values specified by the contractor, the contractor will be bound to accept the decision made by WBPDCCL in respect of taking further course of action.

#### **5.13.1.9 ACCEPTANCE CRITERIA:**

- Each module is to be tested for electro luminescence test at Manufacturer test lab to detect micro cracks and pass the test as per IEC norms and also record of data on the test for each module will be done by WBPDCCL for future studies. Contractor has to co operate at site.
- 25 no modules to be carried out all the type tests as per IS from NISE, Delhi or any NABL or MNRE accredited test centers.
- For the above (i.e.25 no modules) special packing if required may be done to shift the panels from manufactory site to testing lab as directed by WBPDCCL.
- Sufficient competent man power to be deployed at test centre for sufficient days to unpack and repack the modules after the test.
- Contractor has to coordinate with WBPDCCL for all the testing activity.
- 1no. module from each batch of production will be tested for PID (1000V) & LID test also need to be carried out test and results should be submitted to WBPDCCL.

### **5.13.2 GRID CONNECTED INVERTERS**

#### **5.13.2.1 SCOPE**

This section covers the activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at project site, storage, erection, testing, commissioning of Solar Inverters/Power Conditioning Unit (PCU) as detailed hereunder.

- a. Adequate number of Indoor Solar Central Inverter of minimum capacity 500 kW having high quality, high efficiency and reliable operation. Total inverter capacity of the plant should not be less than 5000 kW(AC).
- b. The scope of supply shall also include necessary spares, if any, required for normal or any breakdown maintenance for at least 05 (five) years and special tools & plants required for erection & maintenance. Corresponding parts of all the equipment & spares shall be of the same specification & workmanship and shall be interchangeable.

All the material & workmanship shall be of reputed make as have proven successful in their respective uses in similar services & under similar condition.

The solar inverter/power conditioning unit shall be suitable for interfacing with SCADA system and all necessary transducers shall be included under the scope of supply.

#### **5.13.2.2 STANDARDS**

The equipment and materials covered by this specification shall conform to the latest edition of following Indian Standards or equivalent IEC standards except where specified otherwise in this specification:

<b>Sl. No.</b>	<b>Standards</b>	<b>Description</b>
1	IEC/IS: 61683	Photovoltaic systems – Power Conditioners – Procedure for measuring efficiency
2	IEC 62093	Balance-of-system components for photovoltaic systems – Design qualification natural environments
3	IEC 60068	Environmental Testing
4	IEC 62116 / IEEE 1547/UL 1741/ equivalent IS standard	Islanding Prevention Measurement
5	IEC 61727 Relevant CEA/ CERC regulation and grid code (amended up to date)	Interfacing with utility grid
6	IEC 61000 series	EMC, harmonics, etc.
7	IEC 62109 (1&2), EN 50178 or equivalent	Electrical safety
8	IEC 62093 or equivalent	Reliability test standard

Solar Inverters should have certificate and approval from VDE, IEC etc. The inverters should have CE conformity according to LVD (Low Voltage Directive) and EMC (Electro Magnetic Compatibility) Directive for safety purpose.

Type test certificate issuing authorities should be any NABL/IEC Accredited Testing Laboratories or MNRE approved test centers.

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out by the contractor.

#### **5.13.2.3 TECHNICAL REQUIREMENTS**

- The inverter should be 3- $\Phi$  static solid state type power conditioning unit.
- Inverter/PCU shall be centralized grid tied in nature, shall consist of MPPT controller. Inverter shall be selected based on array design. Associated control and protection devices shall be an integrated part of the PCU.
- Degree of protection of the Outdoor Inverters shall confirm at least IP-65.
- The inverters shall be built in with data logging system for remote monitoring of the plant performance through external PC. (PC shall be provided as a part of the Solar PV Plant).
- The dimension, weight, foundation details etc. of the PCU shall be clearly indicated in the technical specification to be submitted with the detailed design report.
- The PCU shall be capable of complete automatic operation, including wake-up, synchronization & shut down independently & automatically. Inverters / PCU shall operate in sleeping mode when there will no power connected.
- The Inverter shall have internal protection arrangement against any sustained fault in output line and lightning in the grid. AC protection boxes shall be provided at the inverter output which shall include over current, under voltage protection etc.
- Both AC & DC lines shall have suitable fuses & surge arrestors and contactors to allow safe start up and shut down of the system (Type-I & II DC side and Type-II AC side).
- PCU shall be capable to synchronize independently & automatically with grid power line frequency to attain synchronization and export power generated by solar plant to grid.

- In case of grid failure, the PCU shall be re-synchronized with grid after revival of power supply. Bidder to furnish the time taken by PCU to be re-synchronized after restoration of grid supply during detailed engineering.
- Inverters shall have the features like Low Voltage Ride through (LVRT), High Voltage Ride through (HVRT) etc. for grid support and connection.
- Inverters should run in synchronized manner, effect of one inverter should not be reflected to the others. The PCU shall be capable of operating in parallel with the grid utility service and shall be capable of interrupting fault line currents, line to ground fault currents and short circuit currents.
- The PCU shall be able to withstand an unbalanced load conforming to related IEC standard (+/- 5% voltage). The PCU shall include appropriate self-protective and self-diagnostic features to protect itself and the PV array from damage in the event of PCU component failure or from parameters – beyond the PCU's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation feature, shall be cleared by the PCU protective devices and not by the existing site utility grid service circuit breaker.
- Operation outside the limits of power quality as described in the technical data sheet should cause the power conditioner to disconnect the grid. Additional parameters requiring automatic disconnection are over current, earth fault, short circuit and reverse power.
- The inverter itself shall consist of one circuit breaker for isolation from the circuit during any fault or maintenance purpose.
- PCU shall have active power limit control, reactive power and power factor control feature. Plant operator shall be able to provide (manual intervention) Active power, reactive power and power factor control/limit set point through SCADA HMI and local control display unit (or Laptop computer). PCU shall be provided with remote start and stop facility from SCADA HMI. All required hardware and software required for this purpose shall be provided by Bidder.
- PCU shall have necessary limiters in build in the controller so as to ensure safe operation of the PCU within the designed operational parameters.

