



**KOLKATA PORT TRUST
HALDIA DOCK COMPLEX
AN ISO- 9001: 2008 ORGANISATION**



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No.: SDM(P&E)-IV/ 1036/ 55

Dated: April 10, 2018.

Dear Sir,

Sub.: Budgetary Offer for Design, Engineering, Supply, Construction, Erection, Testing, Commissioning and 10 years O&M of 1 MW (AC) Solar PV Power Plant at Haldia Dock Complex, Kolkata Port Trust at Haldia, Dist.- Purba Medinipur, State- West Bengal - Regd.

Haldia Dock Complex, Kolkata Port Trust intends to establish 1 MW (AC) Solar PV Power Plant at their premises at Haldia Township near Jawahar Tower.

Tentative 'Bill of Materials' as well as 'Technical Specification' for the said work are attached herewith for ready reference.

It will be kind enough if the budgetary offer be submitted from your end, latest by 20th April, 2018 (Friday), in line with the attached 'Bill of Materials'.

Budgetary offer as well as other details, if any, may please be forwarded to the e-mail ID: koushikm.hdc@nic.in

Thank you,

Yours faithfully,

(K. MUKHOPADHYAY)
Sr. Dy. Manager (P&E)
Haldia Dock Complex
Kolkata Port Trust
April 10, 2018
Encl: As stated above.

Table 1: Total EPC Contract Price for 1 MW (AC) SPV Plant.

Sl. No.	Item Description	Basic Price (In Rs.)	% of applicable GST	Direct/ Bought Out (Mention)
1	Supply & delivery of PV Modules, Inverters and balance of system including all equipments, materials, spares, accessories, MMS etc. up to site (mention quantity & wattage/ capacity)			
2	Installation & commissioning of PV Modules, Inverters and other balance materials etc. at site.			
3	Supply & delivery of transformer & switch yard including transmission overhead line connecting to take-off point & interconnection at Haldia Dock Complex (11 kV)			
4	Installation & commissioning of transformer & switch yard including transmission overhead line connecting to take-off point & interconnection at Haldia Dock Complex (11 kV)			
5	Civil and allied works including construction of buildings, MMS foundations, perimeter etc.			Not Applicable
	Total Contract Price excluding GST (in Rs)		Not Applicable	Not Applicable

NOTE: The above Bill of Materials (BoM) is indicative only. The purpose is for complete supply, delivery, installation & commissioning of 1 MW (AC) SPV Plant with the provision for evacuation of generated power to nearby 11 kV network (i.e. 11 kV overhead line) of Haldia Dock Complex (HDC), Kolkata Port Trust (KoPT) at Haldia Township, Haldia.

Table 2: Total Price for O&M Contract for 1 MW (AC) SPV Plant.

Sl. No.	Item	Price (excluding GST) (in Rs)	% of applicable GST
1.	Operation and Maintenance of the 1 MW (AC) PV Grid Interactive Power Plant including transmission & evacuation system for-	----	----
(i)	First Year		
(ii)	Second Year		
(iii)	Third Year		
(iv)	Fourth Year		
(v)	Fifth Year		
(vi)	Sixth Year		
(vii)	Seventh Year		
(viii)	Eight Year		
(ix)	Ninth Year		
(x)	Tenth Year		
	Total O&M Contract Price excluding GST (in Rs)		

NOTE: (i) **GST as applicable will be paid extra as actual. Applicable rate (in %) of GST may please be indicated.**

(ii) During O&M period of 10 years, the plant will have to be manned **round the clock** by one Technician and one Helper.

(iii) During O&M period, as indicated at (ii) above, one Technician and two Helpers will have to be manned in the General Duty (i.e. from 08:00 hrs. to 17:00 Hrs. normally) to look after different maintenance activities as well as trouble shooting.

(iv) One supervisor (Diploma in Electrical) will have to be manned in General duty, responsible for round the clock O&M for 365 days.

D. Technical Specification of Solar power plant

4. Bill of Material:

The equipment and material for said (AC) capacity Grid Interactive Solar Photovoltaic Power Plant with associate system (typical) shall include, but not limited to the following:

Item Details	Unit
PV Modules	Nos.
Module Mounting Structures including fasteners and clamps	Set
Main Junction Boxes with monitoring capabilities	Lot
Solar module array to Junction box Interconnection cable (Cu)	RM
Junction box to Inverter Interconnection Cable (Cu/ Al)	RM
Connection accessories – lugs, ferrules, glands, terminations etc.	Lot
AC Cable (LT/ HT) of appropriate sizes	RM
Power Conditioning Units/ Inverters	Nos.
Meteorological station with sensors and data logger	Lot
String level monitoring system (SCADA) and ancillaries	Set
Transformers (Power and Auxiliary)	Set
Circuit breakers, CT and PT (at 11 kV) set	Set
11 kV Indoor/ outdoor interfacing panels with CT, VCB, PT, Relays etc.	Set
11 kV XLPE Outgoing feeder cable and supports	Set
11 kV outdoor bay complete in all respect	Lot
AC & DC distribution panels/ boards, PDB, LDB etc.	Lot
Control and Relay Panel	Lot
Lightning Arresters of suitable ratings	Nos.
Earth mat for switch yard, DC field array and equipment	Lot
Control and power cables	Lot
Surge Protection devices and Fuses	Set
Earth cables, flats and earthing pits	Lot
Equipment and Control cum office Building with associated equipment	Lot
Rubber Mats for specific kV ratings and safety gadgets, PPE	Lot
Fire extinguisher - Foam type, CO2 type, ABC type etc., as applicable	Lot
Sand Buckets	Lot
Discharge Rods	Lot
Cable for power evacuation with suitable H poles, towers etc.	Lot
Power efficient peripheral lighting arrangement for the plant safety	Nos.
Fire Alarm system and signboards in buildings	Lot
Metering Equipment (Meters. and associated CT and PT's)	Set

Protection Equipment	Set
Solar Observatory with remote monitoring assistance	Set
Module cleaning system	Lot
CCTV cameras	Lot
Danger sign plates, anti-climbing, bird protection etc.	Lot

All the information shown here is indicative only and may vary as per design and planning by the bidder. The bidder must provide the BOM of the plant as per the design during the time of bidding. The technical features of major equipment are described hereunder.

5. Photovoltaic Modules

Total capacity of PV Modules to be supplied for the 1 MW (AC) project is minimum of 1.1 MWp which is the cumulative rated capacity of all solar PV module under supply as per relevant IEC standards under Standard Temperature Condition (STC). The Project shall consist of Mono/poly-crystalline silicon photovoltaic modules as per the specifications given below:

- 5.1 The solar photovoltaic modules with efficiency more than 16% for multi-crystalline, 18% for mono-crystalline silicon based modules with positive tolerance only.
- 5.2 The glass used to make the crystalline silicon modules shall be toughened low iron glass with minimum thickness of 4.0 mm for 72 cell module and 3.2 mm for 60 cell module. The glass used shall have transmittance of above 90% and with bending of less than 0.3% to meet the specifications.
- 5.3 The back sheet used in the crystalline silicon based modules shall be of 3 layered structure. 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/m²/day. The Back sheet shall have voltage tolerance of more than 1000 V.
- 5.4 The EVA used for the modules should be of UV resistant in nature. No yellowing of the back sheet with prolonged exposure shall occur.
- 5.5 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.
- 5.6 The junction box used in the modules shall have protective bypass diodes to prevent hot spots in case of cell mismatch or shading. The material used for junction box shall be made with UV resistant material to avoid degradation during module life and the Junction sealing shall comply IP65 degree of protection.

- 5.7 The crystalline silicon based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided.
- 5.8 The rated output of the modules shall have positive tolerance of +5W and no negative tolerance is allowed.
- 5.9 Modules should have rugged design to withstand tough environmental conditions and high wind speeds (minimum up to 150 km/h).
- 5.10 Modules shall perform satisfactorily in relative humidity up to 95% and temperature between -10°C and 85°C (module temperature).
- 5.11 PV modules must be warranted for their output peak watt capacity, which should not be less than 90% of the initial value at the end of 10 years and 80% of the initial value at the end of 25 years.
- 5.12 The modules shall be warranted for minimum of 10 years against all material/ manufacturing defects and workmanship.
- 5.13 All modules shall be certified
- IEC 61215 2nd Ed. (Design qualification and type approval for Crystalline Si modules),
 - IEC 61730 (PV module safety qualification testing @ 1000 V DC or higher)
 - IEC 61701: Salt Spray test for highly corrosive environment, if applicable
 - IEC 62716: Ammonia Resistant certified, if applicable
 - Test certificate from NABL approved or /ILAC member body certified labs shall be provided.
- 5.14 Not used.
- 5.15 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.
- 5.16 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.
- 5.17 The Contractor would be required to maintain accessibility to the list of module IDs along with the parametric data for each module.
- 5.18 The temperature co-efficient of power for the modules shall not be more than 0.45% / °C.
- 5.19 The module mismatch of the modules connected to an inverter should be less than 2%.
- 5.20 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.
- 5.21 The module frame shall be made of anodized Aluminium or corrosion resistant material, which shall be electrically compatible with the structural material used for mounting the modules. In case of metal frames for modules, it is required to have provision for earthing

to connect it to the earthing grid.

- 5.22 All materials used for manufacturing solar PV module shall have a proven history of reliability and stable operation in external applications. Module shall perform satisfactorily in relative humidity up to 95% with ambient temperature between -10°C to +50°C. The material shall withstand adverse climatic conditions, such as high speed wind, blow with dust, sand particles, and saline climatic / soil conditions and for wind speed of **150 km/hr**.
- 5.23 Modules only with the same rating and manufacturer shall be connected to any single inverter.
- 5.24 Bidder shall provide data sheet for Solar PV Module (Under STC) along with their offer as per Guarantee Technical Particular Data Sheet- 1. Also, the bidder must provide the commercial data sheet indicating the exact power of the module, if the data sheet consists of a range of modules with varying output power.
- 5.25 The Employer or its authorized representative reserves the right to inspect the modules at the manufacturer's site prior to dispatch.
- 5.26 The Bidder is advised to check and ensure the availability of complete capacity of modules prior to submitting the NIT document.
- 5.27 Entire drawings, detailed test & flash reports and compliance certificates of the offered modules should be submitted for approval of Employer within 15 days from the date of placement of order and supply should start thereafter.

6. PV Array Configurations

The Solar array shall be configured in multiple numbers of sub-arrays, providing optimum DC power to auditable number of sub arrays. The bidder shall submit their own design indicating configuration of PCU and respective sub arrays and associated bill of material.

6.1 Module Mounting Structure:

- 6.1.1 The structure design shall be appropriate and innovative. It must follow the existing land profile.
- 6.1.2 The structure shall be designed to allow easy replacement of any module and shall be in line with the site requirements.
- 6.1.3 Design drawings with material selected and their standards shall be submitted for prior approval of Employer within 14 days of NTP.
- 6.1.4 The support structure design & foundation shall be designed with reference to the existing soil conditions in order to withstand wind speed applicable for the zone (Site Location) or **150kmph**, whichever is higher, using relevant Indian wind load codes. The structures and foundations shall also conform to the seismic conditions pertaining to the zone using relevant Standards and codes.
- 6.1.5 The structure must be designed with considering appropriate factor of safety. The bidder

must provide the detail design and calculation for the structure design.

- 6.1.6 The structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation & tilt, absorb and transfer the mechanical loads to the ground properly. Welding of structure at site shall not be allowed.
- 6.1.7 The array structure shall be made of mild steel members of suitable sizes with weather protection coating. The coating shall be as per ASTM A792/ A792M-10 standard Al– Zn alloy with hot dip process and thickness of 150GSM on both sides. It is to ensure that before application of this coating, the steel surface shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such foreign material as are likely to interfere with the coating process. The bidder should ensure that inner side should also be coated.
- 6.1.8 The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels at the same time.
- 6.1.9 Nut & bolts, washers (packing and spring) supporting structures including Module Mounting Structures shall have to be adequately protected from atmosphere and weather prevailing in the area.
- 6.1.10 Two numbers of anti-theft fasteners of stainless steel on two diagonally opposite corners for each module shall be provided. All the fasteners and washers for Module Mounting Structures and modules, shall be adequately protected from atmosphere and weather prevailing in the area. Fasteners and washers to be used for erection of mounting structures could be of SS 304/ UNS S 20430 or equivalent, however fasteners used for fixing modules over structures shall be of stainless steel of grade SS 316 or equivalent, and must sustain the adverse climatic conditions to ensure the life of structure for 25 years.
- 6.1.11 Modules shall be clamped & bolted with the structure properly. The material of clamps shall be Al / Steel having weather resistant properties. Clamp – bolt shall use EPDM rubber and shall be designed in such a way so as not to cast any shadow on the active part of a module.
- 6.1.12 The array structure shall be grounded properly using maintenance free earthing kit.
- 6.1.13 The bidder/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagram and drawings.
- 6.1.14 The Bidder should design the structure height considering highest flood level at the site. The minimum clearance between the lower edge of the module and the ground shall be the higher of (i) accessed highest flood level at the site and (ii) 500 mm.
- 6.1.15 For multiple module mounting structures located in a single row, the alignment of all modules shall be within an error limit of maximum 10mm.
- 6.1.16 Civil foundation design for Module Mounting Structures (MMS) as well as control room, equipment room and power equipment shall be made in accordance with the Indian

Standard Codes and prevailing soil conditions. The Successful Bidder shall submit the detailed foundation & structural design analysis along with calculations and basis/ standards in the Bid duly certified by a Chartered Structural Engineer having substantial experience in similar work.

- 6.1.17 Cable should pass from Pipes and Cable-ties shall be used to hold and guide the Pipes (cables/wires) from the modules to junction boxes or inverters. All the cables were aesthetically tied to module mounting structure.
- 6.1.18 In case the string monitoring unit (SMU or JB) is mounted on the module mounting structure, bidder to take into consideration of the load thus added on the MMS. Accordingly, suitable supporting members for mounting the SMU/ JB must be designed and supplied. Separate structure for mounting of SMU can also be proposed.
- 6.1.19 Bidder must submit the complete quality documents i.e. test certificates for all tests conducted starting from raw material stage, in process, final testing w.r.t structure.
- 6.1.20 Every major Component of the Plant should be suitably named/ numbered & marked for ease of traceability, identification and maintenance.

6.2 Junction Box/ Combiner Box:

- 6.2.1 All junction/ combiner boxes including the string junction box, array junction box and main junction box/ combiner box should be equipped with appropriate functionality, safety (including fuses, grounding, contacts etc.) and protection.
- 6.2.2 The terminals will be connected to copper bus-bar arrangement of proper sizes to be provided. The junction boxes will 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 UV resistant cable ferrules will be fitted at the cable termination points for identification.
- 6.2.3 The Junction Boxes shall have suitable arrangement for the followings:
 - Strings are required to be connected to the bus bar through individual fuses. However, if the bidder propose to use a "Y" Connector; maximum of 2 (two) strings can be combined, keeping the losses within the specified limit.
 - Provide arrangement for disconnection for each of the groups.
 - Provide a test point for each sub-group for quick fault location and to provide group array isolation.
 - SCADA Communication device with all necessary equipment for communicating with main SCADA Server.
 - Suitable space for workability and natural cooling.
 - Provision of adequate number of spare terminals
- 6.2.4 The rating of all component of JB's shall be suitable with adequate factor of safety to

inter connect the Solar PV array.

- 6.2.5 The junction boxes shall be dust, vermin, and waterproof and made of thermoplastic/ metallic in compliance with IEC 62208, which should be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP65 (Outdoor) and Protection Class II.
- 6.2.6 The Array Junction Box will also have suitable surge protection. In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Device (SPD). The maintenance free earthing shall be done as per the relevant standards.
- 6.2.7 If the solar PV module is not equipped with reverse blocking diode, then each Array Junction Box will have suitable Reverse Blocking Diodes of maximum DC blocking voltage of 1000V with suitable arrangement for its connecting. The bypass & reverse blocking diodes should work for temperature extremes and should have efficiency of 99.98%, confirmed by appropriate IEC standards.
- 6.2.8 Adequate capacity solar DC fuses & isolating miniature circuit breakers should be provided in recommendation with the inverter manufacturer. The fuses should be so designed that it should protect the modules from the reverse current overload.
- 6.2.9 Details of junction box specifications and data sheet, including all components, shall be provided with the Bid document.
- 6.2.10 Bidder shall submit all the test reports/ test certificates and compliance certificates before installation at site.

