v. The insulator shall be provided with a completely galvanized steel base designed for mounting on the support. The base and mounting arrangement shall be such that the insulator shall be rigid and self-supporting and no guying or cross bracing between phase shall be necessary.

vi. **Porcelain of the insulator**:

a. The porcelain used for the manufacture of the insulators shall be homogeneous, free from laminations and other flaws or imperfections that might effect the mechanical or dielectric quality and shall be thorough vitrified, tough and impervious to moisture. The glazing of the porcelain shall be uniform brown colour, with a smooth surface arranged to shade away rain water and free from blisters, burns and other similar defects. Insulators shall be inter-changeable.

b. The porcelain and metal parts shall be assembled in such a manner and with such materials that any differential thermal expansion between the metal and porcelain parts throughout the operating temperature range will not loosen the parts or electrical strength or rigidity. The assembly shall not have excessive concentration of electrical stress in any section or across leakage surfaces. The cement used shall not give rise to chemical reaction with metal fittings. The insulator shall be suitable for water washing by rains or artificial means in service conditions. Further the insulators to be supplied shall be of high- quality and should not result in mismatch and misalignment of stacks during erection and operation.

c. Each cap shall be of a high grade cast iron or malleable steel casting or steel forging. Cap and base insulators shall be interchangeable with each other. The insulator shall conform to the requirement of the latest edition of IS: 2544,or any other equivalent standard. The Bidder should furnish the characteristics of insulators in the Bid.

Busbars

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

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

iii. The ACSR bus bars are an underground 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.

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

v. Since aluminum 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.

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

vii. The isolator shall be provided with padlocking device to permit locking of the isolator in both fully open and fully closed positions.

5.2.19 Control & Relay Panel Specifications

i 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.

i The enclosure external finish color shade shall be decided by the Company, The internal surface shall have a glossy white finish all over.

i The control & relay panel shall contain the following metering and protection devices.

- Metering, Indications & Controls
- Ammeter – 0 ..... A
- Ammeter selector switch
- Voltmeter – 0 – 12/36 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 aluminum strips and 'ON' 'OFF' indications for isolators

5.2.20 Low Voltage Switchgear

i This specification is for the 415V TP&N Power Control Centre (PCC).

i The PCC shall be rated for the maximum output of the supply transformer feeding the system.

i The short circuit withstand rating (1 sec) at rated voltage of the switchgear shall be minimum of 20 kA (rms) and corresponding dynamic rating shall be 50 kA (peak).

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

5.2.21 Execution

i Single front / compartmentalized, modular design, degree of protection IP52 with provision of extension on both sides.

i Incomer feeders: mains incomer - Electrically operated draw out type Air Circuit

Breakers (ACBs).

iii. Outgoing feeders : Electrically operated draw out type Air Circuit Breakers (ACBs) / Moulded Case Circuit Breakers (MCCBs)

iv. The color 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 PURCHASER, the same shall be intimated to the supplier.

v. 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.

vi. The gland plates shall be 3 mm thick.

5.2.22 Control & Relay Panel Specifications for 415 V TP&N Power Control Centre (PCC)

i. This specification is for the 415V TP&N Power Control Centre (PCC).

ii. The PCC 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 minimum of 20 kA (rms) and corresponding dynamic rating shall be 50 kA (peak)

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

Execution

Power Control Centres (Construction)

a. Single front / compartmentalized, modular design, degree of protection IP52 with provision of extension on both sides.

b. Incomer feeders: mains incomer - Electrically operated draw out type Air Circuit Breakers (ACBs).

c. Outgoing feeders : Electrically operated draw out type Air Circuit Breakers (ACBs) / Moulded Case Circuit Breakers (MCCBs)

d. The colour finish shade of switchgear enclosure for interior shall be glossy white & for exterior it shall be light grey, RAL 7032 of IS: 5. If a different exterior shade is desired by the PURCHASER, the same shall be intimated to the supplier.

e. 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

f. The gland plates shall be 3 mm thick.

Control Circuit

a. Control supply for breaker closing / tripping - 110V DC

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

c. Moulded Case Circuit Breakers – 240 V AC, 1 phase

d. Indications, annunciation – 110V DC

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

Busbar and Cable Cavity

a. The material for main bus bars and tap off bus bars shall be electrolytic grade aluminum with HR PVC sleeved insulation

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

c. Bottom cable entry for incoming and outgoing cables

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

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

5.2.23 Control Room Electrical Wiring

i Electrification of building shall be carried out as per IS 732-1989, IS 46481968 and other relevant standards. Suitable AC Distribution Board should be designed to Supply AC power in Control room.

i Control room AC distribution Board theoretical design, calculations and detailed explanations along with drawing shall be provided and approved by HPGCL.

5.2.24 Auxiliary Power Supply

i The Contractor shall install a separate 33 kV / 415 V step down transformer to supply power for internal equipment such as power for control equipment, area lighting, water pumps, conference room fixtures, control room lighting and air-condition, etc.

i This auxiliary power should be utilized from the internal connection before the metering point of Solar PV Plant. A separate meter can be installed for auxiliary consumption just for internal accounting purpose.

The Contractor/ bidder has to quote/ achieve the NEEGG at metering point considering that auxiliary power consumption is met from the internal connection of PV Plant. At metering point, there should be net metering with import and export power accounting, for determining "Actual Delivered Energy" against the NEEGG.