- The Contractor shall ensure by carrying out all necessary studies that the PCU will not excite any resonant conditions in the system that may result in the islanded operation of PV plant and loss of generation. In case there is excitation of any resonant condition in the system during PV plant operation that may result in the islanding/tripping of the PV plant and affect the power transfer, it shall be the responsibility of contractor to rectify the design and carryout required modification in the equipment of his supply.
- PCU shall be provided with Mobile user interface facility for monitoring of inverter by plant O&M personal for better O&M and highest yield from the PV plant. In case PCU does not have this facility, then Bidder can provide the same facility through plant SCADA system.
- PCU shall have AC and DC side monitoring capability and reporting to SCADA system (measured analog and digital value measured within PCU). Any special software if required for this purposes shall be provided for local and remote monitoring and report generation.
- All-important alarm and trip signals shall be configured in the PCU and their corresponding modbus address shall be provided for SCADA configuration. Signal shall necessarily be included such as LVRT/HVRT in action & trip operated, islanding protection operated, over current operated, Inverter cabinet temperature high alarm and all other important signals.
- DC Overloading:- Maximum PCU DC overload loading shall be limited to its design PV Array Power to PCU nominal AC power ratio. Bidder needs to submit all the relevant technical document/test report from PCU manufacturer (OEM) during details engineering stage in support of declared PCU design DC overloading capacity.
- The inverters shall operate satisfactorily within the operating ambient temperature range of -15°C to +60°C. The contractor shall assure that the inverter should not de-rate upto 50°C ambient temperature. Humidity: 95 % non-condensing.
- To take care of PID (Potential Induced Degradation), the inverters should have active negative grounding kit.
- **EARTHING OF INVERTERS-** The PCU shall be earthed as per manufacturer recommendation (OEM). The Bidder needs to submit the details earthing arrangement of PCU and system earth pit requirement



during detail engineering stage. The detail specification for panel earthing for safety has been mentioned elsewhere in this specification

#### **5.13.2.3.1 OPERATING MODES OF PCU**

- **Low Power Mode:-** The PCU shall be able to wake-up automatically when PV array open circuit voltage value is equal/more than preset value in the PCU program. Once its start generation the PCU shall automatically enter maximum power mode.
- **Maximum Power Point Tracking (MPPT):-** In order to maximized the energy collection from solar PV array, the PCU shall have inbuilt maximum power point tracker (MPPT) controller and MPPT shall be able operate the PV array at its maximum power point by adjusting output voltage of PV array system according to atmospheric condition. PCU MPPT controller shall ensure that it operate the PV array system at its global maximum power point and it shall not trapped into PV array local maximum power point during cloudy atmospheric condition.
- **Sleep Mode :-** PCU shall automatically go into sleep mode when the output voltage of PV array and/or output power of the inverter falls below a specified limit. During sleep mode the inverter shall disconnect from grid. Inverter shall continuously monitor the output of the PV array and automatically start when the DC voltage rises above a pre-defined level.
- **Standby Mode:-** In standby mode the PCU DC & AC contactor are open, inverter is powered on condition and waiting for start command.
- **String Monitoring facility:-** PCU shall be provided with current monitoring transducer at incoming DC cables from each string combiner box (SCB) for PV array zone monitoring purpose. The current transducers used for this purpose shall have accuracy of 1.0 class or better.
- The PCU should be designed for parallel operation through galvanic isolation. Solid state electronic devices shall be protected to ensure smooth functioning as well as ensure long life of the inverter. Parallel operated PCU system are also accepted subjected to recommendation of PCU manufacturer. In such case, PCU design shall also ensure that no abnormal interaction shall take place among the PCU unit during any grid operating condition which may result in outages.

- Bidder may offer liquid cooling system subject to WBPDCCL approval. In case Liquid cooled inverters are offered, Bidder to ensure that coolant is used in closed cycle. Complete inverter along with cooling system shall be of proven design.
- The Inverter shall have suitable arrangement for negative grounding of solar PV array system and the ground current shall be limited to safe limit. Ground current shall be measured continuously and alarm shall be generated in case ground current reaches to predefined set value. Inverter shall trip in case ground current more than safe operating limit.
- Inverter shall have emergency stop push button for tripping of inverter with complete DC & AC electric isolation.
- Following protections shall be provided with the inverter.
  - Over voltage and under voltage both at input & output
  - Over current both at input & output
  - Over/under grid frequency
  - Heat sink over temperature
  - Cooling system failure protection
  - PV array ground fault monitoring & detection
  - PV array insulation monitoring
  - LVRT protection
  - Anti-islanding protection
  - Over temperature protection.
  - Short circuit
  - Protection against lightning
  - Surge arrestors to protect against Surge voltage induced at output due to external source
  - Direct earth fault protection and body earthing
  - Set point pre-selection for VAR control
  - Synchronization loss protection
  - Grid monitoring
  - Any other protections required
- Inverters should have user friendly LED/LCD or touch display for programming and view on line parameters in LED/LCD as well as in SCADA. These parameters are:
  - Inverter per phase Voltage, current, kW, kVA, frequency and power factor.

- 15 minute, Daily, monthly & Annual energy generated by the solar system(kWh)
- Solar system temperature
- Ambient temperature
- Grid Voltage, frequency and power factor
- AC and DC side voltage and current
- Power factor on AC side
- DC injection into the grid
- Inverter Import export kWh summation
- Solar kWh summation
- Inverter ON/OFF
- Grid ON/OFF
- Inverter under voltage/over voltage
- Inverter over load
- Inverter over temperature etc.
- Total Current Harmonics distortion in the AC side
- Total Voltage Harmonic distortion in AC side
- Efficiency of the inverter
- Solar system efficiency
- Display of I-V curve of the solar system
- Fault details with time when occur.
- Any other parameter considered necessary by supplier of the solar PV system based on prudent practice.

#### 5.13.2.4 SPECIFICATION

Sl. No.	Operating Parameter	Desired specification
1	Input (DC)	
	PV array connectivity capacity	As per site requirement
	MPPT Voltage range	Compatible with the array voltage
	Number of MPPT Channel	Number of MPPT channel shall be minimum one. One spare MPPT channel shall be provided.
2	Output (AC)	
	Nominal AC Power output	500 kW (minimum)
	Number of Grid Phase	3
	Adjustable AC voltage range	+/- 10%
	Nominal output voltage frequency	50Hz

Sl. No.	Operating Parameter	Desired specification
	Continuous operating frequency range	47.5 Hz to 52 Hz
	Frequency range	+/- 5%
	Operating power factor range	Operating power factor (adjustable) shall be 0.8 Lead to 0.8 Lag.
	AC wave form	Sine wave
	THD	Less than 3%
	Switching	H.F. transformer/transformer less
3	General Electrical data	
	Efficiency	97.5 % (minimum)
	VAR Control	The PCU shall be capable of supplying reactive power as per grid requirement. PCU shall have night SVG function (Q at night).
	No load loss	< 1% of rated power
	Maximum loss in sleep mode	< 0.05% of rated power
4	Protection	
	DC Side	As mentioned in the Technical Requirement
	AC side	As mentioned in the Technical Requirement
	Isolation Switch	PV array Isolation switch (DC)
	Ground fault detection device (RCD)	To be provided
5	Display	
	Display type	LED/LCD or touch display
	Display parameter	
	DC	As mentioned in the Technical Requirement
	On grid connected mode	As mentioned in the Technical Requirement
9	Interface (Communication protocol)	Suitable port must be provided in the inverter for i. On site upgrade of Software ii. On site dumping data from the memory iii. Plant based remote monitoring system
10	Storage of Data	At least for 1 year. Separate data logger may be provided to meet the criteria.
11	Monitoring	Matched with the monitoring and data logging system (SCADA)
12	Mechanical Data	
	Protection Class	As mentioned in the Technical Requirement
	DC Switch	Integrated
	Operating ambient temperature	-15° C to 60° C
	Relative Humidity	15 to 95 %
	Noise Emission	Less than 75 dB (A) @ 1 meter (indoor)
	Cooling	Forced cooling

#### **5.13.2.5 Communication interface**

The project envisages a communication interface which shall be able to support:

- Real time data logging
- Event logging
- Supervisory control
- Operational modes
- Set point editing

#### **5.13.2.6 COMMUNICATION SYSTEM**

Communication System shall be an integral part of inverter. All current values, previous values up to 40 days and the average values of major parameters shall be available on the digital bus.