6.3 Power Conditioning Unit (PCU)

- 6.3.1 Power Conditioning Unit (PCU)/ Inverter shall consist of an electronic inverter along with associated control, protection and data logging devices.
- 6.3.2 **The rated power/name plate capacity of the inverters shall be the AC output of the inverter at 50°C.** Any inverters with AC output at 50°C, below the name plate/rated power of the inverter shall not be allowed.
- 6.3.3 **The inverter supplied shall have minimum of 10% additional DC input Capacity. (E.g. Inverter is supplied with rated capacity of 500 kW (AC) shall accept at least 550 kW of DC power.)**
- 6.3.4 All PCUs should consist of associated control, protection and data logging devices and remote monitoring hardware and compatible with software used for string level monitoring.
- 6.3.5 Dimension, weight, cooling arrangement etc. of the PCU shall be indicated by the Bidder in the offer. Type (in- door & out-door) of installation also to be indicated.
- 6.3.6 Only those PCUs/ Inverters which are commissioned for more than said (AC) capacity

solar PV projects till date in India shall be considered for this project. Bidder has to provide sufficient information to the satisfaction of the Employer before placing the final order for PCUs/Inverters.

- 6.3.7 The minimum European efficiency of the inverter shall be 98% load as per IEC 61683 standard for measuring efficiency. The Bidder shall specify the conversion efficiency of different loads i.e. 25%, 50%, 75% and 100% in its offer. The Bidder should specify the overload capacity in the bid.
- 6.3.8 The PCU shall be tropicalized and design shall be compatible with conditions prevailing **at site. Provision of exhaust fan with proper ducting for cooling of PCU's should be incorporated in the PCU's, keeping in mind the extreme climatic condition of the site** as per the recommendations of OEM to achieve desired performance and life expectancy.
- 6.3.9 The inverters shall have minimum protection to IP 65(Outdoor)/IP 21(indoor) and Protection Class II.
- 6.3.10 Nuts & bolts and the PCU enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.
- 6.3.11 Grid Connectivity: Relevant CERC regulations and grid code as amended and revised from time to time shall be complied. The system shall incorporate a unidirectional inverter and should be designed to supply the AC power to the grid at load end. The power conditioning unit shall adjust the voltage & frequency levels to suit the Grid.
- 6.3.12 All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency.
- 6.3.13 The inverter output shall always follow the grid in terms of voltage and frequency. This shall be achieved by sensing the grid voltage and phase and feeding this information to the feedback loop of the inverter. Thus control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation (PWM) technology.

6.4 Operational Requirements for Inverter/ PCU

- 6.4.1 The PCU must have the feature to work in tandem with other similar PCU's and be able to be successively switched "ON" and "OFF" automatically based on solar radiation variations during the day. Inverters must operate in synergy and intelligently to optimize the generation at all times with minimum losses.
- 6.4.2 The PCU shall be capable of controlling power factor dynamically.
- 6.4.3 Maximum power point tracker (MPPT) shall be integrated in the power conditioner unit to maximize energy drawn from the Solar PV array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism of MPPT shall be mentioned by the Bidder in its offer. The MPPT unit shall conform to IEC 62093 for design

qualification.

- 6.4.4 The system shall automatically "wake up" in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.
- 6.4.5 **Sleep Mode:** Automatic sleep mode shall be provided so that unnecessary losses are minimized at night. The power conditioner must also automatically re-enter standby mode when threshold of standby mode reached.
- 6.4.6 **Stand – By Mode:** The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.
- 6.4.7 **Basic System Operation (Full Auto Mode):** The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.
- 6.4.8 PCU shall have provisions/features to allow interfacing with monitoring software and hardware devices.

6.5 Protection against faults for PCU

The PCU shall include appropriate self-protective and self-diagnostic feature 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 failure, shall be cleared by the PCU protective devices. In addition, it shall have following minimum protection against various possible faults.

- 6.5.1 **Grounding Leakage Faults:** The PCU shall have the required protection arrangements against grounding leakage faults.
- 6.5.2 **Over Voltage & Current:** In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Devices (SPD).
- 6.5.3 **Galvanic Isolation:** The PCU inverter shall have provision for galvanic isolation with external transformer, if required.
- 6.5.4 **Anti-islanding** (Protection against Islanding of grid): The PCU shall have anti islanding protection. (IEEE 1547/UL 1741/ equivalent BIS standard)
- 6.5.5 **Unequal Phases:** The system shall tend to balance unequal phase voltage (with 3-phase systems).
- 6.5.6 **Reactive Power:** The output power factor of the PCU should be of suitable range to supply or sink reactive power. The PCU shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line.
- 6.5.7 **Isolation:** The PCU shall have provision for input & output isolation. Each solid- state

electronic device shall have to be protected to ensure long life as well as smooth functioning of the PCU.

6.5.8 PCU shall have arrangement for adjusting DC input current and should trip against sustainable fault downstream and shall not start till the fault is rectified.

6.5.9 Each solid state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter.

6.5.10 All inverters/ PCUs shall be three phase using static solid state components. DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. Fuses & Circuit breakers used in the DC lines must be rated suitably.

6.6 Standards & Compliances

6.6.1 PCU shall confirm to the following standards and appropriately certified by the labs:

- Efficiency measurement: IEC 61683
- Environmental Testing: IEC 60068-2 or IEC 62093
- EMC, harmonics, etc.: IEC 61000 series, 6-2, 6-4 and other relevant Standards.
- Electrical safety: IEC 62109 (1&2), EN 50178 or equivalent
- Recommended practice for PV – Utility interconnections: IEEE standard 929 – 2000 or equivalent
- Protection against islanding of grid: IEEE1547/ UL1741/ IEC 62116 ore equivalent
- Grid Connectivity: Relevant CEA/ CERC regulation and grid code (amended up to date)
- Reliability test standard: IEC 62093 or equivalent

6.6.2 The Bidder should select the inverter (Central) as per its own system design so as to optimize the power output.

6.6.3 Desired Technical Specifications of PCU.

- Sinusoidal current modulation with excellent dynamic response.
- Compact and weather proof housing (indoor/ outdoor)
- Comprehensive network management functions (including the LVRT and capability to inject reactive power to the grid)
- Total Harmonic Distortion (THD) <3%
- No load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%
- Optional VAR control
- Power factor Control range: 0.9 (lead – lag)
- Humidity: 95% Non – Condensing
- Unit wise & integrated Data logging
- Dedicated Prefabs / Ethernet for networking

6.6.4 Inverter/ Power Condition unit must provide protection against:

- Over current
- Sync loss
- Over temperature
- DC bus over voltage
- Cooling Fan failure (If provided)
- Short circuit
- Lightning
- Earth fault
- Surge voltage induced at output due to external source
- Power regulation in the event of thermal overloading
- Set point pre-selection for VAR control
- Bus communication via -interface for integration
- Remote control via telephone modem or mini web server
- Integrated protection in the DC and three phase system
- Insulation monitoring of the PV array with sequential fault location

6.6.5 Ground fault detector which is essential for large PV generators in view of appreciable discharge current with respect to ground.

6.6.6 Over voltage protection against atmospheric lightning discharge to the PV array is required.

6.6.7 The power conditioner must be entirely self-managing and stable in operation.

6.6.8 A self-diagnostic system check should occur on start up. Functions should include a test of key parameters on start up.

6.6.9 PCU/inverter front panel shall be provided with display (LCD or equivalent) to monitor, but not limited to, the following:

- DC power input
- DC input voltage
- DC Current
- AC power output
- AC voltage (all the 3 phases and line)
- AC current (all the 3 phases and line)
- Power Factor

6.6.10 Documentary Requirements & Inspection

- The bill of materials associated with PCU's should be clearly indicated while delivering the equipment.
- The Contractor shall provide to the Employer, data sheet containing detailed technical

specifications of all the inverters and PCUs, Type test reports and Operation & Maintenance manual before dispatch of PCUs.

- The Employer or its authorized representative reserves the right to inspect the PCUs/ Inverters **at the manufacturer's site prior to dispatch.**

6.7 Cable and Wires

- 6.7.1 All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, salt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. (Note: DC cables for outdoor installations should comply with the TUV 2PFG 1169/09.07 for service life expectancy of 25 years)
- 6.7.2 Insulation: Outer sheath of cables shall be electron beam cross-linked XLPO type and black in colour. In addition, Cable drum no. / Batch no. to be embossed/ printed at every one meter. Cable Jacket should also be electron beam cross-linked XLPO, flame retardant, UV resistant and black in colour.
- 6.7.3 DC cables used from solar modules to array junction box shall be solar grade copper (Cu) with XLPO insulation and rated for 1.1kV only. However, the cables used from array junction box to inverter can be XLPO Aluminium with 1.1kV rating as per relevant standards. Bidder shall provide the type test report for each type of cable used before dispatch of the cable.
- 6.7.4 Wires with sufficient amp city and parameters shall be designed and used so that maximum voltage-drop at full power from the PV modules to inverter should be less than 1.5% (including diode voltage drop). Successful Bidder shall provide voltage drop calculations in excel sheet.
- 6.7.5 Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted. All wires used on the LT side shall conform to IS and should be of appropriate voltage grade. Only copper conductor wires compliant with IEC 60228, Class 5 of reputed make shall be used.
- 6.7.6 All high voltage cables connecting the main junction box/inverters to the transformers should be XLP insulated grade conforming to IS 1554 and cables shall also conform to IEC 60189 for test and measuring the methods. The Underground Cable should be XLPE only.
- 6.7.7 Cable terminations shall be made with suitable cable lugs & sockets etc., crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles.
- 6.7.8 All cable/wires shall be provided with UV resistant printed ferrules for DC side however, for HT cables, punched/ embossed aluminium tags are required. The marking on tags

shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

- 6.7.9 The wiring for modules interconnection could be in the weather resistant pipe of reputed make. All the buried cables can be run through HD pipe/ DWV conduit. However, for crossing with road, drain and trenches etc., the cable must pass through GI pipe of appropriate size.

6.8 Switchboard box / DC Distribution Box (DCDB) / AC Distribution Box (ACDB) panels

- 6.8.1 Successful Bidder shall provide sufficient no. of switchboards / DCDB / ACDB wherever required.
- 6.8.2 All boxes/ panels should be equipped with appropriate functionality, safety (including fuses, grounding, etc.) and protection.
- 6.8.3 The terminals will be connected to bus-bar arrangement of proper sizes to be provided. The panels/ boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables.
- 6.8.4 Adequate rating fuses & isolating MCB/ MCCB should be provided.
- 6.8.5 The panels/ boxes shall have suitable arrangement for the followings:
- Provide arrangement for disconnection
 - Provide a test point for quick fault location
 - To provide isolation
 - The current carrying rating of the boxes/ panels shall be suitable with adequate safety factor
 - The rating of the boxes/ panels shall be suitable with adequate safety factor to inter connect to the local/ internal grid
 - Thermal/ heat dissipation arrangement/ Vent for safe operation.
 - Adequate number of spare terminals
- 6.8.6 The boxes/ panels shall be dust, vermin, and waterproof and made of thermoplastic/ metallic in compliance with IEC 62208, which should be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP 65(Outdoor)/ IP 20(indoor) and Protection Class II.
- 6.8.7 All panels/ boxes shall be provided with adequately rated bus-bar, incoming control, outgoing control etc. as a separate compartment inside the panel to meet the requirements of the Chief Electrical Inspector General (CEIG). All live terminals and bus bars shall be shrouded. The outgoing terminals shall be suitable to receive suitable runs and size of cables required for the Inverter/Transformer rating.
- 6.8.8 The boxes/ panels must be grounded properly to ensure all safety related measures for safe operation. The parts of panel, wherever applicable, must be insulated properly.

6.8.9 All the Panels to be manufactured with sufficient space for working and must have temperature suitability up to 85° C with separate cable and bus bar alley.

6.9 Lightning Protection for PV Array

6.9.1 The source of over voltage can be lightning or other atmospheric disturbance. Main aim of over voltage protection is to reduce the over voltage to a safe level before it reaches the PV or other sub-system components as per NFC 17 – 102. Bidder to provide ESE type lightening arrester, placed at strategic locations to protect the plant from lightening and shall not cause any shadow on the solar modules.

6.9.2 Necessary foundation / anchoring for holding the lightning conductor in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.

6.9.3 The site is prone to lightning strikes and hence bidder is suggested to take utmost care while designing the lightning protection system. The Bidder shall submit the drawings, calculations and detailed specifications of the PV array lightning protection equipment to Employer for approval before installation of system.

6.9.4 The lightning conductor shall be earthed through flats and connected to the grounding mats as per applicable Indian Standards with earth pits. Three earth pits shall be provided for each lightning arrester. Each lightning conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS.

6.10 Solar Photovoltaic Power Plant Electrical System

The technical requirements of design & engineering, testing at works, supply, installation testing & commissioning of all electrical equipment required for the Solar Photovoltaic Power Plant starting from the local control panel of Plant and up to the Grid tie up with the State grid including all control protection, metering equipment, step up generator voltage transform, 33kV indoor/ outdoor switchgears and balance of equipment complete in all respect shall be of high standard and quality meeting the requirement of respective Indian standard (following table). All the type test reports along with Material Despatch Clearance Certificate (MDCC) for all equipment and cables are to be submitted by the Contractor prior to the despatch of the same. Bidder has to provide the type test report for all the equipment used under this contract. If the equipment is not type tested, the bidder has to ensure conduction of such test and supply the type test to the Employer without any additional cost. The brief particulars and requirement of equipment is as under-

IS/ IEC Reference	Specification
IEC-298	A.C. Metal – enclosed and control gear for rated voltages above 1KV and including 72.5KV
IS-3427	A.C. Metal – enclosed and control gear for rated voltages above 1KV and including 52KV.
IS-8623	Specification for Low Voltage Switchgear and Control gear assemblies.
IS-13118/ IEC-56	Specification for High Voltage AC Circuit Breakers.
IEC-529	Degrees of Protection.
IS-5578 & 11353	Making and arrangement for switchgear bus bar main connections and auxiliary wiring.
IS-325	Specification for 3 Phase Induction motors.
IS-2629	Recommended practice for not dip galvanizing of iron and steel.
IEC-137	Bushing for AC Voltages.
IS-3347	Porcelain Transformer Bushings.
IS-5561	Terminal Connectors
IS-3156	Voltage Transformers
IS-2705	Current Transformers
IS-3231	Electric relays for power protection.
IS-13010	Watt hour meters
IS-13779	Static Energy Meters
IS-8686	Static Protection Relays
IS-1248	Electrical measuring instruments
IS-2099	High Voltage Porcelain Bushings.
IS-10118	Minimum clearances for Outdoor Switchgear.
IEC-694	Common Clauses for High Voltage Switchgear and Control gear
IEC-60255 & IEC-61330	Numerical Relays

6.11 Step-Up Transformer

- 6.11.1 The transformer shall be copper wound, 3 phase, natural cooled, core type construction, and oil immersed and shall be suitable for outdoor applications.
- 6.11.2 The Bidder shall provide the complete turnkey design, supply, erection, testing and commissioning of transformers and transformer substation to step-up the output of the inverter to 11 kV at the location of the inverter. The power from different inverter rooms shall be collected at a common location from where it shall be transmitted to the near by 11 kV overhead line through underground cable. However, the detailed scheme of design lies with the bidder and must submit the same to Employer for approval prior to construction.
- 6.11.3 Power Transformers utilized shall be 3 phase, Oil Filled, 11 kV, 50 Hz and associated Switchgear of approved make. RTCC panel, as per design, will be provided in control room. It is recommended to have standard ratings of transformer used. Bidder is to provide the type test reports for the transformer (s) used. The vector group of transformer (s) must be in line with the system requirement and follow the prevailing grid codes at

the location of Site.

6.11.4 All the transformers shall be suitable for outdoor installation with 3 phase 50Hz in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 10% to minus 15%.