#### **5.13.2.7 DATA LOGGER SYSTEM**

Data logger system (Hard ware) and the software for study of effect of various environmental & grid parameters on energy generated by the solar system and various analyses would be required to be provided.

The communication interface shall be suitable to be connected to local computer and also remotely via the Web using either a standard modem or a GSM / WIFI modem.

PCU shall have suitable communication card (Modbus TCP/IP) for networking and SCADA integration and same shall support dual master communication. PCU shall include all important measured & internal calculated analog values and alarm & trip signals for remote monitoring, storing and report generation purpose in SCADA system. Details list of above such parameters shall be provided along with their Modbus address during detail engineering stage

#### **5.13.2.8 APPROVAL**

The Detailed Design Report Submitted by the contractor to WBPDCCL must contain but not limited to the following details of the Solar Inverter/Power conditioning Unit:

- Detailed technical description of the complete unit
- Necessary Drawings
- Type Test Report etc.

Joint inspections and testing will be done by WBPDCCL and the authorized representatives of the contractor at the manufacturer's workshop on regular basis

for quality assurance and testing. Acceptance Tests as per relevant Standard shall be carried out at the module manufacturer's workshop. Following tests shall be carried out on certain number of Inverters from a lot (decided by WBPDCCL) as acceptance tests of Solar Inverters:

- Visual Inspection
- Performance Test and measurement of AC & DC parameters
- DC reverse polarity protection
- Islanding Protection
- Over Voltage & Under Voltage withstand
- Over Frequency & Under Frequency withstand
- Night consumption
- Any other test as desired by WBPDCCL

Arrangements for the aforesaid testing and inspection at manufacturer's end are to be provided by the contractor.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Safety precautions
- Test reports for routine tests and acceptance tests etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCCL.

#### **5.13.2.9 Acceptance:**

##### **Type test:**

During detailed engineering, the contractor shall submit all the type test reports including temperature rise test and surge withstand test carried out within last five years from the date of LOA of this project for Owner's approval. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of techno-commercial bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under

this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.

**Routine tests:**

Routine tests to be conducted as per IEC norms in the presences of WBPDCCL staff along with warranty & guarantees certificates.

### 5.13.3 PV ARRAY

**Desired specification of the PV Array shall include but not limited to the following:**

Sl No	Item	Description
1.0	PV Module interconnection connector	MC-4 / Tyco
2.0	PV Module interconnection cable and array cable	PV 1-F standard /NEC standard "USE-2 or RHW-2" type ( double insulated)
3.0	PV array String Voltage	Compatible with the MPPT Channel of the inverter

### 5.13.4 STRING MONITORING BOX (SMB)

#### 5.13.4.1 SCOPE

This section covers activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of array junction box as detailed hereunder.

- a. Adequate number of String Monitoring Boxes shall be provided for termination of array string with inverter.
- b. The number and specification of PV String Monitoring Box will be as per plant configuration.

The String Monitoring Boxes shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

#### 5.13.4.2 STANDARDS

The String Monitoring Boxes shall conform to the latest edition of following Standards except where specified otherwise in this specification:

Sl. No.	Standards	Description
1	IS 13703: Part 1	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC: General Requirements
2	IEC 60269: Part 4 /IS 13703: Part 4	Low-voltage fuses: Supplementary requirements for fuse-links for the protection of

		semiconductor devices
3	IEC 60269-4: Part 6	Low-voltage fuses: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems
4	VDE 0636	Low-voltage fuses

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the bidder without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

#### **5.13.4.3 TECHNICAL REQUIREMENTS**

- The junction Boxes shall have suitable arrangement for the followings (typical):
  - Combine groups of modules into independent charging sub-arrays that will be wired into the controller.
  - Provide arrangement for disconnection for each of the groups.
  - Provide a test point for each sub-group for quick fault location finding.
  - To provide group array isolation.
- The string monitoring box shall be dust, vermin, and waterproof and made of Polycarbonate Plastic.
- The string monitoring box shall be of IP 65 or better.
- The terminal will be connected to bus-bar arrangement of proper size. The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables.
- Suitable markings shall be provided on the bus-bars for easy identification and Cables shall be fitted at the cable termination points as per appropriate polarity.
- Each String shall be terminated through Fuses of required current rating
- The string monitoring box shall be provided with suitable Surge Protection Device (SPD).

#### **5.13.4.4 APPROVAL**



The Detailed Design Report Submitted by the contractor to WBPDCCL must contain but not limited to the following details of the String Monitoring Boxes:

- Detailed specification
- Necessary drawings etc.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manuals
- Necessary test certificates

The contractor shall deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCCL.

### **5.13.5 THREE WINDING TRANSFORMER (INVERTER DUTY TRANSFORMER)**

#### **5.13.5.1 SCOPE:**

This section covers the activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of step up transformers and associated equipment as detailed hereunder.

- a. One number of 3- $\Phi$ , three winding, oil filled, ONAF/ONAN type cooled transformers per pond with suitable capacity (not less than 10% higher margin as per NIT) shall be provided to step up voltage from 3- $\Phi$ , Grid tied Solar Inverter output to 33 kV voltage level for feeding the generated power to the 33 kV switchyard.
- c. Two LV winding of the three winding transformer will be connected to the outputs of two inverters and the HV sides will be connected to the 33 KV line through VCB, Isolator etc. Three winding transformer will be Oil Type and placed outside of Inverter cum control room.
- d. Supply, laying, termination, testing, charging of 33/36 kV grade cable from respective Transformer to 33 kV switchgear at Main Switchgear & Control room near Raw Water Pond no.2 (Refer NIT Drawing) is under bidder's scope.

The scope of supply shall also include necessary spares required for normal operation & maintenance of transformers for a period of 5 (five) years & special tools & plants required for erection & maintenance. Corresponding parts of all the equipment & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of

suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The transformers and associated equipment shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

#### **5.13.5.2 STANDARDS**

The equipment and materials covered by this specification shall conform to the latest edition of following Indian Standards or equivalent IEC standards except where specified otherwise in this specification:

<b>Sl. No.</b>	<b>Standards</b>	<b>Description</b>
1	IS: 2026 (Part I to IV), IS:6600, IEC: 60076	Power Transformer
2	IS: 2099, IEC:60137, IS:3347, IS 12676	Transformers bushings
3	IS: 2705, IEC 60185	Current transformers
4	IEC 60296	Transformer oil
5	IS: 3637	Gas and oil operated relay
6	IS: 5120	Fittings and accessories for power transformers
7	IS: 6088	Dimensions for porcelain transformer bushings
8	IS: 3347	Loading guide for oil-immersed transformers
9	CBIP No. 295	CBIP Manual on Transformers Publication

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the contractor without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

#### **5.13.5.3 TECHNICAL REQUIREMENTS**

The transformers shall be three winding, ONAF/ONAN, oil filled, 3- $\Phi$ , Step Up transformers.

<b>Sl. No.</b>	<b>Standards</b>	<b>Description</b>
1	Type	Three Winding
2	No. of phases	Three
3	Duty, Service,	Continuous Solar Inverter application and converter duty

Sl. No.	Standards	Description
	Application & Installation	(Outdoor), Outdoor on rails/channel
4	Rated continuous MVA at maximum ambient temperature of 50°C	As required according to Solar Inverter capacity
5	% Impedance at 75°C, rated current & frequency	As per system requirement & as per Inverter manufacturer recommendation.
6	Type of cooling	ONAN/ONAF
7	Winding material	Copper
8	Connection	
	HV	Delta
	LV	Star-Star
9	Vector group	YNy11 or as per system requirement
10	Voltage	
	HV	33 kV
	LV	As per Solar Inverter Output Voltage
11	Rated Frequency	50 Hz
12	Type of Bushing	
	HV Winding	Porcelain/ XLPE bushing
	LV Winding	Porcelain bushing
13	Insulation level (impulse withstand)	
	HV	170kV (Peak)
	LV	NA
14	Insulation level (Power freq. withstand)	
	HV	70 kV (rms)
	LV	3 kV (rms)
15	Tapping	OCTC
	Range	+5% to -5% @ 2.5%
16	Temperature rise of oil/winding over design ambient temperature of 50°C (irrespective of taps)	50°C / 55°C
17	Hot spot temperature over a maximum yearly weighted average ambient temperature of 32 °C	105°C
18	Short circuit current for 1 sec. on HV side	25 kA
19	Short circuit withstand time	2 sec
20	Insulation	
	HV winding	Class B (Winding insulation shall be able to withstand 33 kV continuously)
	LV winding	Class B (Uniformly insulated)
21	Voltage withstand capacity during sudden disconnection of load	1.4 times the rated voltage for 5 sec. 1.25 times the rated voltage for 1 min. 1.1 times the rated voltage for continuous operation.

Sl. No.	Standards	Description
22	Noise level	< 90 dB As per NEMA TR-1 standard
23	Cooling medium	Mineral oil (as per IS 335)
24	Earthing	LV neutrals solidly earthed through neutral CT, HV side should also be earthed.
25	Minimum efficiency	98%

#### 5.13.5.4 DESIGN CRITERIA

- The rating of the Transformers shall be sufficient to evacuate generated power from the Solar Inverter under full load conditions. The Transformers shall be able to evacuate generated power under all conditions of ambient temperature, frequency and voltage variations.
- The transformers will have Off Circuit Tap Changer (OCTC) with tap ranging +5% to -5% in steps of 2.5 % at HV side. The transformers will operate without injurious heating at the rated capacity at any voltage within +/-10% of the rated voltage of that particular tap. The transformer will be designed to deliver rated MVA continuously even at the lowest tap without exceeding specified temperature rise.
- HV line terminals shall be brought out through 33 kV class weather proof shaded porcelain bushing.
- Ambient air temperature for the transformer
  - Maximum ambient air temperature: 50° C
  - Minimum ambient air temperature: - 5° C
- Inverter Transformer shall have copper/Aluminum Shield winding between LV & HV windings. Each LV winding must be capable of handling non-sinusoidal voltage with voltage gradient as per relevant applicable standards and Inverter manufacturer recommendation. Also each shield winding shall be taken out to tank with two separate connection from shield to bushing with proper support with 2 nos. 3.6 kV shield bushings and same shall be brought down along with support insulator from tank & copper flat up to the bottom of the tank for independent grounding.
- Harmonic Factor as per Inverter manufacturer recommendation must be taken into account while designing the transformer. The extra no load loss due to voltage harmonics and load and stray load loss due to current harmonics (as applicable) and must be taken into consideration in transformer design. In

addition, the dc bias component of 0.5% of rated Inverter output current is to be accounted for its effect on the transformer design.

- The thermal design of Inverter Transformer needs to consider the temperature dependent performance of the Inverter. It is to in accordance with Inverter output and under worst condition it should not limit Inverter output.
- The three winding transformer needs to be designed for long term operating conditions with asymmetrical load on LV side i.e., in this case three winding design, the transformer needs to operate reliable with only one Inverter supplying power to only one LV winding.
- For three winding transformer, it is recommended to have close coupling and equal impedances on each of LV winding to HV winding and to have high enough impedance (8% min. based on one LV winding rating) between two LV windings in order to decouple these windings.
- The transformer shall be capable of withstanding the short circuit stresses 25 KA due to a terminal fault on one winding with full voltage maintained on the other winding for minimum period of two (2) seconds. This capability shall be demonstrated by type test report.
- Neutral Grounding Resistor (NGR) (if applicable):
  - The resistor element shall be made of non-aging stainless steel having high electrical resistivity and low temperature co-efficient of resistant. Group of resistor elements shall be mounted together between end plates to form a bank. Banks are then to be connected in series-parallel combination to provide the current and ohmic value required. Adjacent banks shall be insulated from each other and the metal frame.
  - Each neutral grounding resistor shall have structural work enclosed on all sides and also on top by sheet steel. Suitable ventilating louvers shall be provided on sides to ensure proper ventilation. The louvers shall be provided with fine wire mesh to make it vermin proof. Protection class shall be IP55 or better.
  - Each cubicle shall be complete with two (2) nos. ground pads, tapped holes and bolts suitable for connection of 75 x 10 mm galvanised steel flats.
- Transformer neutral shall be grounded through NGR. The Neutral Grounding Resistor (NGR) shall be used for non-effective grounding of HV System of the plant. NGR shall be connected between the equipment neutral point and earth.

- Neutral Grounding Resistor shall be used to limit the magnitude of earth fault current so that damage of Electrical equipment is reduced, safety of personnel is increased and sensitive / selective earth fault protection can be provided.
- The transformers will be capable of being loaded in accordance with IS 3347 - loading guide for oil immersed power transformers. The transformers shall also be designed for operation at unbalanced loading conditions.
- The transformers shall be suitable for co-ordination and integration with SCADA System and necessary contacts and/or ports for the purpose shall be provided.
- Earthing arrangement of the transformers shall be provided as per the relevant Indian Standard.
- Necessary protection arrangement should be provided in the transformer.
- Construction of different parts of the transformer shall conform to the latest edition of IS 2026.
- Fittings and accessories as per relevant Indian Standard shall be provided within the scope of the work.
- Oil pit with sump pump arrangement to be provided if oil capacity of the transformer is more than 2000 l. Capacity of oil pit shall be minimum 1.25 times of total oil capacity of transformer.
- **Insulating oil**
  - The transformer shall be filled with mineral insulating oil suitably inhibited to prevent sludging.
  - First filling of oil along with 10% excess shall be furnished for each transformer. Oil shall be supplied in non-returnable containers suitable for outdoor storage.
  - Oil preservation shall be by means of bellows/ diaphragm sealed conservator tank with silica gel breather to avoid direct connection between atmosphere and transformer oil. It shall be complete with level gauges, pipes, drain valve, buchholz relay with shut-off valves at both sides etc. The level gauges shall be so placed that same can be readable standing from ground. Necessary device shall be kept to provide annunciation in the event of rupturing of bellow.
  - Oil sample requirement for all Inverter duty transformers:

Sl. No.	Parameters	Before filling in main tank & tested for	Prior to energization for following properties & acceptance norms:

i)	BDV	60 kV (min)	60 kV (min)
ii)	Moisture content	10 ppm (max.)	10 ppm (max.)