6.11.5 General requirement for the transformers shall be as per below:

Standards	Relevance
IS: 2026 (Part 1 to 4)	Specifications for Power Transformer
IS: 2099	Bushings for alternating voltage above 1000 V
IS: 3639	Fittings and accessories for power transformer
IEC: 60076 (Part 1 to 5)	Specifications for Power Transformer
IS: 9921 Part 1 to 5	Alternating currents dis connectors (isolators) and earthing switches rating, design, construction, tests etc.
IS: 2705 Part 1 to 4 & IEC: 185	Current transformer
IS: 3156 Part 1 to 4	Voltage Transformer
IS: 3070 part 1 to 3	Lightning arrestors
IS: 2544	Porcelain insulators for system above 1000 V
IS: 5350	Part III – post insulator units for systems greater than 1000V
IS: 5621	Hollow Insulators for use in electrical equipment
IS: 5556	Serrated lock washers – specification

6.12 General Standards

6.12.1 The equipment and accessories covered by this specification shall be designed, manufactured and tested in accordance with the latest relevant standards and codes of practice published by the relevant Indian Standards (IS) as applicable.

6.12.2 All electrical equipment and installation shall confirm to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified for installation and operation of electrical plants. Relevant national and international standards in this connection can be followed in order to improve the efficiency and safe operations.

6.12.3 All working parts, insofar as possible, are to be arranged for convenience of operation, inspection, lubrication and ease of replacement with minimum downtime. All parts of equipment or of spare equipment offered shall be interchangeable.

6.12.4 The quality of materials of construction and the workmanship of the finished products / components shall be in accordance with the highest standard and practices adopted for the equipment covered by the specification.

6.12.5 All items of equipment and materials shall be thoroughly cleaned and painted in accordance with relevant Indian Standards. The finish paint shall be done with two coats of epoxy based final paint of colour Shade RAL 7032 of IS: 5 for indoor equipment.

6.12.6 Any fitting or accessories which may not have been specifically mentioned in the

specification but which are usual or necessary in the equipment of similar plant or for efficient working of the plant shall be deemed to be included in the contract and shall be provided by the Contractor without extra charges. All plant and apparatus shall be complete in all details whether such details are mentioned in the specifications or not.

- 6.12.7 All equipment shall be designed for operation in tropical humid climate at the required capacity. The reference parameters for which the transformers are to be designed are as under:-

Particulars	Condition
Maximum ambient temperature	50°C
Maximum daily average ambient temp	40°C
Maximum yearly weighted average ambient temp	35°C
Minimum ambient air temperature (Cooling)	-5°C
Max. Relative Humidity	95%
Yearly Avg. number of thunder storms	30-50
Average Number of rainy days	60 days
Fog	In winter
Number of months during which topical monsoon prevail	5 months
Dust storms	May not occur
Average Annual rain fall	100 cms.
Maximum wind speed	150 kmph

6.13 Ratings and specifications (415V / 11 kV Transformer)

The typical rating and electrical characteristics of the 0.415kV/ 11 kV ONAF type inverter duty transformer shall be as under however, the ratings may vary subjected to design by the bidder and relevant to the respective IS codes :

Particulars	415V / 11 kV Transformer Specs.
Continuous kVA ratings	As per design
Type	Oil immersed
Frequency	50 Hz
Type of cooling	Oil Natural Air Forced (ONAF)
No. of phases	3 (Three)
Rating voltage H.V. side	11 kV
Highest System voltage on H.V. side	12 kV r.m.s.
Rated voltage on L.V. side	0.433 kV r.m.s.
Vector Group	Dyn11
Max core windings	3
Connections	
a. H.V. Winding	Delta
b. L.V. winding	Star with Neutral solidly earthed(as per state grid code)
On load taps on H.V. Side (for H.V. Variation)	+ 5 to - 10.0 % (in steps of 1.25%)
Tap changer type	OLTC

Impedance voltage (%) as per IS 2026	4%
Transformer connections	LV side – Cables/ Bus Duct with weather proof enclosure as per design
	HV Side –Bushing with enclosure

6.13.1 Efficiency:

The percentage loading for the maximum efficiency shall be clearly stated at unity power factor as well as 0.8 and 0.9 power factor (lead and lag).

6.13.2 Insulation:

The dielectric strength of the winding, given insulation and the bushings shall conform to the values given in IS: 2026 (Part III)/1981 (or its latest amendment) for highest system voltage of 12 kV, 1.1 kV and shall be suitable for the impulse test/power frequency test voltages.

6.13.3 Factory Assembly and Tests:

The transformer shall be completely assembled and tested at the Factory. Routine and Acceptance tests as per specification/ standards are to be conducted and no deviation in respect of conducting these tests will be acceptable. No extra charges for these tests will be paid. Test charges shall be part of cost of the equipment. If purchaser selects to send a representative, all tests shall be carried out in his presence. Type test certificate shall be furnished before start of supply.

6.13.4 Routine Tests:

Each completed transformer shall be subjected to following routine tests as per IS: 2026 Part. I & III (latest amendment). No extra charges for any of the tests shall be paid. No deviation shall be acceptable. If the supplier desires, he may not fix radiators on transformers (other than the one which is to be type tested) during routine testing. However in that case, radiator manufacturer's test certificate shall be furnished for reference of inspecting officer with undertaking that supplier shall be responsible for proper alignment/fixing of radiator on transformer at site.

- Measurement of resistance of each winding.
- **Measurement of turn's ratio** between HV-LV windings at each tap.
- Checking of polarity and phase relation-ships for each winding.
- Measurement of no load loss and no load current.
- Positive phase sequence impedance/short circuit impedance between HV-LV windings on minimum, maximum and normal taps.
- Separate source voltage withstand test.
- BDV test on transformer oil.
- Induced over voltage withstand test.

- Measurement of neutral unbalance current.
- Regulation at rated load at unity, 0.90 and 0.80 lagging power factor.
- Load losses measured at rated frequency by applying voltage sufficient to produce the rated relevant current in one winding with the other winding short circuited.
- Measurement of insulation resistance.
- The total losses shall comprise of the No Load Losses, load losses at rated output duly converted at 75°C average winding temperature and shall also be indicated in the test report. Load losses shall be that corresponding to rated load on HV & LV winding.
- Routine dielectric tests as per IS: 2026(Part. I & III), 1981 and any amendments thereto.
- Check complete transformer against approved outline drawing, provision for all fittings, finish oil level etc.

6.13.5 Tests at Site

After erection at site all transformer(s) shall be subjected to the following tests:

- a) Insulation resistance test.
- b) Ratio and polarity test.
- c) Dielectric test on oil.
- d) Physical check

In case the equipment is not found as per the requirements of the purchase order, all expenses incurred during site testing will be to the tenderer's account and the material shall be replaced by him at site, free of cost.

6.13.6 Further Tests:

The purchaser reserves the right of having other reasonable tests carried out at his own expenses either before dispatch or during performance guarantee period from Govt. approved/ Govt. recognized lab to ensure that the transformer complies with the requirements of this specification after due intimation to the supplier. In case the equipment is not found meeting the requirement of PO / specification, all expenses incurred for such testing will be on supplier's account and the material shall be replaced by the supplier at site free of cost

6.13.7 Frequency and System Voltage:

The transformer shall be suitable for continuous operation with a frequency variation of $\pm 2.5\%$ from normal of 50Hz without exceeding the specified temperature rise. The highest system rated voltage shall be 12 kV. However the flux density requirements shall be as per this specification.

6.13.8 Installation & Commissioning

Mainly following activities are required to be carried out before commissioning of Power Transformers:-

- Assembling of Power Transformer accessories as per GA drawing.
- Testing activities in presence of Purchaser such as
 - Ratio Test
 - Megger Value
 - Magnetic balance.
 - Oil BDV
 - Earth Resistance
 - Buchhloz Relay checking.
 - WTI/OTI/MOLG (oil level) checking.
 - Checking of points of leakage of oil from Transformer body/ Radiator/Valve
 - Setting of Relays in Panel

6.14 Auxiliary transformer

The transformer used for auxiliary distribution within the plant must be in accordance with the reference standards. The ratings of the transformer shall be suitably designed by the bidder in order to maximize the net generation from the plant. The guaranteed technical particulars of the auxiliary transformer must be supplied along with the bid. The bidder shall also provide the list of auxiliary loads considered for the project.

6.15 Instrument Transformer

- 6.15.1 The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshalling box for a set of three single phase units. The tank as well as top metallic shall be hot dip galvanized or painted Grey colour as per RAL 9002.
- 6.15.2 The instrument transformers shall be oil filled hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.
- 6.15.3 Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block. The insulators shall have cantilever strength of more than 500 kg.
- 6.15.4 Current Transformer, Voltage Transformer, Circuit Breaker and Relays should match state Utility requirements.

6.16 Current Transformer (CT)

- 6.16.1 Current transformers may be either of the bushing type or wound type. The bushing types are normally accommodated within the transformer bushings and the wound types are invariably separately mounted. The location of the current transformer with respect to associated circuit breaker has an important bearing upon the protection scheme as well as layout of, substation. Current transformer class and ratio is determined by electrical protection, metering consideration.

6.16.2 Technical specifications – Current ratings, design, Temperature rise and testing etc. should be in accordance with IS: 2705 (part I to IV)

6.17 Type and Rating

6.17.1 The current transformer should be of indoor/ outdoor type, single phase, oil immersed, self-cooled and suitable for operation in 3 phase solidly grounded system.

6.17.2 Type test certificate for the proposed CT shall be provided to the bidder before dispatch.

6.17.3 Each current transformers should have the following particulars under the site conditions for the system under design

6.17.4 General Parameters: 11 kV CT

Particulars	Details
Highest system Voltage (Vm)	12 kV rms
Rated frequency	50 Hz
System Neutral Earthing	Effective earthed
Installation	Indoor (IP 20)/ Outdoor (IP 65)
Rated dynamic current	63 kA (Peak) appropriate dynamic current as per design calculations
Rated min power frequency withstand voltage (RMS value)	70 kV
Rated lightning impulse withstand voltage (peak value)	170 kVp
Partial discharge level	10 Pico coulomb max.
Temperature rise	As per IEC 60044
Type of insulation	Class A
Number of cores	Two (2) with One (1) protection core and one (1) metering core of accuracy 0.5 class
CT secondary current	Protection cores – 1 Amp. Metering Core – 1 Amp
Number of terminals in marshalling box	All terminals of control circuits wired up to marshalling box plus 20% spare terminals
CT ratio & Rated VA Burden, short time thermal rating ,class of accuracy	Minimum burden required (as per design): 1. Metering core – 40 VA 2. Protection core – 10 VA

6.18 Voltage Transformer (VT/ PT)

6.18.1 Voltage transformers shall be electro-magnetic (EMU) type and shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.

6.18.2 The secondary shall be protected by 3A HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings. The secondary terminals shall be terminated on stud type non- disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP 55. The access to

secondary terminals shall be without the danger of access to high voltage circuit.

6.18.3 The accuracy of metering core shall be maintained through the entire burden range up to 75 VA on all three windings without any adjustments during operations.

6.18.4 The PTs should be single phase oil immersed self -cooled type suitable for outdoor.

6.18.5 The core should be of high grade non – ageing electrical silicon laminated steel of high permeability. The PTs should be hermetically sealed to eliminate breathing and prevent air and moisture entering the tank.

6.18.6 Bidder has to provide the type test certificate for the proposed VT before dispatch.

6.18.7 Each voltage transformers should have the following particulars under the site conditions for the system under design

6.18.8 General Parameters: **11 kV VT**

Particulars	Details
Highest system voltage (Um)	12 kV
System neutral earthing	effective earthed
Installation	Indoor (IP 20)/ Outdoor (IP 65)
System fault level	Appropriate
Rated min power frequency withstand voltage (rms value)	70 kV
Rated lightning impulse withstand voltage	170 kVp
Standard reference range of frequencies for which the accuracy are valid	96% to 102% for protection and 99% to 101% for measurement
Rated voltage factor	1.2 continuous & 1.5 for 30 sec
Class of Accuracy	0.5 / 3P
Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:358
One Minute Power frequency withstand voltage for secondary winding	2 kV rms
Temp rise over an ambient temp. of 50°C	As per IEC 60044
Number of terminals in control Cabinet	All terminals of control circuits wired up to marshalling box plus 10 terminals spare
Rated total thermal burden	350 VA (or as per design)
Partial discharge level	10 pico Coulombs max.
Number of cores	2 (two) – 1 for protection and 1 for metering with 0.5 class accuracy.
Rated Output, insulation level, transformation ratio, rated voltage factor	Should be provided by Bidder

6.19 11 kV METERING BAY (Owner Substation)

6.19.1 The current & potential transformers shall be of outdoor type single phase, 50 Hz, oil immersed self-cooled suitable for operation in the climate conditions specified shall be complete in all respects.

6.19.2 The instrument transformers shall be hermitically sealed to eliminate breathing and

entering of air and moisture in the tank. Provision of pressure releasing device is not permitted.

6.19.3 The CT core, to be used for protective relays shall be of accuracy class, specified or appropriate class suitable for back up, over current and earth fault, differential, bus bar and other protections as prescribed

6.19.4 Applicable Standards:

Unless otherwise modified in this specification, 11 KV CT-PT Metering Sets shall comply with the following Indian Standard Specification (latest version):

IS: 2705-1992 Specification for current transformers.

IS: 3156-1992 Specification for voltage transformers.

IS: 5621-1980 Specification for Hollow insulators and accessories

IS: 2099-1986 Specification for insulators/ bushing

IS: 3347-1986 Specification for the dimension of Porcelain transformer

IS: 335-1983 Specification for new insulating oil

6.19.5 The core of instrument transformers to be used for metering and instrumentations shall have saturation factor, low enough to avoid damage to the instruments, in the event of maximum short circuit current.

6.19.6 Nuts and bolts (or screws used for fixation of interfacing porcelain bushings for taking out terminals) shall be provided on flanges, cemented to the bushing and not on the porcelain i.e. Flange type 11 KV bushing for CT/PT, shall be provided.

6.19.7 For gasket joints, wherever used, Nitrile Butyl rubber gaskets shall be used. The gasket shall be fitted properly with adequate space for accommodating the gasket under compression.

6.19.8 The metering sets shall be supplied with first filling of insulating oil conforming to IS: 335 (including latest amendment).

6.19.9 The outer surface of metal tank shall be Hot Dip Galvanised, whereas, the inner portion shall be painted with oil resistive, insoluble paint. The purchaser reserves right for stage inspection during manufacturing process of tank / CT/PT.

6.19.10 The external surfaces of tanks of CT-PT sets shall be painted with one coat of primer and two coats of synthetic enamel paint of shade No.631 of IS: 5, the internal surfaces of the tank shall be painted with two coats of suitable heat resistant oil insoluble paint.

6.19.11 The instrument transformers shall be suitable for mounting on steel structures or concrete pedestals.

6.19.12 For load shading single phasing is adopted in the 11 kV system. The offered 11 kV CT

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PT set shall be suitable for working under such abnormal operation condition.

6.19.13 The 11 kV CT – PT sets shall three nos. of single phase PTs. The primary winding of 3 single phase PT shall be connected in star formation in the tank with common neutral of

11 KV brought outside the tank through 3 KV bushing for earthing.

6.19.14 The secondary terminal box shall have cable gland/ flange suitable to receive two Nos. control cable of size 6x4 sq.mm and 4x2.5 sq.mm at the bottom of the secondary box for metering connections to secondary winding of 33 kV CT-PT circuits respectively.