#### **5.13.5.5 General Construction**

Transformer shall be constructed in accordance to IS: 2026 and IS: 3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect

- i) The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane.
- ii) A double float type Buchholz relay conforming to IS: 3637 shall be provided.
- iii) All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at site
- iv) Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
- v) The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel breather (in transparent enclosure). Silica gel shall be isolated from atmosphere by an oil seal.
- vi) Transformer shall have Oil Temperature Indicator and Winding temperature Indicator with accuracy class of +/-2 deg.
- vii)** Radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/valve at the bottom and air release plug at the top.

- **Marshalling box:**

- A sheet steel, weatherproof, IPW55, marshalling box shall be provided for the transformer. The box shall contain all auxiliary devices except those which must be located directly on the transformer.
- All terminal blocks for cable connection shall be located in this box.
- The marshalling box shall be provided with cubicle lamp with door switch, space heater with thermostat and removable cable gland plate.

- **Windings**

- The Bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.
- The conductors shall be of electrolytic grade copper/Aluminum free from scales & burrs.
- All windings of the transformers shall have uniform insulation.
- Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.

- **Core**

- The core shall be constructed from non-ageing, cold rolled, super grain oriented silicon steel laminations equivalent to M4 grade steels or better.
- Core isolation level shall be 2 kV (rms.) for 1 minute in air.
- Adequate lifting lugs will be provided to enable the core & windings to be lifted.

- **Bushing CTs**

Shall be of adequate rating for protection (differential and others if any) as required, WTI etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.

All CT terminals shall be provided as fixed type terminals on the M. Box to avoid any hazard due to loose connection leading to CT opening. In no circumstances Plug In type connectors shall be used for CT.

- **Valves**

All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies. Sampling & drain valves should have zero leakage rate.

- **Gaskets**

- Gasket shall be fitted with weather proof, hot oil resistant, rubberized cork gasket.
- If gasket is compressible, metallic stops shall be provided to prevent over compression.
- The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further



period. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

- **Cable boxes & disconnecting chamber (Disconnecting chamber applicable for Inverter Transformer 33kV side)**

- HV Cable boxes shall be of phase segregated air insulated type & shall be of sufficient size to accommodate Employer's cable & termination. Phase segregation shall be achieved by insulating barriers (for 33 kV and above side).
- Cable boxes shall have bus bars / suitable terminal connectors of adequate size & bolt holes to receive cable lugs. The degree of protection of cable boxes shall be IP 55W.
- A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box The support from base for the cable box (for 33 kV and above side) shall be of galvanized iron
- The contractor shall provide earthing terminals on the cable box, to suit GI flat.
- The minimum length provided for terminating 33 kV, XLPE cable shall be 1000 mm (for 33 kV) for the cable boxes, for 433V side suitable length shall be provided (shall be discussed during detail engineering). The final cable size, number & length of terminating XLPE cable shall be furnished during detailed engineering.
- Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).

- **FITTINGS**

Following fittings shall be provided with Transformers

i)	-Conservator for main tank shall be provided with MOG with low oil level alarm contact, drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.
ii)	- Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement.
iii)	- For Inverter transformer and transformers with rating 2 MVA & above, shall be provided with minimum two numbers of spring operated PRD (with trip contacts) with suitable discharge arrangement for oil shall be provided.

	- For Auxiliary transformers, diaphragm type explosion vent shall be provided.
iv)	OTI & WTI shall be 150 mm dial type with alarm and trip contacts with max. reading pointer & resetting device (maximum height 1500 mm above ground level). For Inverter Transformers, WTI shall be provided at least for all LV windings.
v)	Top & bottom filter valves with threaded male adapters, bottom sampling valve, drain valve/sludge removal valve at the bottom most point of the tank.
vi)	Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings (as applicable).
vii)	Prismatic/toughened glass oil gauge for transformers.
viii)	Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.
ix)	Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Cooling equipment.
x)	Rain hoods to be provided on Buchholz, MOG & PRD. Entry points of wires shall be suitably sealed.
xi)	Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs, inspection cover, Bilingual R&D Plate, Terminal marking plates, two nos. earthing terminals etc.
The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformers are deemed to be included.	

#### **5.13.5.6 TESTS AND INSPECTION**

##### **• TYPE TEST**

In case the bidder/contractor has conducted type test(s) within last ten years, he may submit the type test reports to the owner for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

In case the Bidder is not able to submit report of the type test(s) conducted within last ten years from the date LOA of this project, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all

such tests under this contract at no additional cost to the Employer and submit the reports for approval.

- **ROUTINE TESTS**

**Following tests to be performed:**

- All routine tests shall be carried out in accordance with IEC 60076 (part 1 to 3).
- Measurement of No load current with 415 V, 50 Hz AC supply.
- Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps.
- Measurement of capacitance & tan delta to determine capacitance between winding & earth.
- Repeat No load current/loss & IR after completion of all electrical test
- Oil leakage test on completely assembled transformer along with radiators (as per relevant clause of this sub section).
- Jacking test followed by D.P. test

- **Leakage test on assembled Oil filled Transformer (ROUTINE TEST)**

All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur. Bidder can perform this test at site depending upon urgency subjected to WBPDCCL approval.

Suitable Fire Fighting arrangements for Oil filled Transformers shall be provided if applicable as per Tariff Advisory Committee (TAC)/statutory requirements. Firewall & soak pit as applicable (as per statutory requirement/TAC/IS 10028 / IS 1646) shall be provided of minimum 230 mm thickness of RCC wall or 355 mm thick fire resisting brick wall subject to WBPDCCL approval.

#### **5.13.5.7 APPROVAL**

The Detailed Design Report Submitted by the contractor to WBPDCCL must contain but not limited to the following details of the transformers:

- Detailed specification including Fittings and Accessories
- Necessary Drawings shall contain but not limited to the following:
  - Outline dimension drawings of transformers and fittings/accessories

- Assembly drawings and weight of main components.
  - Transport drawings, showing main dimensions and weight of each package.
  - Foundation details
  - Tap-changing equipment
  - Name-plate diagrams
- Necessary test certificates and type test reports.

A joint inspection and testing will be done by WBPDC and the authorized representatives of the contractor at the manufacturer's workshop. Testing and inspection of the transformers will be carried out as per relevant Indian Standard. Arrangements for the aforesaid testing and inspection at manufacturer's end are to be provided by the contractor.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Safety precautions
- Test reports for routine tests and acceptance tests etc
- Detailed schematics of all power instrumentation and control equipment and subsystems along with their interconnection diagrams. Schematics shall indicate wiring diagrams, their numbers and quantities, type and ratings of all components and subsystems etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBPDC.

### **5.13.6 33kV INDOOR SWITCHGEAR & POWER EVACUATION**

#### **5.13.6.1 SCOPE**

Proposed plant site is at STPS and evacuation voltage level is 33kV. This specification covers the design, manufacture, testing at manufacturer's works before dispatch, supply, delivery at site, transit insurance, storage at site, erection, testing & commissioning of 36KV, 3 phase, 50 Hz air insulated Metal clad indoor VCB type switchgear & Power Evacuation System unit with horizontal draw out horizontal isolation circuit breaker as per IS 13118 (1991)/IEC-60056 and other standards for satisfactory operation of 5 MW Solar PV Power Plant in STPS, Santaldih, Purulia, West Bengal though **the bus bar capacity of the 33kV switchgear shall be capable of handling 12.5 MW power with 10% higher margin.**

Corresponding parts of all the equipment & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The design of the switchgear shall be based on safety to personnel and equipment during operation and maintenance, reliability of service, ease of maintenance, mechanical protection of equipment, interchangeability of equipment and ready addition of future loads.

**Power shall be evacuated from new 33 kV Indoor Switchgear installed at Control Room for Floating Solar near Raw Water Pond No.2. The technical details of the said switchgear are mentioned in this specification.**

Necessary space provisions of at least one similar panel at each side need to be kept during layout finalization. The following equipment shall be supplied for the extension of this 33kV switchgear:

**a. 33kV incoming feeder:**

Two (2) nos 33kV Incoming feeder from Inverter Transformer of pond no. 1 Floating Solar plant shall be supplied as incomer of 33kV Switchgear. One similar incoming feeder shall be kept as spare panel.

Supply, laying, termination and charging etc of cable 36 kV grade shall be done from the Inverter Transformers to the incoming feeder 33kV Switchgear.

**b. 33kV Outgoing Feeder for Power Evacuation:**

One (1) out going feeder and with separate Line PT shall also be supplied and connected on having a power evacuation capacity of 12.5 MW with 10% higher margin complete with all accessories.

Supply, laying, termination and charging etc of cable 33/36 kV grade shall be done from this new outgoing feeder to new 33kV bay at STPS Switch Yard (under scope of this package). Distance from Main Floating Solar Control Room to New 33 kV Switchyard is around 1200 mtrs. However bidder shall evaluate this distance during detail engineering.

**c. Outgoing feeder for 350kVA Station Auxiliary Transformer (SAT):**

One (01) Outgoing feeder for new Station Auxiliary Oil Type Transformer (350 kW capacity) shall also be supplied and installed.

Supply, laying, termination and charging etc. of cable 33/36 kV grade shall be done from this outgoing Station Aux. Transformer Feeder to Station Aux. Transformer are under bidder scope.

**d. BUS PT:**

One number Bus PT panel to be envisaged separately.

Table for new 33 kV panel extensions:

<b>S1 No.</b>	<b>Description</b>	<b>Quantity</b>
1	Incoming feeder from each Floating Solar Inverter Transformer (from Pond no. 1)	2 Nos.
2.	Outgoing feeder with separate Line PT (Evacuation of Power), capacity 12.5 MW with 10 % higher margin	1 No.
3.	Outgoing feeder for 400 KVA SAT	1 No.
4	One Spare feeder for Incoming capacity	1 No.
5	Bus PT	1 No.
6	LINE PT	1 No.

**Details of the Electrical Layout is shown in the attached tender drawing No.ST-FLSP-DWG-E-01 for ready reference of the bidder.**

**STANDARDS**

The equipment covered under this chapter shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

<b>Sl. No.</b>	<b>Standards</b>	<b>Description</b>
1	IS: 5	Colors for ready mixed paints & enamels
2	IEC-62271-100,200; IEC-600298 / 600694; IS-3427	AC metal enclosed switchgear & control gear for rated voltages above 1 kV & up to & including 52 kV.
3	IS: 13947/ IEC 60529	Degree of protection provided by enclosures for switchgear.
4	IS: 1901	Specification for visual indication lamps
5	IEC-60056 / IS 13118 /IEC	High Voltage Alternating current Circuit Breakers
6	IS: 2705 - (Part I - IV)/ IEC 60185	Current Transformers
7	IS: 3156 - (Part I - IV)/ IEC 60186	Voltage Transformers

Sl. No.	Standards	Description
8	IEC: 60694	Common clauses for high voltage switchgear & control gear
9	IS: 1248	Indicating Electrical measuring instruments
10	IS: 8084	Inter connecting Bus bars for AC voltage between above 1 kV up to and including 36 kV
11	IS-3231 & 3842 / IEC 60255	Electrical relays for Power Systems
12	IEC: 62271-102/ IEC 60129	Alternating current disconnectors and earthing switches
13	IEC-99-4	Metal oxide surge arresters without gates for A.C. systems

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the contractor without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

#### **5.13.6.2 SPECIFIC TECHNICAL REQUIREMENTS/PARAMETERS:**

All indoor switchgear panels shall have minimum technical parameters for design consideration as mentioned hereunder:

##### **BUS BARS/CUBICLE**

Sl. No.	Description	Requirement
1	Nominal/Highest System Voltage	33 kV/36 kV
2	Type of Installation	Indoor
3	Max. Ambient Temp. and Temp. Rise	As per IS/IEC
4	Min. Clearances in air (Phase to Phase and Phase to Earth)	As per IS/IEC
5	Degree of protection	IP 52
6	Continuous current rating	As per system design which is capable of handling 20MW power
7	Short Time Current Rating for 1 sec	25 kA
8	Rated Power Frequency withstand voltage	70 kV (rms)
9	Rated Lightning Impulse Withstand Voltage	170 kV (peak)
10	Cable Entry	From bottom

##### **CIRCUIT BREAKERS:**

<b>SI. No.</b>	<b>Description</b>	<b>Requirement</b>
1	Type	Vaccum
2	No. of Poles	3
3	Nominal/Highest System Voltage	33 kV/36 kV
4	Type of Installation	Indoor
5	Duty Cycle	O- 0.3 sec-CO-3 min-CO
6	Operating cycles	Min. 10000
7	Control Voltage	110/220 V DC (10% to -15%)
8	Short Time Current Rating for 3 sec	25 kA
9	Continuous current rating	As per system design
10	Symmetrical Breaking Current Capacity	25 kA (rms)
11	Short Circuit Making Current	62.5 kA
12	Degree of protection	IP 55
13	Operating mechanism	Spring Charged

#### **CURRENT TRANSFORMER**

<b>SI. No.</b>	<b>Description</b>	<b>Requirement</b>
1	Type	Cast Resin Type
2	Nominal/Highest System Voltage	33 kV/36 kV
3	Short Time Current Rating for 1 sec	25 kA
4	No. of Phases	Single
5	Insulation Class	Class B or better
6	Rated Power Frequency withstand voltage (Primary/secondary)	70 kV (rms)/3 kV (rms)
7	Rated Lightning Impulse Withstand Voltage	170 kV (peak)
8	Protection Class	5P20
9	Diff./REF Protection Class	PS
10	Metering Class	Class 0.2 and ISF <=5

#### **POTENTIAL TRANSFORMER**

<b>SI. No.</b>	<b>Description</b>	<b>Requirement</b>
1	Type	Cast Resin Type
2	Nominal/Highest System Voltage	33 kV/36 kV
3	Short Time Current Rating for 1 sec	25 kA
4	No. of Phases	Single
5	Insulation Class	Class B or better
6	Rated Power Frequency withstand voltage	70 kV (rms)/3 kV (rms)



SI. No.	Description	Requirement
	(Primary/secondary)	
7	Rated Lightning Impulse Withstand Voltage	170 kV (peak)
8	Accuracy Class	0.2 for metering and of 0.5 for other purposes.