6.19.15 The 11 kV CT – PT Set shall have 3 Nos. incoming and 3 Nos. outgoing outdoor type bushing complete with 6 Nos. bimetallic terminal connectors suitable for Dog/ Panther Conductor

6.19.16 General Parameters: **11 kV CT (Owners Bay and Metering Bay)**

Particulars	Details
Normal system voltage (kV rms)	11 kV
Highest system voltage (kV rms)	12 kV
Frequency	50 Hz
Impulse withstand voltage (kVp) (on assembled CT/ PT set)	170
One minute power frequency dry withstand voltage (on assembled CT-PT set)	
Primary (r.m.s.)	70 kV
Secondary (r.m.s.)	3 kV
Transformation ratio (CT Ratio)	400/1 A or as per requirement
Rated output (VA burden)	10 VA
Class of accuracy	0.2S
Rated continuous thermal current	1.2 times of rated primary current.
Short time thermal current rating for 1sec.	25kA for 400/1 A Current density corresponding to Short Time Thermal Current should not exceed 160A /mm sq.
Rated dynamic current	2.5 times of short time thermal current rating.
Number of cores	One
Instrument security factor	Not exceeding 5
Max. ratio error	As per IS:2/05/1992

6.19.17 General Parameters: **11 kV VT (Owner's Bay & Metering Bay)**

Particulars	Details
Nominal system voltage (kV rms)	11 kV
Highest system voltage (kV rms)	12 kV
Nos. of phases	Three
Impulse withstand voltage (kVP) (on assembled CT-PT set)	170kVp
One minute power frequency dry withstand voltage (on assembled CT-PT set)	
Primary	70 kV r.m.s
Dry secondary	3 kV r.m.s

Frequency	50 Hz
Transformation ratio (PT Ratio)	11 kV/ 110V
Rated output (VA burden)	30 VA per phase
Class of accuracy	0.2 (As per IS:3156/1992)
Winding connection	Star/ Star
Rated voltage factor and time	1.2 Continuous & 1.9 for 30 seconds.
Temp. Rise over max. Ambient temp.	Within limits of IS:3156/1992
Phase angle error max.	-do-
Max. Phase angle error	-do-
Ratio error (Max.)	-do-

6.20 Circuit Breaker

6.20.1 The circuit breakers shall be capable of rapid and smooth interruption of currents under all conditions completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small currents or leading or lagging reactive currents. The circuit breakers shall be 'Restrike-Free' under all operating conditions. The details of any device incorporated to limit or control the rate of rise of re-striking voltage across, the circuit breaker contacts shall be stated. The over voltage across, the circuit breaker contacts shall be stated. The over voltage caused by circuit breaker while switching inductive or capacitive loads shall not exceed 2.5 times the highest phase to neutral voltage. The actual make and break times for the circuit breakers throughout the ranges of their operating duties shall be stated in the offer and guaranteed

6.20.2 Applicable Standards: The materials shall conform in all respects to the relevant Indian Standard Specifications/ IEC Standards, with latest amendments indicated (reference only) below:

IS-13118/1991	General requirements for Circuit breakers for voltage above 1000 V IEC 62271-100-1/2001
IS-2705/1992	Current Transformers
IS-2099/1986	Bushings for alternating voltages above 1000 V
ISS-2633/1964	Methods of testing uniformity of coating of zinc coated articles
IS-3231/1986	Electrical relays for power system protection
IS-1248/1983	Specification for Ammeters & Voltmeters
IS-335/1983	New insulating oils Electrical IEC 71 (For oils in CTs) Clearances
IS-2147/1962	Degree of protection provided by enclosures for low voltage switchgear & control gear

6.20.3 The arc quenching chambers shall have devices to ensure almost uniform distribution of voltage across the interrupters.

6.20.4 Appropriate & adequate Capacity 415V AC indoor air Circuit Breaker as per the IEC 60898 / IEC 62271 – 100 or equivalent Indian Standards along with control circuit and protection

relay circuit, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

- 6.20.5 Circuit breaker shall be C2/MI class under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 6kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.
- 6.20.6 The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 11 kV transformers. It shall also be capable of breaking line charging currents as per IEC- 62271-100 with a voltage factor of 1.4.
- 6.20.7 The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC: 62271-100.
- 6.20.8 The Bidder may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.
- 6.20.9 Bidder shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.
- 6.20.10 While furnishing particulars regarding the D.C. component of the circuit breaker, the Bidder shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation.
- 6.20.11 The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and arc duration shall be indicated.
- 6.20.12 Bidder has to provide the type test reports for the CB before the dispatch.
- 6.20.13 All the duty requirements specified above shall be provided with the support of adequate test reports.

6.21 Operating Mechanism

- 6.21.1 Circuit shall be vacuum type with electrically spring charged mechanism.
- 6.21.2 The operating mechanism shall be anti-pumping and trip free (as per IEC definition) electrically under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the leakage of operating media and / or gas. The circuit breaker shall be able to perform the duty cycle without any interruption.
- 6.21.3 Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. 'Local / remote' selector switch and close & trip push buttons shall

be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided. The VCB coil DC supply through appropriately rated battery bank and charger to be supplied by the Bidder.

6.21.4 Operating mechanism and all accessories shall be in local control cabinet. A central control cabinet for the three poles of the breaker shall be provided along with supply of necessary tubing, cables, etc.

6.21.5 Mounting and supporting structure for Circuit Breaker: The circuit breakers should be self-supporting type. However, if necessary for the purpose of minimum ground clearance the circuit breakers should be mounted on raised steel structures which should be included in the scope of supply of circuit breaker. Bidder to obtain the necessary information and data required for design of foundations of the circuit breaker be obtained from the CB supplier.

6.21.6 Max. Impact loading in terms of equivalent static load both compression and upward due to opening/closing of the breakers. It shall be clearly stated whether these forces shall act simultaneously or at different timing.

6.21.7 Necessary connecting materials such as clamps, bolts, nuts, washers etc. and fixing bolts for mounting the equipment on the supporting structures wherever required should be obtained from the circuit breaker supplier.

6.21.8 General parameters: **Vacuum type Circuit Breaker:**

Particulars	Details
Type of circuit breaker	Vacuum type
Highest System Voltage	12 kV
Rated operating voltage	11 kV
Rated frequency	50 Hz (+3% to -5%)
Number of poles	Three (3)
Rated/ minimum power frequency Withstand voltage	70 kV
Rated lightning impulse Withstand voltage	170 kV
Rated operating duty cycle	0 - 0.3 sec. - CO – 3 min. – CO
Rated line charging breaking	As per IEC
Reclosing	Single and three phase high speed auto reclosing
Maximum fault level	25 kA (r. m. s.) for 1 sec.
Auxiliary contacts	As required plus 6NO and 6NC contacts per pole as spare.
Noise level	Maximum 140dB at 50m distance from base of circuit breaker
Seismic acceleration	0.4 g horizontal

6.21.9 Co-ordination of rated voltages, short circuit breaking current and rated normal current for guidance as per IS 13118 for rated voltage 33 kV and above as commonly used are as given in bellow table.

Rated voltage (kV)	Rated short-circuit breaking current (kA)	Rated normal current (A)				
36	8	630	1250	1600	2500	4000
	16	630	1250	1600		
	40					

6.21.10 Circuit Breaker Protection against

- Over Current
- Earth fault
- Under voltage & over voltage protection
- Under frequency & over frequency
- SF6 gas pressure low (where applicable)
- DC supply failure

6.22 Isolators

6.22.1 The isolators and accessories shall conform in general to IEC 62271-102 (or equivalent Indian standard) except to the extent explicitly modified in specification.

6.22.2 Each isolating switch should have the following particulars under the site conditions for the system under design (typical values for 12 kV system are given).

6.22.3 General Parameters: 11 kV Isolators

Particulars	Details
Operating mechanism of Isolator and Earth Switch	Motor operated
Nominal system voltage	11 kV
Highest system voltage	12 kV
Type	Outdoor (IP 65)
Rated short time current of isolator and earth switch	40 kA (rms) for 1 sec. Or appropriate as per design
Rated dynamic short time with stand current of isolator and earth switch	80 kA (peak) Or appropriate as per design
Impulse withstand voltage with 1.2/50 micro sec. wave	325kVp to earth 195kVp across isolating distance
One minute power frequency withstand Voltage	140 kV (rms) to earth & 150 kV (rms) across isolating distance
Temperature rise	As per Table-IV of IS: 9921
Rated mechanical terminal load	As per 62271-102

6.23 Indicating and Integrating Meters/Instruments:

All indicating instruments shall be of switchboard type, back connected, suitable for flush mounting and provided with dust and vermin proof cases for tropical use and finished in suitable colour. All instruments shall have practical laboratory means for adjustment of

accuracy. The limits of errors for ammeters/voltmeters shall be those permissible for class 1.5 instruments as per IS: 1248.

6.23.1 A.C. Static HT Tri vector Meter:

A.C. Static HT Tri vector Meter shall be as per NMPT/State Utility norms and shall be intimated while placement of order. The meters shall be located at eye level to facilitate observations of readings correctly.

6.23.2 The ammeters and voltmeters shall be suitably scaled to indicate the current/voltage for all the rating of current/voltage transformers. A phase selector switch with four/six position shall be used to measure the current/voltage of each phase/line. The Bidder shall provide test certificate and calibration certificate along with the supply of the instrument.

6.23.3 The meters shall be located at normal eye level to facilitate observation of readings correctly.

6.24 Surge Arrestors

6.24.1 The surge arrestors (SAs) shall conform in general to IEC 60099-4 or IS: 3070 except to the extent modified in the specification. Arresters shall be of hermetically sealed units, self-supporting construction, suitable for mounting on lattice type support structures. Bidder shall furnish the technical particulars of Surge arrester.

6.24.2 The SA's shall be of heavy duty station class and gapless Metal Oxide type without any series or shunt gaps. The SAs shall be capable of discharging over-voltages occurring during switching of unloaded transformers, and long lines.

6.24.3 Arrestors shall be complete with insulating base for mounting on structure. Suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit with necessary connection.

6.24.4 The surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4.

6.24.5 Each lightning arrestors should have the following particulars under the site conditions for the system under design.

6.24.6 Technical requirements for metal oxide (gapless) lightning arrestors

6.24.7 Typical values of **Isolator for 12 kV system are given**

Particulars	Details
Rate System Voltage	12 kV
Rate Arrester Voltage	10 kV
Nominal discharge current	10 kA of 8/20 micro-sec wave
Minimum discharge capability	5 kilo joule/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics)
Class	Station class

Maximum Continuous Operating	11 kV rms
Max. residual voltage (1 kA)	10 kVp
Max. residual voltage at 10 kA nominal discharge current(8/20 micro sec wave)	170 kVp
Max. switching impulse residual Voltage at 1000 A peak	140 kVp
Max. steep current residual voltage	186 kVp at 10kA
High current short duration test Value (4/10 micro-sec-wave)	100 kAp
Current for pressure relief test	40 kA rms
One minute power frequency withstand voltage of arrestor housing (dry and wet)	140 kV (rms)
Impulse withstand voltage of arrestor housing with 1.2/50 micro sec. Wave	325 kV (Peak)
Radio interference voltage at 156 kV	Not more than 1000 micro volt
Partial discharge at 1.05 MCOV (continuous operating voltage)	Not more than 50pC
Whether insulating base and discharge counter with milli- ammeter are required.	Yes

6.25 Protective Relays

- 6.25.1 The Solar PV system and the associated power evacuation system interconnections should be protected as per IEC 61727 Ed.2, norms. Over current relays, reverse power relays, differential protection relays and earth fault relays have to be essentially provided. All relay should be numerical type & should be remote operating and controlling facility from the control room.
- 6.25.2 All the relays must be solid state type and based on open access communication protocol. The numerical relays shall have RS 485 port for communication.
- 6.25.3 The operating voltage of the relays shall be 110 V DC/220 V DC as per battery bank rating.
- 6.25.4 Necessary battery bank shall also be provided in order to supply uninterrupted power to relays and control & protection circuit of the plant.
- 6.25.5 Detailed Design calculations shall be provided on fault power computations and the philosophy of protective relaying with respect to short circuit kA calculations. Design, drawing and model of protection relay shall be approved by Employer/ state utility.
- 6.25.6 The bidder must submit the relay setting chart as a part of design documents in coordination with the connecting substation.

6.26 Earthing for PV Array

- 6.26.1 The photovoltaic modules, BOS and other components of power plant requires adequate earthing for protecting against any serious faults as guided by IEC 60364.
- 6.26.2 The earthing system shall be designed with consideration of the earth resistivity of the project area. The earth resistivity values shall be measured prior to designing the earthing

system. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed.

- 6.26.3 The permissible system fault power level at 33 kV also shall be kept in consideration while designing the earthing system. Each array structure of the PV yard, LT power system, earthing grid for switchyard, all electrical equipment, control room, PCU, All junction boxes, ACDB & DCDB, all motors, pumps and any special earthing as required (electrical/electronics) shall be grounded properly as per IS 3043 - 1987. All metal casing / shielding of the plant shall be thoroughly grounded in accordance with Indian electricity act / IE Rules.
- 6.26.4 The earthing for array and LT power system shall be made of 3.0 m long 40 mm diameter perforated GI pipe / chemical compound filled, double walled earthing electrodes including accessories, and providing masonry enclosure
- 6.26.5 with cast iron cover plate having pad-locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS: 3043.
- 6.26.6 Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.
- 6.26.7 Each string/ array and MMS of the plant shall be grounded properly.
- 6.26.8 For each earth pit, a necessary test point shall be provided.
- 6.26.9 Earthing Mesh is to be prepared and installed in entire power plant.
- 6.26.10 The array structures are to be connected to earth pits as per IS standards. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.
- 6.26.11 The complete earthing system shall be mechanically & electrically connected to provide independent return to earth.
- 6.26.12 In compliance to Rule 11 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode.
- 6.26.13 The Bidder should submit the earthing system design calculations along with the system layout for Owner approval. Prior to the installation of the system
- 6.26.14 Unless otherwise specified, the earthing system primary and secondary grid conductors, equipment connections shall be constructed with galvanized iron flat. However the earthing of transformer neutrals, plc and inverter terminals and electronic earthing shall be provided using copper earthing conductor only.

6.27 Isolator and Isolator-cum-Earthing Switches

- 6.27.1 The Isolators and Isolator-cum-Earthing Switched shall comply with the requirements of the

IS: 9921 and IEC: 129 (latest edition) except specified herein. The Insulators shall comply with the requirements of IS: 2544 and IEC: 168-1988 (latest edition).

- 6.27.2 The Isolators shall be double break, outdoor, gang operated type, with blades rotating in horizontal plane. The design shall be for upright mounting. If required, and the Isolators shall be convertible for right or left hand control with minimum labour and replacement of part. The live parts shall be so designed that as far as possible, sharp points, edges and other corona producing surface are eliminated. Except the Insulator caps and bases, all other live parts shall be non-ferrous. Bolts, Screws and Pins shall be provided with locking arrangement and shall be of the best materials.
- 6.27.3 Each pole shall have three **Pedestal type of Insulator's** stacks. Necessary arrangements shall be provided for proper alignment of the contacts. Gang operated links shall be so designed that all phases shall make and break simultaneously.
- 6.27.4 The design of Isolators and Isolator-cum-Earthing Switches shall be provided for positive control of blades in all positions with minimum mechanical stress on the Insulators. Fixed guides shall be so provided that proper setting of contacts shall be obtained, when a blade is out of alignment even by 25mm in either direction. All movable parts which may be in current path shall be shunted by flexible copper conductor of adequate cross-section and capacity, which shall be furnished under bill of material.
- 6.27.5 The length of the handle for manual operation shall not be more than one meter and shall be stated on the drawing. The rotating parts shall have a smooth movement.
- 6.27.6 The clearance of 4000 mm from live parts to ground as per provision of I.E. Rules shall be considered while manufacturing of isolators & to decide location of operating mechanism box. Height of structure of isolator from ground is to be considered as 2900 mm including 150mm for muffing.
- 6.27.7 Contacts:
- The moving & fixed contacts shall be made of hard drawn electrolytic grade copper strips and shall be heavy duty self-aligning & high pressure type preferably which applies pressure to the contact surfaces after the blades are fully closed and release the pressure before they start to open. High pressure type contacts shall wipe the contact surfaces, while opening and closing. The contacts shall be so designed that wiping, action shall not cause securing or abrasion on the contact surfaces. The wiping action shall be sufficient to remove oxide film, formed during the operation of the switches. The pressure shall be developed by rotation of the entire blade.
 - The temperature rise of contacts due to the flow of rated short circuit current for a period of 3 seconds shall not cause any annealing or welding of contacts.
 - The moving contacts, if provided, shall close first and open last so that no damage is caused

due to arcing whatever to the main contacts. The Bidder shall give full details of such contacts with necessary drawings.

- The arcing contacts, if provided shall close first and open last so that no damage is caused due to arcing whatever to the main contacts. The tender shall give full details of such contacts with necessary drawings.
- The female contact and its tensioning by spring shall be such that there will, always, be a positive contact with adequate pressure to give enough contact surface for the passing of current. The springs provided should not go out of alignment or get entangled with the male contact during operation. The details of springs shall be furnished on the G.A. drawing.

6.28 Earthing Blades

- 6.28.1 The Isolators controlling the underground line shall be equipped with earthing blades. The Earthing blades shall be counter balanced to ensure easy operation.
- 6.28.2 Line earth switch shall consist of three Earthing links per Isolator which will normally rest against the frames, when the connected Isolator is in closed position. The Earthing links of all three phases shall be suitable for fitting on either side of the Isolator.
- 6.28.3 Short time current withstand capacity of earthing blades of Isolator Earthing Switch shall be same as that of the main blades of Isolator. The material of the earthing Isolator, Each earthing blade shall be provide with flexible copper connections of adequate length of not less than 60mm² are for connection between the operating shall and the base frame.
- 6.28.4 The rated making capacity of earthing switches shall be as specified in the applicable standard of isolators

6.29 Insulators

- 6.29.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137. Hollow column insulators shall be manufactured and tested in accordance with IEC: 60233/IS: 5261. The support insulators shall be manufactured and tested as per IS: 2544 / IEC: 600168/IEC: 600273. The insulators shall also conform to IEC 815 as applicable. Bidder shall furnish the technical particulars of all type of insulators used.
- 6.29.2 Porcelain insulator shall comply IS: 731-1976 or equivalent international standard and shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.
- 6.29.3 Bidder may offer silicone rubber housed composite type insulator as an alternative to the above porcelain insulator with equivalent creep age distance.
- 6.29.4 Data sheets for the insulators with cantilever strength and compression strength, etc. shall be submitted.

6.29.5 Insulators shall be rated for not less than 6kN for bus bar supports and 4kN for isolators.

6.30 Bus Bar

6.30.1 The outdoor bus-bars and equipment connections shall be with ACSR conductor (suitable size as per design).

6.30.2 The bus-bars and the connection jumpers shall be supported on post insulators wherever required.

6.30.3 The ACSR bus bars are an over ground system of wires strung between two supporting structures and supported by strain type insulators. The stringing tension may be limited to 500-900 kg depending upon the size of the conductor used. These types of bus bars are suitable for earthquake prone areas. All the bus bars are to be provided with insulating sleeves with appropriate colour code.

6.30.4 Bus bar Material – The materials in common use for bus bars and connections of the strain type are ACSR conductor.

6.30.5 Since aluminium oxides rapidly, great care is necessary in making connections. In the case of long spans expansion joints should be provided to avoid strain on the supporting insulators due to thermal expansion or contraction of pipe.

6.30.6 The bus bar sizes should meet the electrical and mechanical requirements of the specific application for which they are chosen.

Note: Unless otherwise specified, all equipment and materials shall confirm to the latest applicable Indian Standards. Equipment complying with any other International Standards will also be considered if it ensures performance of equipment equal to a superior to Indian Standard.

6.31 Control & Relay Panel Specifications

General Requirement:

6.31.1 The control & relay panel shall be free standing, simplex type, floor mounting type, fabricated from 2 mm thick MS sheet for main enclosure and 1.6 mm thick MS sheet for internals and partitions. The main enclosure shall be mounted on a base frame fabricated out of 100x50 ISMC mild steel section.

6.31.2 The enclosure external finish colour shade shall be decided by the Employer, The internal surface shall have a glossy white finish all over.

6.31.3 The control & relay panel shall contain the following metering and protection devices:

- Metering, Indications & Controls
- Ammeter: 0 – A
- Ammeter selector switch
- Voltmeter: 0 – 36 kV
- Voltmeter selector switch
- Load manager to display the following parameters: MW, MVA, MVARh, MVAR Cos Ø, Hz,

- Indication lamps for R, Y, B phases, Breaker 'ON' (R), Breaker 'OFF' (G), Breaker 'TRIP' (A), Spring charged (W), Trip Circuit Healthy (B)
- TNC switch, spring return to neutral position shall be provided for circuit breaker operation.
- Local / Remote selection switch for circuit breaker operation
- Semaphore indicators (LED type) for CB and Isolator 'Open' & 'Close' positions
- Mimic diagram for the 33 kV systems with aluminium strips and 'ON' 'OFF' indications for isolators

6.32 Low/ High Voltage Switchgear Panels

6.32.1 The LT/ HT switchgear panels shall be designed as per the relevant IS codes and as per the approved design for the panel. All the parts of the panels must be rated as per the relevant rated voltage level. All the panels must have multifunction meters (MFM) flushed with the surface of the panels. However, the outgoing feeder can have Tri vector meter (TVM) for the energy accounting.

6.32.2 The Power Control Centre (PCC)/ Switchgear shall be rated for the maximum output of the supply transformer feeding the system. The short circuit withstand rating (1 sec) at rated voltage of the switchgear shall be relevant to the existing electrical system short circuit ratings.

6.32.3 The configuration of the PCCs shall be as per the Single Line Diagram of the system.

6.32.4 Power Control Centres (Construction)

- Single front / compartmentalized, modular design, degree of protection IP52 with provision of extension on both sides.
- Incomer feeders: mains incomer - Electrically operated draw out type Air Circuit Breakers (ACBs)/ Vacuum Circuit breakers (VCBs), as applicable.
- Outgoing feeders: Moulded Case Circuit Breakers (MCCBs)/ electrically operated draw out type Air Circuit Breakers (ACBs) / Vacuum Circuit Breakers (VCBs), as applicable.
- The colour finish shade of switchgear enclosure for interior shall be glossy white & for exterior it shall be light grey, semi glossy shade 631 of IS: 5. if a different exterior shade is desired by the Employer, the same shall be intimated to the supplier.
- The PCC shall be fabricated out of CRGO sheet steel; 2 mm thick for the outer shall all-round. The internal walls and separators shall be of 1.6 mm thick CRGO sheet steel
- The gland plates shall be 3 mm thick

6.33 Control Circuit

6.33.1 Control supply for breaker closing / tripping - 110V DC

6.33.2 Air Circuit Breaker spring charge motor – 240 V AC, 1 phase

6.33.3 Moulded Case Circuit Breakers – 240 V AC, 1 phase

6.33.4 Indications, annunciation – 110V DC

6.33.5 Space heater, sockets, etc. – 240 V AC, 1 phase

6.34 Bus Bar & Cable Cavity

6.34.1 The material for main bus bars and tap off bus bars shall be electrolytic grade aluminium with properly colour coded HR PVC sleeved insulation.

6.34.2 Bus bars shall be suitable for short circuit rating and current suitable for all connected load.

6.34.3 Cable entry for incoming and outgoing cables shall be from Bottom.

6.34.4 A suitable gland plate shall be supplied for termination of power, control and instrumentation cables.

6.34.5 Whenever feeders are housed in multi-tier configuration, these tiers shall be segregated by sheet metal barriers.

6.34.6 Earthing: Earthing bus bar shall be terminated at both ends of the switchgear to suit the connections to outside earthing conductor. All components inside the module are required to be earthed individually and are to be looped and connected to the horizontal earth bus. All the non-current carrying parts of the panels, e.g., enclosure, must be connected to earth as per the regulations.

6.35 Terminals:

6.35.1 CT circuit - Isolating link type terminals with shorting facility

6.35.2 PT circuit – clip on type terminals

6.35.3 Spare contacts shall be wired up to terminal block. 10% spare terminals shall be provided for each module

6.36 Specific Requirement

6.36.1 All ACBs/ VCBs, as applicable, shall be 4 pole, electrically operated, draw-out type, with closing coil, spring charge motor, trip coil, TNC switch for close and trip, manual closing and tripping push buttons, door I/L, test and service position micro switches, emergency P.B., safety shutters, etc. The circuit breaker shall be provided with anti-pumping feature.

6.36.2 ACBs/ VCBs, as applicable, shall be complete with microprocessor release and shall be provided with over current, short circuit and earth fault protections.

6.36.3 Minimum 10% spare feeders of each rating shall be provided in the switchgear.

6.36.4 All current transformers shall have 5/1A secondary and all meters shall be suitable for 5/1A operation.

6.36.5 All indicating lamps shall be of LED cluster type. ACB feeders shall be provided with ON, OFF, AUTOTRIP, SPRING CHARGED, TEST, SERVICE, TRIP CIRCUIT HEALTHY indications

6.36.6 All indicating instruments, including MFM, shall be flush mounting, Digital type and of standard size.

6.36.7 Window annunciator with hooter and accept, test, reset button shall be provided. Necessary

auxiliary relays for contact multiplication shall be provided in the panel.

6.36.8 The maximum temperature of the bus bars, droppers and contacts at continuous current rating under site reference ambient temperature of 50° C shall not exceed 105° C.

6.36.9 Instrumentation: Switchgear instrumentation shall be provided as follows:

- Mains Incomer – Voltmeter with selector switch
- Ammeter with selector switch
- Power Factor meter
- Frequency meter
- TVM + MD meter
- Potential indicating lamps
- Outgoing Feeders
- Ammeter with selector switch on all feeders

6.37 General Technical Specifications (LT/ HT Switch gear Panel)

6.37.1 The panel shall be self-supporting, free standing, floor mounted, modular type with construction having degree of protection of IP 54 as per IS 2147.

6.37.2 The panel shall be fabricated from 14 SWG CRCA sheet steel for frame & load bearing surfaces. Partitions may be fabricated from 16 SWG CRCA if no components are mounted on them.

6.37.3 The panel shall be painted with 2 coats of primer after pre-treatment and 2 coats of Polyurethane / epoxy paint with shade as decided by the Owner

6.37.4 Stiffeners shall be provided at corners & between modules to make panel rugged. The stiffeners will necessarily be required for relay compartments or doors where heavy components are mounted.

6.37.5 The openable covers will be provided with lift off type hinges, quarter turn door locks and flexible copper wire for earth connection.

6.37.6 The panel shall be dust and vermin proof. Synthetic or neoprene gaskets shall be provided at all openings.

6.37.7 The panel shall be of dead front construction suitable for front operated and back maintained functioning.

6.37.8 Panel shall be provided with fluorescent lamp of 20W capacity operated by door operated limit switch. Panel shall also have space heaters and thermostat arrangement.

6.37.9 Panel shall be provided with 3 pin switch socket combined unit of 5 Amp capacity.

6.37.10 Lifting hooks shall be provided at the top of the panel.

6.37.11 The hardware components used in the panel shall be hot dipped galvanized.

6.37.12 The control components shall be fixed on mounting plate by drilling & tapping.

6.37.13 Aluminium anodized legend plates shall be provided for all the components. For

components mounted on front face, legend plate from inside shall also be provided.

- 6.37.14 Pre-treatment by 7 tank process shall be done before painting / powder coating the panel.
- 6.37.15 Panel shall have provision of drawing pocket.
- 6.37.16 The panel shall be designed to ensure maximum safety during operation inspection, connection of cables and maintenance. Inside panel, checking and removal of components shall be possible without disturbing other units.
- 6.37.17 Cable entries will be from bottom. The opening of cable entry shall be covered by 3 mm thick gland plates.
- 6.37.18 The panel shall be provided with all necessary components / devices and instruments as per the recommended schematic diagram and functional requirements.
- 6.37.19 The components such as protective relays, auxiliary relays, push buttons, switches, instruments shall be flush mounted on the front side of a panel.
- 6.37.20 The control wiring shall be done with PVC insulated flexible copper wire. For CT secondary circuits 2.5 sq.mm wire shall be used. For control wiring 1.5 sq.mm wire will be used.
- 6.37.21 Earthing bus bar of suitable cross section shall be provided throughout the length of panel.
- 6.37.22 The panel shall be fully wired all the terminals shall be brought out for cable connections. 10% spare terminals shall be provided on each terminal block. Separate terminal block shall be provided for different voltages. All wire shall have P.V.C. ferrules as per wiring diagram.
- 6.37.23 Proper shrouding to incoming and outgoing terminals shall be provided to ensure safety during operation, inspection and maintenance.
- 6.37.24 Indicating lamps shall be with multiple LEDs & shall be suitable for the voltage specified.
- 6.37.25 All the components in the panel shall be properly labelled. The labels shall be made of non-rusting metal or engraved PVC material properly fixed by screws.
- 6.37.26 The panel layout shall be made in such a way that it will always facilitate easy removal and reconnection of control cables without disturbing other wiring.
- 6.37.27 Centre lines of control switches, push buttons and indicating lamps shall be matched so as to give neat appearance. Similarly top lines of indicating instruments and relays shall also be matched.
- 6.37.28 The panel shall be provided with electrolytic grade aluminium bus bar of suitable cross section so as to maintain max current density of 0.8 AMP/ Sq.mm.
- 6.37.29 Bus bars shall be provided with colour coded heat shrinkable insulating sleeves.
- 6.37.30 Bus bars shall be supported by high quality epoxy insulators provided at specified distances so as to withstand to the given fault level.
- 6.37.31 The bus bar chambers shall be provided with suitable ventilation arrangements so as to limit the maximum temperature of 85°C while carrying rated current.
- 6.37.32 Proper clearance of minimum 25 mm shall be maintained between phase bus bars and between bus bars.

- 6.37.33 The panel shall be inspected at manufactures works before dispatch to site at the discretion of Employer.
- 6.37.34 All routine tests shall be carried out on the panel in presence of Employer or their representative or its representative. These tests shall include following:
- Verification of components ratings and operation.
 - High voltage measurement test.
 - Insulation Resistance measurement.
 - Control testing
- 6.37.35 Approval on following drawings shall be obtained before manufacturing the panels
- General arrangement drawing
 - Wiring Diagram.
 - Detail bill of material
 - Bidder shall provide 33kV power evacuation with bay and metering on Turnkey basis as per Port requirement.
- 6.37.36 In case, the bidder is using bus duct at the incoming/ outgoing terminals, appropriate arrangement has to be made in the LT/HT panel for the incorporation. Construction of bus ducts shall be as per relevant IS standards. Bus ducts must be provided with the space heaters and silica gel as recommended.

6.38 Metering System

- 6.38.1 ABT energy meter shall be provided as approved by state Utility under the metering scheme, to measure the delivered quantum of energy to the grid for sale. The responsibility of arranging for the meter, its inspection/calibration/testing charges etc. rests with the Bidder. All charges incurred on Meter testing, shall be borne by the Bidder. ABT energy metering system is to be approved by state utility.
- 6.38.2 Meter must be provided with the necessary data cables.
- 6.38.3 Separate metering system has to be provided for L.T. (incoming) and H.T. (outgoing) supply.
- 6.38.4 The Bidder shall provide ABT compliant meters at the interface points.
- 6.38.5 Interface metering shall conform to the Central Electricity Authority (Installation and Operation Meters) Regulation 2006 and amendment thereof Commercial settlement of solar Photovoltaic Grid Interactive based power project.
- 6.38.6 Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment existing at the station either through a synchronization pulse received from the time synchronization equipment or through a remote PC synchronized to GPS clock shall also be in the scope of Bidder.
- 6.38.7 All charges for testing and passing of the meter with relevant government agency shall be

borne by Bidder, the Employer will assist Bidder for necessary document as and when required. Bidder has to intimate the required documents at least 7 days prior of such requirements.

- 6.38.8 ABT compliant Energy Meters shall have technical specification as given below (not limited to specified requirement, Bidder can provide Meter with latest facilities):
- 6.38.9 Meters shall be microprocessor-based conforming to IEC 60687 / IEC 6205211/ IEC 62053-22 / IS 14697
- 6.38.10 Meters shall carry out measurement of active energy (both import and export) and reactive energy (import) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.
- 6.38.11 Meters shall have an accuracy of energy measurement of at least Class 0.2 for active energy and at least Class 0.5 for reactive energy according to IEC 60687, and shall be connected to Class 0.2 CT cores and Class 0.2 VT windings or as per state grid regulations.
- 6.38.12 The active and reactive energy shall be directly computed in CT & VT primary ratings.
- 6.38.13 Meters shall compute the net MWh and MVARh during each successive 15- minute block metering interval along with a plus/minus sign, instantaneous net MWh, instantaneous net MVARh, average frequency of each 15 minutes, net active energy at midnight, net reactive energy for voltage low and high conditions at each midnight.
- 6.38.14 Each energy meter shall have a display unit with a seven digit display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MW demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.
- 6.38.15 All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.
- 6.38.16 At least the following data shall be stored before being over-written for the following parameters.