#### **ISOLATOR/DISCONNECTING SWITCH**

SI. No.	Description	Requirement
1	Type	Cast Resin Type
2	Nominal/Highest System Voltage	33 kV/36 kV
3	Short Time Current Rating for 1 sec	25 kA
4	No. of Poles	3
5	Continuous current rating	As per system design which is capable of handling 20MW power
6	Short Time Current Rating for 3 sec	25 kA
7	Rated Power Frequency withstand voltage	
	a. To earth & between poles	70 kV (rms)
	b. Across isolating distance	80 kV (rms)
8	Rated Lightning Impulse Withstand Voltage	
	a. To earth & between poles	170 kV (peak)
	b. Across isolating distance	195 kV (peak)

#### **SURGE ARRESTOR**

SI. No.	Description	Requirement
1	Type	Metal Oxide Gapless
2	Rated Voltage	30 kV
3	Nominal Discharge Current	As per IS
4	Installation	Indoor
5	Rated Power Frequency withstand voltage	70 kV (rms)
6	Rated Lightning Impulse Withstand Voltage	170 kV (peak)

#### **5.13.6.3 GENERAL REQUIREMENTS**

The 33 kV Indoor Switchgear shall be designed considering the minimum general requirements as mentioned hereunder:

##### **A. STRUCTURAL & MECHANICAL CONSTRUCTION**

- i. The Switchgear shall be factory assembled, totally enclosed, metal clad, dead front cubicle. It shall be of sheet Steel (preferably galvanized to avoid

rusting) construction and shall be dust, moisture and vermin proof complying with degree of protection of not less than IP-4x as per IS-3427 (1997). The panels shall be of Metal Clad compartmentalized design with all the High Voltage compartments viz. Circuit Breaker, Bus Bar, Current Transformers and Voltage Transformers separated by metallic partitions. The switchgear panels shall be rigid without using any external bracing. The switchboard panels should comply with relevant ISS/IEC and revision thereof and shall be designed for easy operation maintenance and further extension. Bus bar, metering, circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. All instruments shall be non draw-out type and safeguard in every respect from damages. The switchgear shall be complete with all necessary wiring fuses, auxiliary contacts, terminal boards etc.

- ii. The overall design of the switchboard shall be such that front access only is required. The panels shall be constructed from prime quality folded and bolted steel sheet of 2 mm thick or Al-Zn sheet steel. Only doors and end covers shall be painted with paint shade as specified.

The observation window on the CB compartment door shall be provided. Observation window shall be of same material and construction as the type tested design/construction.

**The design of the panels shall be such that no permanent or harmful distortion occurs either when being lifted by eyebolts or when moved into position by rollers or transpallets.**

The switchgear and control gear should have the minimum degree of protection (in accordance with IEC 60529)

- IP 4X for the enclosure for rated current up to 1250A
- IP 3X for the enclosure for rated current up to 2500A
- IP 2X for the partition between compartments

The switchgear must be readily extendable in either direction.

- iii. For Seismic Applications: The switchboard may be subject to seismic disturbance, hence the switchgear supplier shall provide proof by type test or calculation according to IEEE 693 standards, documentation to support the offered equipment.

- iv. Each cubicle shall be equipped with anti-condensation heater controlled by thermostat.
- v. Assembly of all current carrying parts shall be such that they shall be easily accessible for inspection and maintenance.
- vi. Switchgear cubicles shall be satisfied the requirement of IEC:62271-200, IEC:60298, IEC:60694.
- vii. Switch gear shall be supplied with basic operating tools.
- viii. The switchgear and control gear shall be suitable for continuous operation under the basic service conditions indicated below.

Ambient temperature °C	- 5 to + 50
Relative humidity	up to 95%
Altitude of installation	up to 1000m, IEC120.

#### **B. BUS BARS AND CONNECTORS**

Bus bars and all other electrical connections between various components shall be made of Electrolytic copper of adequate cross-section. The bus bar section shall be of ample capacity to carry the rated current for 20MW power with 10% higher margin, continuously without excessive heating and for adequately meeting the thermal and dynamic stresses in the case of short circuit in the system up to full fault MVA.

All bus bars shall be rigidly and firmly mounted. Spacious bus bar chamber shall be provided with use of tubular busbar design and free from any high voltage stresses by avoiding all sharp edges and bringing them to uniform potential. Bus bar shall be sleeved for full voltage. Sleeve shall be heat shrinkable BTM type of Raychem make. **No PVC sleeve in bus bar for 36KV is acceptable.**

Bus bar shall be located in a separate metal clad chamber and shall be air insulated. It shall be adequately supported on insulators or integral epoxy spouts to withstand dynamic stress due to the short circuit current as specified.

Bus bar shall be extensible on either side to make it in switch board configuration in future.

#### **C. CIRCUIT BREAKER**

- a) The Circuit Breaker shall be drawing out type suitable for installation in the switchgear cubicle. The breakers shall comply with IS-13118 / IEC-60056 conforms to latest amendment thereof.
- b) The Circuit Breaker shall be spring operated, DC Motor charged, manually released spring closing mechanism with three pole simultaneous operation. The indicating device shall show the OPEN and CLOSE position of breaker visible from front of the cubicle. The spring charging time of the motor shall not exceed 15 sec. The "TRIP" and "CLOSE" coils shall be of reliable design and low consumption preferably less than 300W. It shall be possible to manually charge the circuit breaker operating spring in case of auxiliary supply failure.
- c) The breakers shall be capable of Making & Breaking the short time current in accordance with the requirement of ISS 13118 / IEC 60056 conform to latest amendment thereof and shall have 3 phase rupturing capacity of 31.5KA at 33KV. The continuous current rating of breaker shall not be less than 1250A for all items.
- d) The circuit breaker shall be isolated by horizontal racking and positively fixing the unit into any one of the following positions;
  - **Service position**; main and auxiliary circuits connected
  - **Test position**; main circuits disconnected auxiliary circuits connected. Circuit breaker in its isolated position shall be completely contained in the apparatus compartment with shutters on main circuit closed and compartment front door closed.
  - **Withdrawn position**; main circuits and auxiliary circuits disconnected. Circuit breaker is removed out of the cubicle.
- e) Locking of circuit breaker in the test position shall be possible by means of key lock on the earth switch manoeuvre.
- f) A position indicator switch or viewing window must be provided for visual indication of the circuit breaker position.
- g) Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Isolation of circuit breaker from bus bar or insertion into bus bar shall only be possible when the breaker is in the "OPEN" position.