S. No.	Parameters	Details	Min No of days
1	Net MWh	15 min. block	90 days in meter
2	Average Frequency	15 min. block	90 days in meter
3	Net MVARh for > 103%	15 min. block	90 days in meter
4	Cumulative net MWh	At every mid night	30 days in meter/ 90 days in PC
5	Cumulative net MVARh for >103%	At every mid night	30 days in meter/ 90 days in PC
6	Date & time blocks for VT failure on any phase		

- 6.38.17 Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.

- 6.38.18 Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment existing at the station provided by Bidder.
- 6.38.19 The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be less than maximum 2VA.
- 6.38.20 The power supply to the meter shall be healthy even with a single- phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory.
- 6.38.21 Even under the absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.
- 6.38.22 Meters shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software.
- 6.38.23 The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.
- 6.38.24 The Employer/ Owner shall have the right to carry out surprise inspections of the Metering Systems from time to time to check their accuracy.

6.39 SCADA and Remote Monitoring System

- 6.39.1 The plant shall be automatically operated and shall be controlled by microprocessor based control system SCADA and should be Open Platform Communications (OPC) compliant. There shall be simultaneous data logging, recording and display system for continuous monitoring of data for different parameters of different sub systems, power supply of the power plant at DC side and AC side.
- 6.39.2 An integrated SCADA shall be supplied which should be capable of communicating with all inverters and provide information of the entire Solar PV Grid interactive power plant.
- 6.39.3 The SCADA shall be string level monitoring compatible and shall have features of remote access to the real time data. SCADA shall have features for generating the day ahead schedule of generation based on historical data/ suitable logic. Also, system must be capable of sending the telemetry data to the local SLDC via GPRS/ GSM/ suitable mode.
- 6.39.4 Computer-aided data acquisition unit shall be a separate & individual system comprising of different transducers to read the different variable parameters, A/D converter, multiplexer, de multiplexer, interfacing hardware & software, which will be robust & rugged suitable to operate in the control room Environment.
- 6.39.5 Reliable sensors for solar insolation, temperature, and other weather and electrical

parameters are to be supplied with the data logger unit.

6.39.6 The Bill of Materials associated with the equipment must clearly indicate especially the details about the PC and Printers, etc.

6.39.7 The Data Acquisition System should be housed in a desk made of steel sheet.

6.39.8 All data shall be recorded chronologically date wise. The data file should be MS Excel/ CSV compatible. The data, if needed, can be accessible remotely through authorized access. The data logger shall have internal reliable battery backup and data storage capacity to record all sorts of data simultaneously round the clock. All data shall be stored in a common work sheet chronologically and representation of monitored data shall be in graphics mode or in tabulation form. All instantaneous data can be shown in the Computer Screen. Provision should be available for Remote Monitoring.

6.39.9 SCADA shall measure and continuously record electrical parameters and provide following data (but not limited to) at a 5-15 minute interval.

- Energy export to grid at 33kV
- Main combiner box parameters
- Inverter level parameters
- Parameters at LV terminal (415V)
- Power characteristics of HT side
- Ambient temperature near array field
- Module surface temperature
- Wind Speed and direction
- Solar irradiation/isolation
- Any other parameter considered necessary by supplier based on current prudent practice

6.39.10 SCADA shall provide 15 minute daily, monthly and annual average of following parameters:

- Exported Energy to grid at 33 kV
- Energy, DC and AC voltage, power and pf of each inverter
- Solar Radiation (horizontal and tilted plane)
- Temperature (ambient and module surface)

6.39.11 SCADA shall have feature to be integrated with the local system as well remotely via the web using either a standard modem or a GSM/WIFI modem. The Bidder shall provide compatible software and hardware so that data can be transmitted via. Standard modem.

6.39.12 SCADA shall be provided with reliable power supply along with backup supply for at least one hour to cater to outage of grid.

6.39.13 The SCADA shall be compatible to the requirements for measuring and reporting the performance-ratio (PR) of the power plant.

6.39.14 The Contractor shall provide all administrative rights/ privileges/passwords of the SCADA

system to the Employer. The Employer have rights over the data generated in the plant.

6.39.15 The Bidder shall submit the data sheet with technical specifications of the SCADA system .

6.39.16 The PC/ workstation shall be of Industrial type, rugged & robust in nature to operate in a hostile environment. The PC will have minimum Intel processor (4th generation) having 2 X 1TB HDD with 4 GB RAM. The PC shall also have 17" TFT Colour monitor, DVD Drive with Writer, USB drive, Scroll Mouse and UPS for 4 hours Power back up. The bidder can suggest the workstation best used for the purpose.

6.39.17 The printer shall be of industrial type, rugged & robust in nature and of reputed make. The printer shall be equipped for printing, colour scanning, copying and fax.

6.40 DC Battery & Charger

6.40.1 Adequate capacity DC battery Bank should be provided for control supply of inverters, control / protection system & emergency lighting at buildings. Appropriate capacity battery charger (float cum boost charger – FCBC) with relevant IS/IEC standards & protection and automatic change over system should be provided to charge the battery bank along with relay circuit, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

6.40.2 A DC power supply Distribution panel/board should be supplied along with the Charger (FCBC) as per relevant IS standards. Control room DC Battery Bank & DC supply system theoretical design, calculations and detailed explanations along with drawing shall be provided and approved by the Employer.

6.40.3 DC Batteries the batteries will have the following specifications:

- Type : VRLA/ MF Stationary, sealed type, storage battery.
- Rating : 110 V D.C., Minimum 80 Ah at 8 Hour rate of discharge (or as per design)
- Standard : IS 1651 – 1979; performance as per IS 8702
- Container : Plastic Resin, ABS or PP
- Terminal Posts : Designed suitably to accommodate external bolted connections

6.40.4 The battery shall be provided with epoxy paint coated exhaust fan for removal of gasses released from the battery cells.

6.40.5 The design of the battery bank and loads considered along with the data sheet for the battery and battery charger shall be submitted for approval.

6.41 Power and Control Cables specifications

6.41.1 The size of each type of cable selected shall be based on minimum voltage drop; however the maximum drop shall be limited to 2%. Due consideration shall be made for the de-rating of the cables with respect to the laying pattern in buried trenches / on cable trays, while sizing the cables.

6.41.2 All cables shall be supplied in the single largest length to restrict the straight- through joints

to the minimum number.

- 6.41.3 PV Modules should be connected with USE-2/RHW-2 cables array to junction box conductors and junction box to photovoltaic dis-connector with the THHN/THWN-2 sunlight resistant with 90°C wet rated insulation cable.
- 6.41.4 Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted. All cable/wires shall be marked with good quality letter and number ferrules of proper sizes so that the cables can be identified easily. The ferrules used must be UV resistant. However, for HT cables, embossed ferrules can be used.
- 6.41.5 Cable terminations shall be made with suitable cable lugs & sockets etc., crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles.
- 6.41.6 All high voltage cables should be PVC insulated grade conforming to IS 1554 and cables shall also conform to IEC 60189 for test and measuring the methods.
- 6.41.7 Irrespective of utilization voltage and current rating all type of power cables shall be minimum of 1100 V grade PVC insulated conforming to IS 1554 / IS 694 for working voltage less than 150 V control cable shall be of minimum 500 V grade, the control and power cable has to be laid separately. All LT XLPE cables shall confirm to IS: 7098 Part I & II. All HT XLPE Cables Shall confirm IS: 7098 PART-3 & IEC -60287, IEC-60332
- 6.41.8 The cables shall be adequately insulated for the voltage required and shall be suitably colour coded for the required service. Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.
- 6.41.9 Cables inside the equipment room, control room and in the switchyard shall be laid in Galvanized Cable Trays mounted on mild steel supports duly painted, in constructed trenches with RCC raft and sidewalls or bricks sidewalls and provided with removable RCC covers.
- 6.41.10 All the communication cables (RS 485, fibre optics etc.) must be supplied with type test reports and shall laid in accordance with the relevant IS codes. It must be laid so that there is no interference with the power cables.
- 6.41.11 Type test reports and Data sheets of individual cable sizes (HT, LT & DC) shall be submitted for approval by Employer. Drum numbers and drum length details shall be submitted with each consignment.

6.42 Power Evacuation and Hardware

- 6.42.1 The power from the plant must be evacuated to nearby 11 kV overhead line through 11 kV HT XLPE Cables of appropriate size as per prevailing conditions at site. The power evacuation system must be reliable, redundant and have low maintenance.
- 6.42.2 The design and arrangement for the laying of cable shall be in bidder's scope. Bidder has to

take necessary precautions for easy maintenance.

- 6.42.3 The cable must be appropriately laid in order to have easy maintenance and marked with route markers for easy identification.
- 6.42.4 Metal fittings of specified material for string hardware meant for power conductor and earth wire shall have excellent mechanical properties such as strength, toughness and high corrosion resistance. The suspension and tension clamps shall be made from aluminium alloy having high mechanical strength. Suspension and tension clamps offered shall be suitable for cable/ conductor as per design.
- 6.42.5 All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching insulators to the tower or to the power conductor shall be so designed as to reduce (to a minimum) the damage to the conductor, insulator or the fitting arising from conductor vibration.
- 6.42.6 All drop-forged parts shall be free-from flaws, cracks, or other defects and shall be smooth, close-grained and of true forms and dimensions. All machined surfaces shall be true, smooth and well-finished.
- 6.42.7 All ferrous parts of hardware shall be galvanized in accordance with IS 2629.
- 6.42.8 The galvanization shall withstand four dips of 1-minute duration each in copper-sulphate solution as per the test procedure laid down in the relevant IS Standards.
- 6.42.9 The threads in nuts and tapped holes shall be cut after galvanizing, and shall be well-lubricated/greased. All other threads shall be cut before galvanizing.
- 6.42.10 Both the suspension and the tension hardware shall be of ball and socket type, and shall be with 'R' and 'W' type security clip of stainless steel or phosphor Bronze conforming to IS 2486. The tension clamps of both compression type and bolted type as shown in the relevant drawings shall be offered. Arcing horns shall be provided on the line side for both the suspension type and compression type hardware.

6.43 Danger Plates

Size of each Danger Notice plates shall be 200 mm x 150 mm made of mild steel sheet and at least 2 mm thick, and vitreous enamelled white on both sides and with inscription in signal red colours on front side as required. The inscriptions shall be in Hindi, Telegu and English.

6.44 Fire alarm System

- 6.44.1 Buildings shall have fire detection and alarm system installed as per relevant standards and regulations. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.
- 6.44.2 Liquefied CO₂/ Foam/ ABC type fire extinguisher shall be upright type of capacity 5/10 kg having IS: 2171. 7 IS: 10658 marked. The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes, Electrical Wiring, Live Machinery Fires, and all Flammable Liquid & Gas. Bidder shall provide portable fire extinguisher as per the

recommendation by relevant fire safety authority.

6.44.3 The minimum 2 no. of fire extinguishers (CO₂ and Foam type each) shall be provided at every buildings.

6.44.4 Sand bucket should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546 at strategic locations.

6.44.5 The plan for fire extinguishing must be provided by the bidder to Employer for the approval.

6.45 CCTV cameras

6.45.1 CCTV cameras must be installed minimum at main entry gate and control room. Bidder may propose other locations as required to provide security for the entire plant. Bidder has to propose the locations and number of cameras required for the plant during bidding. However, Employer will decision on number of cameras shall be final.

6.45.2 The CCTV system shall be designed as a standalone IP based network architecture. System shall use video signals from different cameras at defined locations, process the video signals for viewing on monitors at control room and simultaneously record all video streams using latest compression techniques.

6.45.3 Camera shall be colour, suitable for day and night surveillance (even under complete darkness) and network compatible.

6.45.4 It shall be possible to control all cameras i.e., PTZ auto/ manual focus, selection of pre-sets, video tour selection etc. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitor for live video.

6.45.5 The system shall support video analytics in respect of the following:

- Video motion detection
- Object tracking
- Object classification

6.45.6 Camera server shall be provided with sufficient storage space to storage recordings of all cameras at HD mode for a period of 15 days. All recordings shall have camera ID, location, date and time of recording.

6.46 Testing Instruments for Electrical & Electronic

Bidder shall also provide required set of onsite testing instruments/equipment viz. earth resistance tester, rheostats, insulation tester, millimetres, clamp meters, CRO, Function Generator, Transformer oil BDV kit, Relay testing kit, infra-red thermal imaging hand held temperature meter, inverter testing kit etc. All testing equipment shall possess valid calibration certificate issued from approved NABL labs.

6.47 General Guidelines

6.47.1 Any civil or electrical work which is not mentioned or included in this tender document but necessary for the plant shall be borne by the Bidder.

- 6.47.2 Successful Bidder shall prepare all designs / drawings have based on the specifications given in the tender and in light of relevant BIS/IS/ equivalent standard.
- 6.47.3 The bidder shall provide type test reports and datasheet/ GTP for all equipment used for the project.
- 6.47.4 The Employer reserves right to modify the design at any stage, to meet local site conditions / project requirements.
- 6.47.5 All work shall be carried out in accordance with the latest edition of the Indian Electricity Act and rules formed there under and as amended from time to time.

6.48 Specification of Weather Monitoring System

As a part of weather monitoring system, Bidder shall provide the following measuring instrument with all necessary software and hardware required to integrate with SCADA.

6.48.1 Pyranometer

- Bidder shall provide minimum 2 (two) number of pyranometers for measuring the incidental solar radiation at horizontal and inclined plane of array.
- Specification of the pyranometer shall be as follows:

Details	Values
Spectral Response.	0.31to2.8micron
Sensitivity	Min7micro-volt/w/m2
Time response (95%):	Max15s
Nonlinearity:	±0.5%
Temperature Response:	±2%
Tilt error:	<±0.5%.
Zero offset thermal radiation:	±7w/m2
Zero offset temperature change	±2w/m2
Operating temperature range:	0 deg to+80 deg.
Uncertainty(95%confidence Level):	Hourly- Max-3%, Daily- Max-2%
Non stability:	Max±0.8%
Resolution:	Min+/- 1W/m2
Input Power for Instrument & Peripherals:	230V a.c.(If required)

- Each instrument shall be supplied with necessary cables. Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the equipment. The signal cable length shall not exceed 20m. Bidder shall provide Instrument manual in hard and soft form.

6.48.2 Thermometer

Bidder shall provide minimum two thermometers (one for ambient temperature measurement with shielding case and other for module temperature measurement). The thermometers shall be RTD/ semiconductor type measuring instrument. Instrument shall have arrange of 0°C to 80°C.The instrument shall have valid calibration certificate.

6.48.3 Anemometer

Bidder shall provide minimum one no. anemometer with wind vane of rotating cup type

Details	Values
Velocity range with accuracy limit	$\pm 0.11\text{m/s}$ upto 10.1 m/s $\pm 1.1\%$ of true when more than 10.1 m/s
Wind direction range with accuracy limit	0 to 360° with accuracy $\pm 4^\circ$

6.49 Specification of Lighting in Solar Power Plant

6.49.1 Scope

This specification covers design of Array yard and sub-station, street light using suitable LED luminaires (to meet the required lux levels), tubular poles (from main gate up to the control room/switchyard gate and periphery wall of the plant) distribution pillar boxes, PVC cables, conduit steel trays etc. which shall be supplied by the contractor for installation of luminaires, their control gear and wiring on them. The street light shall work on the auxiliary supply and same shall be incorporated in auxiliary loads. The bidder will also design, supply and install lighting fixtures and accessories based on LED for equipment room and control room building and entry points/ gates. The Bidder shall furnish Guaranteed Technical Particulars. All LED luminaires shall be supplied with proper diffuser to avoid direct visibility of LED with proposer thermal management for longer life. Renowned brands available in the market need to be used.

6.49.2 General Technical Requirements:

The lighting system for outdoor and indoor areas of Solar Power Plant shall be designed in such a way that uniform illumination is achieved.

In outdoor yard equipment /bus bar areas and the peripheral wall are to be illuminated and luminaires shall be aimed for clear view.

6.49.3 Lighting Levels

- The average LUX level of 10 lm is to be maintained in switchyard. However, a lux level of 20 lm (10+10) additional switchable on requirement only) is to be maintained in switchyard on transformer.
- Lighting in other areas such as control room, office rooms and battery room & other areas (i.e. street light) shall be such that the average LUX level to be maintained shall be as under:

S. No	Area	LUX
1.	Control Room and equipment rooms	300
2.	Office	300
3.	Battery & other rooms	150
4.	Other areas including periphery wall	10

5.	Transformer yard	20
6.	H _ pole and metering point	10

6.49.4 Emergency Light Points:

- Light points using LED lamps of 15-20 W (at 240 V) shall also be provided as given below:

Control room and equipment room	4 Nos.
Battery room	1 Nos.
Office	1 Nos.
Corridor	1 Nos.

- These lights shall operate on AC/DC changeover supply from the DC distribution Board. Separate wiring and distribution board shall be provided from these lights.
- The lighting level shall take into account appropriate light output ratio of luminaires, coefficient of utilization maintenance factor (of 0.7 or less) to take into account deterioration with time and dust deposition.
- LED luminaires shall meet the following parameters

PARAMETER	SPECIFIED VALUE
	170-260 V
Input Frequency	
Power Factor	0.95 (Minimum)
Power Efficiency	>96%
LED efficacy	>130
Dispersion Angle	Minimum 120°
Usage hours	Dusk to dawn
Total Harmonic Distortion	< 15 %
Working Temperature	
Working Humidity	10% -
Index of Protection Level	Minimum IP 65
Lamp Casing	Powder coated metal / Aluminium
Life	>
LED Type	Power LEDS from reputed makes.
Colour Temperature	
Colour Rendering	>75
Junction Temperature	< 60° C
Electrical Connector	Lead wire with 2 meter long –or as required by the customer at site
Expected Life of components	Passive electronic components life greater than >100 000 hours
Moisture protection in case of	IP 65 (preferably Totally encapsulated)

casing damage	
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- Luminaire Compliances:

Luminaire Specification:

Control gear specification:

EN 61347-2-13: Particular requirements for D.C. or A.C. supplied electronic control gear for LED modules

EN 62384: D.C. or A.C. supplied electronic control gear for LED modules.

Luminaire EMC specification:

EN 61000-3-2: Electromagnetic compatibility (EMC). Limits for harmonic current emissions (Equipment input current < 16 A per phase)

EN 61000-3-3: Limitation of voltage fluctuation and flicker in low voltage supply systems for equipment with rated current < = 16 A

- Additional information:

The LED luminaire housing, heat sink, pole mounting bracket, individual LED reflectors and front heat resistant tempered glass should be provided.

The LED luminaire housing should be made of non-corrosive high pressure die cast aluminium and the housing should be power coated grey, so as to ensure good wetherability.

Each individual LED source should be provided with a asymmetrical distribution high reflectance aluminized reflector, which should ensure that the light distribution of the luminaire is suitable for road lighting applications (wide beam distribution) and should ensure high pole to pole spacing.

The luminaire should be provided with in built power unit and electronic driver. The luminaire should be so constructed to ensure that the gear and LED modules are replaceable, if required.

The luminaire should be suitable for both standard street light poles with a typical pole diameter of 50 mm – 60 mm and should be suitable for both side entry and bottom entry (post top).

E. Performance Measurement procedure

7. Performance Ratio Test Procedure

7.1 PR - Provisional Acceptance Test Verification Procedure

7.1.1 The Performance ratio test aims at the comparison of the actual PV plant energy production with the guaranteed value for a limited operation time of the PV plant of 30 consecutive days.

7.1.2 After Commissioning of the Plant and after receiving all the satisfactory results regarding

the correct operation of the plant, there will be continuous monitoring of the performance for 30 days. This monitoring will be performed on the site under the supervision of the Employer / Employer's engineer.

- 7.1.3 The final tests to prove the guaranteed performance parameters shall be conducted at site by the Contractor in presence of the Employer. The Contractor's commissioning / start-up Engineer shall make the plant ready to conduct such tests. The Performance Guarantee Tests (PG tests) shall be commenced, within a period of one (1) month after successful Commissioning. Any extension of time beyond the above one (1) month shall be mutually agreed upon. These tests shall be binding on both the parties to the contract to determine compliance of the equipment with the guaranteed performance parameters.
- 7.1.4 The test will consist of guaranteeing the correct operation of plant over 30 days, by the way of the efficiency rate (performance ratio) based on the reading of the energy produced and delivered to the grid and the average incident solar radiation.
- 7.1.5 The Efficiency or performance ratio (PR) of the PV Plant is calculated as follows (according to IEC 61724)

$$\text{Performance Ratio (PR)} = \{Y_A / Y_R\} * [1 - \alpha * (T_{\text{Cell avg.}} - T_{\text{Cell}})]$$

Where;

Y_A = Final PV system yield (representing the number of hours that the system would need to operate at its rated output power P_{Nom} to contribute the same energy to the grid as was monitored)

Or
$$Y_A = E_{\text{ac}} / P_{\text{Nom}}$$

Y_R = Reference yield (representing the number of hours during which the solar radiation would need to be at STC irradiance levels in order to contribute the same incident energy as was monitored)

$$Y_R = I_{\text{R Site}} / I_{\text{R STC}}$$

E_{ac} = AC energy injected into the grid during a clearly specified amount of time (kWh)

P_{Nom} = Installed nominal peak power of modules (Flash test rating at STC) (kWp)

$I_{\text{R Site}}$ = Irradiation on the module plane of array during a clearly specified amount of time (measured with a pyranometer installed on the array plane) (kWh/sq. m)

$I_{\text{R STC}}$ = Irradiance at STC (kW/ sq. m)

$T_{\text{cell avg}}$ = Average cell/ module temperature (°C)

T_{cell} = STC cell/ module temperature (°C)

α = temperature coefficient of power (negative in sign) corresponds to the installed Module (%/°C)

7.2 Monitoring System for PR Verification

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

- Power Meter at the delivery point.
- Power Meter for each inverter/ LT panel incomer for reference only.
- One nos. calibrated pyranometer to determine irradiance on the plane of array (with a target measurement uncertainty of ± 2).
- One nos. calibrated pyranometer to determine irradiance on horizontal plane (with a target measurement uncertainty of ± 2)
- Two nos. thermocouples to measure module temperature with a measurement uncertainty of ± 1 °C.
- Shielded ventilated thermocouple with a measurement accuracy of ± 1 °C.
- An anemometer mounted on a 10m mast to measure wind speed (without additional shadowing on modules).

7.3 Data measurement shall be witnessed in the format mutually agreed before the start of PR test by the Employer and the Contractor jointly for the said period.

7.4 The bidder shall show the specified PR for Operational Acceptance and committed CUF for Final Acceptance (i.e. after one year from the date of commissioning).

7.5 Capacity Utilization Factor (CUF) shall be calculated as per the following formula :

$$CUF = E_N / (8760 * P_{nom})$$

E_N = No. of units recorded at the ABT meter excluding the auxiliary consumption
i.e. net generation

P_{nom} = Installed DC capacity

F. Civil Works

8. Detailed Contour Survey & Soil Investigation of the Site

The turnkey contractor shall be responsible for detailed soil investigation and contour survey at required location for the purposes of foundation design and other design/ planning required for the successful completion of the project. The contractor must submit the detailed reports for soil investigation, bore log records, ERT reports, contour survey, etc. to Employer.

8.1 Topographical survey

Topographical survey shall have to be done by the Successful Bidder of the proposed site at 10m interval with the help of Total Station or any other suitable standard method of survey. All necessary Reduced Levels (RL) as entered in the Field Book have to be submitted along with pre contour layout of the total site. The formation levels of the proposed power plant have to be fixed with reference to High Flood Level of the proposed site. The ground level

and plinth level of structures shall be fixed taking into consideration the highest flood level and surrounding ground profiles. Accordingly, a detailed drawings for levelling and grading (if necessary) shall be submitted. The volume of cutting and filling of earth shall also be mentioned in the drawings. The filled earth must be well compacted as per relevant IS standards.

8.2 Soil Tests:

The Contractor is advised to and is solely responsible to carry out detailed Geotechnical investigation to ascertain soil parameters of the proposed site for the use of planning / designing / construction / providing guarantee / warranty of all civil work including but not limited to foundations / piling for module mounting structures, HT lines, etc. The Contractor shall carry out soil investigation through any Govt. approved / certified soil consultant. These reports shall be furnished to the Employer prior to commencing work. All RCC works shall be provided of required grade of concrete as per relevant IS specifications as well as soil data considering appropriate earthquake seismic zone, wind velocity, weather effect, soil characteristics etc.

8.3 Soil Investigations:

The scope of soil investigation covers execution of complete soil exploration including boring, drilling, collection of undisturbed soil sample where possible, otherwise disturbed soil samples, conducting laboratory test of samples to find out the various parameters mainly related to load bearing capacity, ground water level, settlement, and soil condition for each bore hole and submission of detail reports along with recommendation regarding suitable type of foundations including module mounting structure, equipment and buildings along with recommendation for soil improvement where necessary.

8.4 Other investigations

Successful Bidder shall obtain and study earthquake and wind velocity data for design of module mounting structure, equipment and building foundations after considering all parameters related to the weathers conditions like Temperature, humidity, flood, rainfall, ambient air etc.

The Successful Bidder shall carry out Shadow Analysis at the site and accordingly design strings and arrays layout considering optimal use of space, material and man-power and submit all the details / design to Employer for its review / suggestions / approval.

8.5 Land Development for site activities

The turnkey contractor is responsible for making the site ready and easily approachable by clearing of bushes, felling of trees (if required with appropriate approval from concerned authority), levelling of ground (including reclamation work wherever required) etc. for commencing the project. It is to ensure that land must be graded and levelled properly for

the flow of water. It is advisable to follow the natural flow of water at the ground. If the land pocket needs any filling of sand, it is to ensure that the filled earth must be well compacted as per the relevant IS standards. In case the filled earth is brought out/ borrowed from outside the plant, the contractor shall provide the necessary challans. On the other hand, excess earth, if any, must be disposed of properly. Bidder shall take reasonable care to ensure that the plant is aesthetically designed. The bidders shall judiciously decide on making the price-bid accordingly

8.6 Foundations:

- 8.6.1 The contractor is responsible for the detailed soil investigation and subsequent foundation design of all the structures in the plant. The foundation of the module mounting structures, equipment, buildings and other important structures must be approved by Employer prior to construction. The contractor must provide the detailed design and calculations of the foundation. The foundation designs must be approved by Chartered Structural Engineer.
- 8.6.2 The foundations should be designed considering the weight and distribution of the structure and assembly, and a maximum wind speed of 150 km per hour. Seismic factors for the site have to be considered while making the design of the foundation. Successful Bidder shall also plan for transport and storage of materials at site.

8.7 Switch yard civil works

Switchyard civil work includes transformer plinth, HT Switchgear kiosk plinth, 2 pole/ 4 pole structure foundation, earth pits and surrounding masonry work, metal spreading curb wall in and around switchyard, plinth protection, trenches & precast covers and fencing. The transformer/ HT switchgear kiosk plinth shall be made of RCC/ brickwork/ Random Rubble masonry, as required and approved, conforming to relevant standards. The height of transformer /HT Switchgear kiosk plinth shall be decided based on 33 kV ground clearance. Earth pit construction shall be of brickwork covered with RCC (1:2:4) slabs. Switchyard/ double/ four pole area must be surrounded by chain link fencing with pre-cast RCC post/ galvanized MS angle of suitable size with double leaf gate will be provided. Area enclosed within this perimeter must be filled with gravel. All the trenches shall be made up of precast sections/ brick work with plaster. The trenches must be covered with precast slabs with handles of suitable sizes.

8.8 Buildings

Buildings are required to be constructed for housing the electrical equipment/ panel and central control room with office cum store building for the operation & maintenance of Solar Photovoltaic Power Plant. Security houses/ cabins shall also be required at strategic locations to secure the plant from any theft/ burglary. The building shall be constructed with

conventional RCC framed structure with brick partition walls. Equipment room shall be designed as per the OEM recommendations to ensure desired life of equipment.

Bidder shall furnish the drawing of the proposed buildings to the Employer for approval, prior to construction. The construction of the same shall be as under-

8.8.1 RCC Works

All RCC works shall be as per IS 456 and the materials used viz. Cement, reinforcement steel etc. shall be as per relevant standards.

8.8.2 Brick Works

Brick works in cement mortar (CM) 1:6 for 9" thick and 4½" thick wall respectively. All brick works shall be using 1st class bricks of approved quality as per IS 3102.

8.8.3 Doors & Windows:

Steel framed doors, Windows and ventilators shall conform to IS— 1081 with necessary float glass panels including of all fixtures and painting etc. complete. Doors and windows shall be made of aluminium sections. All sections shall be 20 microns anodized. Sections of door frame and window frame shall be adopted as per industrial standards. Door shutters shall be made of aluminium sections and combination of compact sheet and clear float/ wired glass. The control room shall require a number of windows/ louvers to provide ventilation/ fresh air circulations.

8.8.4 Plastering

Plastering in cement mortar 1:5, 1:6 and 1:3 shall be applied to all internal, external walls and ceiling of slab respectively as per IS 1542.

8.8.5 Flooring (as per relevant IS codes for selection and laying)

Store area:	Cement flooring in concrete mix (1:2:4) using 10 mm aggregates as per IS 2571: 1970
Control Room cum supervisor room:	Heavy Duty Vitrified tiles 8 mm thickness
SCADA Room:	Heavy Duty Vitrified tiles 8 mm thickness
Equipment room:	Heavy Duty Vitrified tiles 8 mm thickness
Battery Room:	Acid/ Alkali resistant tiles of suitable thickness
Toilets:	Ceramic tiles 8 mm thickness
Lobby:	Vitrified Tiles 8 mm thickness

The floor finishing must include skirting up to a suitable height. The wall tiles, if proposed, shall be glazed tiles of 6 mm thickness and provided up to lintel level.

8.8.6 Roofing

The roof of the building shall be insulated and waterproofing shall be done as per relevant IS standard.

8.8.7 Plinth Protection

Plinth protection 1000mm wide shall be provided around all the buildings as per relevant standards using brick bats.

8.8.8 White washing & colour washing.

White washing and colour washing work shall conform to relevant IS codes. The right of selection of colour/ shades shall lie with the Employer. Bidder has to follow respective and relevant IS codes of practice for the finishing process.

- Internal walls: Acrylic distempering
- External walls: Heat reflective synthetic enamel
- MMS foundations and Earth pit enclosures: Cement painting
- Steel/ Al doors, windows and ventilators: Powder coated paint

8.8.9 Rolling Shutters.

Rolling shutters made of cold rolled strips shall conforming to IS 4030 with approved gauge thickness shall be provided with all fixtures, accessories, painting all etc. complete.

8.8.10 Water supply.

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.

8.8.11 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.

8.8.12 Electrification of Building

Electrification of buildings shall be carried out as per relevant IS 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, fans etc., controlled by required ratings of MCBs and MCB, DBs. Supervisor room must be fitted with suitably sized HVAC system. It is encouraged that bidder shall use the latest energy efficient equipment for the electrification and illumination.

8.8.13 Toilet:

Toilet shall be designed for 15 persons; and constructed with following finish

- Floor: Vitrified tiles/ ceramic tiles
- Door: made out of aluminium sections/ PVC
- 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 1,000 litre capacity

8.8.14 Drainage for Toilets:

Drainage pipes shall be of PVC (6 kg/cm²) of reputed make. Gully trap, inspection chambers, septic tank for 15 person and soak well to be constructed for above mentioned requirement.

8.8.15 Air Conditioner for Control Room:

The control room shall be equipped with appropriate numbers of fans for effective heat dissipation. The supervisor room and SCADA cabin shall have split type air conditioning units.

8.8.16 Fire Extinguishers:

Liquefied CO₂ / foam/ ABC type fire extinguisher shall be upright type of capacity 10 kg having IS: 2171. 7, IS: 10658 marked. The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes, Electrical Wiring, Live Machinery Fires, and all Flammable Liquid & Gas.