- h) Each circuit breaker shall be provided with following accessories.
  - i) ON-OFF indicator for indicating circuit breaker position.
  - ii) Trip push button
  - iii) Shunt trip coil operating between 70% - 110% of rated control voltage.
  - iv) Close coil, operating between 85% - 110% of rated control voltage.
  - v) Spring charge motor, operating between 90% - 110% of rated control voltage.
  - vi) Two trip coils and one closing coils shall be provided in all the breakers.
  - vii) Metering with higher class of accuracy (Class 0.2 and ISF  $\leq 5$  for metering.)
- i) The switchgear shall be provided with facilities for full operation from a remote point. In case of Local Operation of circuit breakers, Control switch of Circuit Breaker shall be located at such a height so that a man can operate standing on ground/floor. It shall be possible to trip the circuit breaker locally by mechanical means.
- j) The circuit breaker truck shall ensure earth in both connected and disconnected positions.
- k) An electro-mechanical device shall be provided to ensure the auxiliary circuits have been securely connected between the fixed and moving portions of the switchgear, before allowing closing operation of the circuit breaker. The voltage rating of the device shall be the same as the voltage used for the closing circuit.
- l) Tripping and/or release coils shall be continuous rated to ensure longer life but rating should not exceed 300 W each. The electrical tripping device shall be of a type which acts directly on the circuit breaker mechanism and shall give positive operation for a supply voltage of 70% of nominal at DC control voltage.
- m) Circuit breakers will be provided with at least one spare normally-open and one spare normally-closed contact, each wired out to terminals for the connection of external wiring.
- n) Each circuit breaker shall be interlocked to prevent:

- the breaker being inserted into service position unless it is open
  - the breaker being withdrawn from the service position unless it is open
  - the breaker being closed unless it is fully in the service or test position
  - remote operation whilst in the service position and/test position
- o) Circuit breakers shall be mechanical latching and electrical and mechanical tripping. The operating mechanism shall be trip-free and shall include an anti-pumping device.
- p) Shutters: Circuit breaker compartment should have nonmagnetic nonferrous automatic safety shutters, which shall be opened and closed by the mechanical drive of the circuit breaker. The bus bar and circuit spout covers shall be operated independently of each other. Padlock facilities can be provided on the metal shutters.
- q) INTERLOCKING Isolation and connection of the circuit breaker shall be carried out inside the compartment with the door closed. The following mechanical interlocks shall be provided for service safety:
- Interlocking which prevents racking-in and racking-out of the circuit breaker when closed
  - interlocking which prevents manual or electrical closing of the circuit breaker in the intermediate positions between connected or isolated.

#### **D. CURRENT TRANSFORMER :**

The CT shall be mounted in a manner to make it very easy for fitting / replacement at site. It shall be designed with built in adjustable cable holding clamps, makes it very easy for removal/sturdy fitting of power cables and to prevent any swing due to forces encountered during short circuit. P1 of primary side of the in-built CT shall be at bus side of all the panels.

#### **E. POTENTIAL TRANSFORMER**

Three numbers Single phase draw out type PT of ratio  $33000/\sqrt{3}$ ;  $110/\sqrt{3}$  Volts with HT/LT fuses mounted on an independent trolley housed at the bottom in the same feeder/transformer panel or separately vertical housed . This Line PT shall not get disconnected along with the Circuit Breaker in case the breaker is drawn out from 'SERVICE' position. Arrangement shall be made in such a way so that PT primary fuse can be replaced without switching OFF the breaker.

## **F. AUXILIARY/CONTROL WIRING**

All the secondary wiring in the panel shall have high quality PVC insulation 1100 volts grade and the same shall be of standard Copper Conductor of size not less than 2.5 sq. mm. for control circuit and 4 sq. mm. for CT circuits. Colours of the secondary / auxiliary wiring should conform to ISS 375/1963 conform to latest amendments thereof. All wiring shall be neatly run and group of wiring shall be securely fixed with clips so that wiring can be checked without necessity of removing the clamps. Ferrules with number shall be provided on both end of the wiring.

**G. PAINTING** The Panels shall be pre-treated using 7-Tank process and then Epoxy Powder Coated with Paint shade of RAL 7032.

## **H. EARTHING**

- a. An earth bus of size minimum 40 mm x 6 mm or equivalent copper shall be provided and shall be extended throughout the length of the switch board with a provision to extend further on both sides of the end switchboard for future extension of switchboards.
- b. It shall be possible to connect each circuit of the switchgear to earth, through earthing switches suitable for fault make current.
- c. Earthing switch shall be mechanically interlocked with the associated breaker as per interlock requirement.
- d. Earthing circuit shall be suitable for testing at 25 KA for 3.0 sec.
- e. Breaker compartment shall have scrapping earth bar and spring load finger shall be provided in withdrawal truck.
- f. Provision of Busbar earthing at both side of Bus-Coupler is to be provided.

## **I. TEST:**

### **• TYPE TESTS**

All equipment to be supplied shall be of type tested design. During detailed engineering, the bidder shall submit following Type test reports (not more than five year old from the date of bid opening) to prove the capability and suitability of his offered switchgear. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

- i. Short Time Current Test on circuit breaker mounted inside the panel along with CTs, bushing and separator for 25KA for 3 second.
- ii. Short Circuit Test duties on Circuit Breaker mounted inside the panel along with CTs, bushing and separator.
- iii. Lightning Impulse withstands Test mounted inside the panel.
- iv. Power Frequency withstands Test mounted inside the panel.
- v. Temperature rise test on breaker and panel together.

If bidder fails to provide test report they have to do the type test without any price implication before delivery of equipment.

• **ROUTINE TESTS**

All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price

**5.13.6.4 OTHER SOME GENERAL REQUIREMENTS:**

- The switchgear shall be indoor, free standing, sheet metal clad, draw out type and shall be fully compartmentalized.
- The Switchgear enclosures shall be totally enclosed design, dust tight and vermin proof.
- Each panel shall be equipped with space heaters to prevent moisture condensation within the enclosure and shall be complete with MCB, thermostats and auxiliary relay (if required).
- Switchgear design shall comprise of fully compartmentalized execution having separate vertical sections for each circuit.
- Structure, buses and control wiring shall be designed and arranged in such a manner so that future extension of the switchboard would readily be feasible.
- All corresponding components of the circuit-breakers and switchgear of same rating shall be fully interchangeable.
- From 33 kV indoor Switchgear of Floating Solar control room, the power shall be fed to 33 kV Inverter duty Transformer through 33 kV XLPE Cable.
- The disconnecting switches shall be provided with local electrical/manual control. The disconnecting switches shall be fitted with earthing link wherever required. The disconnecting switch shall be connected between the transformer and circuit breaker for the power incoming from solar PV and for