8.8.17 Sand Bucket:

Sand buckets should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546. Bucket stands with four buckets on each stand shall be provided in the Transformer Yard – 4 Nos.

8.8.18 Sign Boards:

The sign board containing brief description of major components of the power plant as well as the complete power plant in general shall be installed at appropriate locations of the power plant as approved by Employer.

- The Signboard shall be made of steel plate of not less than 3 mm. Letters on the board shall be with appropriate illumination arrangements.
- Safety signs, building evacuation plan and direction signs, assembly points shall also be placed at strategic locations.
- The Contractor shall provide to the Employer, detailed specifications of the sign boards.

8.9 Water supply & Cleaning

- 8.9.1 Water used for cleaning purpose shall be fit for cleaning the PV modules, cleaning procedure and pressure requirement shall be as per the recommendation of PV module manufacturer.
- 8.9.2 A suitable arrangement of water shall be ensured to cater the day-to-day requirement of drinking water and needs of Solar Photovoltaic plant during entire O&M period.
- 8.9.3 The Bidder shall estimate the water requirements for cleaning the photovoltaic modules at least once in every week or as per the soiling conditions prevailing at site, in order to operate the plant at its guaranteed plant performance. Also, bidder is required to plan the water storage accordingly.
- 8.9.4 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 all the necessary equipment, accessories, tool & tackles, pumps, tankers, tractors and piping arrangement pertaining to module cleaning system.
- 8.9.5 Bidder has to plan and install the effective module cleaning system as per the prevailing conditions at Site. The system may include the storage water tanks, pumps, laying of GI/ HDPE/ UPVC pipes, flexible pipes, taps/ valves, pressure gauges etc.as per the planning by the bidder. Bidder has to submit the drawing/ plan for the proposed module cleaning system.
- 8.9.6 All the pipes thus laid must be buried in ground at least 150mm below FGL. Road crossings and drain crossings, the pipes must be passed through GI/ Hume pipes as applicable.

8.10 Roads within Solar Power Plant

- 8.10.1 Suitable approach road and internal Solar Photovoltaic roads 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. These roads are to be designed optimally to carry the crane load with all necessary chambers, gradients, super elevation, and radius of curvatures for the easy movement of cranes, trucks and public transport.
- 8.10.2 Roads are to be constructed with sufficient width (minimum 3.5m) 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.
- 8.10.3 All peripheral roads and pathways from central road to Inverter room road shall be WBM road. Also, all cable crossings and other crossings shall be provided with GI/ Hume pipes.

8.11 Peripheral Boundary/ peripheral wall:

- 8.11.1 The objective to provide a peripheral wall/ fencing is to demarcate the boundary and to keep

away the unauthorized access to plant. The contractor shall provide GI chain link/ RCC pre cast/ RR masonry wall all around the periphery of the plant. The wall height must be minimum of 2 meter from the FGL. The boundary wall must be provided with a rugged main entry gate (s). The construction of peripheral wall and the main entry gate must conform to the relevant IS standards and practice. Additionally, there should be few strands of barbed wires attached to a tilted bracket above the fencing/wall.

- 8.11.2 All the drawings/ specifications for the peripheral wall and main entry gate design/ planning must be submitted to Employer for approval prior to construction for their accord.

8.12 Drainage

- 8.12.1 The storm water drainage shall be planned for the plant to ensure no water stagnation in the plant. The drains must be constructed with brickwork/ RCC/ RR masonry as suitable for the site conditions. The drains outfall must be connected to the nearest drain outside the plant premises. It is advised that the drainage for the plant must be designed keeping the natural flow of water to the nearest exit point.
- 8.12.2 Bidder is to provide RCC Hume pipe of appropriate size at the crossing of road and drains and at required locations. The peripheral drain may be of brick pitching which is backed up by cement mortar bed and all joints are filled up with cement mortar in C.M. 1:4, no pointing and plastering is required. Alternate suitable drain can also be explored. Drains are required to provide weep holes with PVC pipes at an interval of 2m. Bidder shall submit the drain plan and drain section details for the complete plot as required for the effective water evacuation to nearest outfall point for suggestion/ approval.

8.13 Painting & Finish:

- 8.13.1 All metal surfaces and support structures shall be thoroughly cleaned of rust, scale, oil, grease, dirt etc. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking the finishing coat.
- 8.13.2 After Phosphate treatment, two (2) coats of yellow zinc chromate primer will be applied followed by two (2) coats of epoxy based synthetic enamelled paint. Shade shall be Siemens Grey RAL- 7032. Thickness of paint shall be not less than 75 micron.
- 8.13.3 All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

8.14 Watchmen / Security Cabin:

Contractor shall provide adequate numbers of prefabricated Watchman's portable cabin at strategic locations with in 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 Employer. 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.

8.15 Underground RCC water Tank

Contractor has to estimate the water requirement for cleaning the modules with a frequency of at least once a week or as per the soiling conditions prevailing at site. The frequency of cleaning shall be mutually agreed and approved during the detail engineering in order to achieve the guaranteed performance. The bidder is required to construct overhead PVC water tank/ underground RCC water tank with silting chamber for filtration of the water before the inlet which will match with invert level of Storm water drain. Suitable sized pump shall also be installed to maintain the water pressure at the extreme ends. Design of RCC water tank shall be such that it shall resist Earth pressure and Water pressure and satisfy all IS codes. The design shall be as per relevant IS codes, bidder to take approval from Employer before the construction of water storage tank and module cleaning system.

G. Inspection & Testing

9. Inspection:

- 9.1 Employer shall have free access to **Bidder's manufacturer's works** to inspect, expedite and witness **shop floor** tests. Any materials or work found to be defective or which does not meet the requirements of the specification will be rejected and shall be replaced at **Bidder's cost**. Employer reserves the right to carry out stage wise inspection of fabrication and components. The Bidder shall furnish a detailed quality assurance plan (QAP) for review by the Employer.
- 9.2 The test & inspection shall be carried out at manufacturer's work and at the site with the Bidders obligation. The test and Inspection shall be done in accordance with the relevant standards and the Manufacturer's standard before the delivery to site as well as after the erection and commission at site. The bidders shall give the list of tests that they will carry out at site to show the performance of plant.
- 9.3 A detailed 'QAP' for Manufacturing and Inspection shall be submitted by the Bidder for Employer's approval. The data of each test and inspection shall be recorded and submitted as soon as the test/ trials are conducted and will also be a part of final documentation.
- 9.4 The shop test shall be carried out to prove the performance parameters of the offered model. The testing shall be done in the presence of the representatives of the department.
- 9.5 The Employer will nominate its representatives (max. of 2 nos.) for inspection of stage

manufacturing and testing at works & 7 days training at premises of SPV module and PCU manufacturer. The notice of such inspection shall be given 30 days in advance in case of countries outside India and 15 days in India.

9.6 Manufacturer has to submit procedure for Test carried out at their Factory:

- Start Up Trials
- Load Test
- Records & Measurements
- Safety Device List
- Setting values for all sensors for Pressure and Temperature
- Dimensional Check-up, Overall Inspection, Completeness of Scope of Supply
- Shop Test/Load Test for Solar Power Plant

10. Load Trials & Reliability test at Site

10.1 Performance Guarantee Test at Site for Grid Connect Solar Power Plant, HT Panel etc.

These tests will be conducted at site as per site conditions at available load and after performing all pre-commissioning check and trials and after readiness of the entire Solar Power Plant system which are required to carry out the load trials

10.2 All the tests which are mentioned in the load test of Solar Power Plant will be carried out in presence of Employers' Representative at Site under site conditions and the parameters checked in accordance with the data sheet and guaranteed parameters given by the Contractor.

10.3 All the equipment supplied by the vendor will be tested as per relevant standard/ Quality assurance plan at site conditions and the performance monitored.

11. Quality Considerations

11.1 Contractor will submit and get finalized detailed comprehensive Standard Field Quality Plan (SFQP) within 30 days from date of issue of the order for bought out items and items manufactured by them. The Standard Field Quality Plan shall relate to the specific and objective erection practices right from storage of equipment till final inspection and testing to be followed for bought out items and items manufactured by Contractor. Accordingly, the Manufacturing Quality Plan shall be submitted broadly under following sub-heads:-

- Raw material/Bought Out items and Components.
- In process inspection and test/checks to establish successful completion/ accomplishment of the process.
- Final tests/checks in accordance with relevant national/ international standards/ specification.

11.2 The quantum of check for each and every inspection/test items shall be based on an

established sampling method and the quantum of check indicated in the SFQP should be designed adequate quality protection.

- 11.3 In case reference documents/acceptance norms are indicated as per plant standards then the same shall be duly substantiated/properly explained by well-established and proven engineering practices. All submissions will be in English language only.
- 11.4 Bidder will to allow Employer to carry out Quality/Audit/Quality surveillance on bidders and our sub-vendor's work with reference to contractual obligations to ensure that the quality management practices/norms as detailed out in the Quality Manual are adhered to. To facilitate this activity, you shall keep Employer informed all progress of work in this contract on monthly basis.
- 11.5 Contractor will associate/fully witness in each inspection being carried out at their/their sub-vendor's works by our authorized inspection engineer(s).
- 11.6 Employer shall also carry out quality audit and quality surveillance of your systems, procedures and quality control activities. However, this shall not relive you of any of your contractual responsibilities under the contract.

12. Performance and Functional Warranty / Guarantees

- 12.1 PV modules used in grid connected solar power plants must be warranted for peak output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.
- 12.2 The modules shall be warranted for at least 10 years for failures due to material defects and workmanship.
- 12.3 The mechanical structures, electrical works and overall workmanship of the grid connected solar power plant must be warranted for a minimum of 5 years.
- 12.4 The Contractor must ensure that the goods supplied under the Contract are new, unused and of most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the Contract.
- 12.5 The warranty / guarantee period shall be as follows:
- Solar PV Modules: Modules shall be warranted for a minimum period of 25 years in the **Bidder's detailed Warranty / Guarantee certificate.**
 - Power Conditioning Units (PCU): PCUs shall be warranted for a period of minimum 5 years or guarantee period provided by the OEM, whichever is higher.
 - Transformers, associated switch gear and others: Bidder must furnish in detail its warranties / guarantees for these items.
 - All other associated equipment, not mentioned, but otherwise included in the scope of the contract must be warranted for minimum 5 years against its performance and workmanship.

- 12.6 During the period of Warranty / Guarantee the Contractor shall remain liable to replace any defective parts, that becomes defective in the plant, of its own manufacture or that of its sub-Contractors, under the conditions provided for by the Contract under and arising solely from faulty design, materials or workmanship, provided such defective parts are not repairable at Site. After replacement, the defective parts shall be returned to the Contractors works at the expense of the Contractor unless otherwise arranged.
- 12.7 ~~At the end of guarantee period, the Contractor's liability shall cease.~~ In respect of goods not covered by the first paragraph of this clause, the Employer shall be entitled to the benefit of such guarantee given to the Contractor by the original Contractor or manufacturer of such goods.
- 12.8 The performance of the plant will be determined by the performance ratio (PR). The same shall be measured and recorded for a period of one month for operational acceptance of the plant as mentioned under TS Clause 7.
- 12.9 During the first year of assured performance demonstration and Operation & Maintenance thereafter, the Contractor shall be responsible for any defects in the work due to faulty workmanship or due to use of sub-standard materials in the work. Any defects in the work during the guarantee period shall therefore, be rectified by the Contractor without any extra cost to the Employer within a reasonable time as may be considered from the date of receipt of such intimation from the Employer failing which the Employer shall take up rectification work at the risk and cost of the Contractor.
- 12.10 During the O&M period, the bidder, in concurrence with the Employer, is encouraged to carry out the PR test in similar fashion for a period of 7 days, at regular intervals, in order to check the continued performance of the plant and to determine the necessary steps to meet the CUF commitment. However, for the O&M period committed CUF shall be considered only. CUF shall be determined for every year for the performance obligations of the Contract.

SHEET-1

Guaranteed Technical Particular data Sheet for Solar PV Module

(To be furnished by the bidder)

S. No.	Particulars	Unit	Type/ value	
1	PV Module Manufacture (Name & Country)			
2	PV Module type (Crystalline- Mono/ Multi)			
3	Product Code (commercial)			
4	No. of PV cells per Module	cells	60	72
5	Mounting arrangement for Solar Module			
6	Solar Module frame material (if framed)			
7	Module dimensions			
8	Output Cables (viz., Polarized Weather Proof DC rated multi-contact connector)			
9	Availability of Reverse Blocking Diode and Bypass Diode			
10	Construction		60	72
	Front glass description and thickness			
	Back sheet details			
	Encapsulating details			
11	Cell efficiency	%		
12	Module efficiency	%		
13	Nominal Wattage (P_{nom})	W		
14	Power Tolerance ($\pm 5W$)	W		
15	Peak power voltage (V_{mp})	V		
16	Peak power current (I_{mp})	A		
17	Open circuit voltage (V_{oc})	V		
18	Short circuit current (I_{sc})	A		
19	Weight of each module	kg		
20	Fill Factor	%		
21	Standards/Approvals from International Agencies	IEC 61215 IEC 61730 IEC 61646 IEC 61701 IEC 62716 Others		
22	Module is suitable to operate up to 50° ambient	Yes/No		

Technical Particular Data Sheet for Power Conditioning Unit

(To be furnished by the bidder)

Particulars	Unit	Value
Make		
Capacity		
Origin		
AC Side		
Nominal AC power @ 25°C	kW	
Nominal AC power @ 50°C	kW	
Output AC voltage	V	
Output AC Current	A	
Frequency (and Variation)	Hz	
Total Harmonic Distortion (< 3%)	%	
AC over/under voltage, over/under frequency protection		
Phase shift (cos phi)		
DC Side		
Maximum Input DC power	kW	
Maximum DC voltage	V	
MPPT voltage range	V	
Maximum DC current	A	
DC over voltage protection		
DC voltage ripple	%	
Others		
Maximum Efficiency	%	
Euro Efficiency	%	
Ambient temperature range	°C	
Humidity (non-condensing)	RH	
Quiescent power	kW	
Degree of protection	IP	
Dimensions approx. (HXWXD)	mm	
Weight	kg	
Compliances (Reference Standards)		

TECHNICAL PARTICULARS OF STEP-UP TRANSFORMER

(To be furnished by the bidder)

S. No.	Description	Guaranteed particulars to be filled in by the manufacturer
1.	Service	
2.	Type	
3.	Rating (kVA)	
4.	Rated frequency (Hz)	
5.	Number of phase HV side LV side Neutral (separate outside)	
6.	Rated Voltage a) HV winding (kV) b) LV winding (kV)	
7.	Vector group	
8.	Type of cooling (ONAN/ONAF)	
9.	Insulation level a) Power frequency withstand -kV rms. (HV/LV) b) Impulse withstand voltage -kV (HV/LV)	
10.	Method of Earthing	
11.	Duty	
12.	Short circuit level	
13.	Off circuit tap changer: a) Range % b) In steps of c) Tapping provided on HV side	
14.	Tap changer type	
15.	Impedance voltage at 75°C a) At principal tapping %	
16.	Temperature rise above 50°C ambient a) Top of oil by thermometer °C b) Winding by resistance °C	
17.	Terminal details a) HV side b) LV side	
18.	Losses (at 75°C and principal tapping) a) No load loss at rated voltage kW and frequency b) Load loss at rated current kW (ONAN) c) Total loss at maximum rated power kW	

S. No.	Description	Guaranteed particulars to be filled in by the manufacturer
19.	Efficiency at 75°C and 0.9 PF a) At full load (ONAN) % b) At 75% load (ONAN) % c) At 50% load (ONAN) %	
20.	Hot spot temperature in winding limit to °C	
21.	Shipping dimensions a) Height m b) Breadth m c) Length m	
22.	Painting	
23.	Reference Standards	

Guaranteed Technical Particulars of LED lights
(To Be Submitted By the Bidder)

S. No.	Parameter	Guaranteed Value
1.	LED Operating Current	
2.	Output Luminous Flux	
3.	Beam Angle	
4.	Illuminance	
5.	Photometric Curve	
6.	Material of Luminaire	
7.	Dimension	
8.	Weight	
9.	Impact Resistance	
10.	LED Life	