5.2.25 DC Battery & Charger

i Adequate capacity DC battery Bank should be provided for emergency control supply of inverters, control / protection system & emergency lighting. A

i appropriate capacity battery charger 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.

i A DC power supply Distribution panel/board should be supplied along with the Charger 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 HPGCL.

i DC Batteries the batteries shall have the following specifications:

a. Type : Nickel Cadmium Stationary, sealed type, storage battery

b. Rating : 110 V D.C., Minimum 80 Ah at 8 Hour rate of discharge

c. Standard : IS 1651 – 1979 ; performance as per IS 8702

d. Container : Plastic Resin, ABS or PP

e. Terminal Post : Designed suitably to accommodate external bolted connections

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

v. The data sheet for the battery shall be submitted along with the Bid for evaluation.

5.2.26 Earthing

i 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.

Terminals

a. CT circuit - Isolating link type terminals with shorting facility

b. PT circuit – clip on type terminals

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

Specific Requirements

1. All ACBs 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.
2. ACBs shall be complete with microprocessor release and shall be provided with over current, short circuit and earth fault protections.
3. Minimum10% spare feeders of each rating shall be provided in the switchgear.
4. All current transformers shall have 5/1A secondary and all meters shall be suitable for 5/1 A operation.
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. All indicating instruments shall be flush mounting, Digital, 96 sq.mm size.
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.
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.

Instrumentation: Switchgear instrumentation shall be provided as follows:

a. Mains Incomer – Voltmeter with selector switch
b. Ammeter with selector switch
c. Power Factor meter
d. Frequency meter
e. TVM + MD meter
f. Potential indicating lamps
g. Outgoing Feeders
h. Ammeter with selector switch on all feeders

5.2.27 General Technical Specifications of Control Panel

i 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.

ii 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.

iii 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 Company.

iv. 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.

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

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

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

viii Panel shall be provided with fl. lamp of 20 w capacity operated by door operated limit switch. Panel shall also have space heaters and thermostat arrangement.

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

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

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

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

xiii Aluminum anodized legend plates shall be provided for all the components. For components mounted on front face, legend plate from inside shall also be provided.

xiv. Pretreatment by 7 tank process shall be done before painting / powder coating the panel.

xv. Panel shall have provision of drawing pocket.

xvi 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.

xvii Cable entries will be from bottom. The opening of cable entry shall be covered by 3 mm thick gland plates.

xviii. The panel shall be provided with all necessary components / devices and instruments as per the enclosed schematic diagram and functional requirements.

xix. The components such as protective relays, auxiliary relays, push buttons, switches, instruments shall be flush mounted on the front side of a panel.

xx. 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 shall be used.

xxi. Earthing busbar of suitable cross section shall be provided throughout the length of panel.

xxii. 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.

xxiii. Proper shrouding to incoming and outgoing terminals shall be provided to ensure safety during operation, inspection and maintenance.

xxiv. Indicating lamps shall be with multiple LEDs & shall be suitable for the voltage specified.

xxv. All the components in the panel shall be properly labeled. The labels shall be made of non-rusting metal or engraved PVC material properly fixed by screws.

xxvi. 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.

xxvii. 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.

xxviii. The panel shall be provided with electrolytic grade aluminum busbar of suitable cross section so as to maintain max current density of 0.8 AMP/ Sq.mm.

xxix. Bus bars shall be provided with color coded heat shrinkable sleeves.

xxx. Bus bars shall be supported by high quality epoxy insulators provided at specified distances so as to withstand to the given fault level.

xxxi. The busbar chambers shall be provided with suitable ventilation arrangements so as to limit the maximum temperature of 85°C while carrying rated current.

xxxii. Proper clearance of minimum 25 mm shall be maintained between phase bus bars and between bus bars.

xxxiii. The panel shall be inspected at manufactures works before dispatch to site at the discretion of HPGCL.

xxxiv. All routine tests shall be carried out on the panel in presence of the Company / its representative. These tests shall include following:

a. Verification of components ratings and operation.
b. High voltage measurement test.
c. Insulation Resistance measurement.

xxxv. Control testing.

xxxvi. Approval on following drawings shall be obtained before manufacturing the panels

a. General arrangement drawing.
b. Wiring Diagram.

xxvi Detail bill of material.

xxvii 33 kV Transmission Line

The Contractor shall provide 33 kV transmission with bay and metering on Turnkey basis as per client's requirement. Bidder shall confirm the same in the Bid. Connection upto DISCOMs interconnection point is under the Contractor's scope.

5.2.28 Metering System

i ABT energy meter shall be provided as approved by DISCOM 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 Contractor. All charges incurred on Meter testing, shall be borne by the Contractor. ABT energy metering system is to be approved by DISCOM.

ii Meter must be provided with the necessary data cables.

iii Separate metering system has to be provided for L.T. (incoming) and H.T. (outgoing) supply. The meter should be Load Manager/ Multifunction Meter with SCADA interface.

iv. The Bidder shall provide ABT compliant meters at the interface points. 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 shall be in accordance with the HPGCL order.

v. 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.

vi All charges for testing and passing of the meter with relevant government agency shall be borne by Bidder, HPGCL will assist Bidder for necessary document as and when required.

vii ABT compliant Energy Meters shall have technical specification as given below (not limited to specified requirement, Bidder can provide Meter with latest facilities):

viii Shall be microprocessor-based conforming to IEC 60687 / IEC 6205211/ IEC 62053- 22 / IS 14697

ix 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.

x 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.

xi The active and reactive energy shall be directly computed in CT & VT primary ratings.

xii 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.

xii. 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.

xiv. 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.

xv. At least the following data shall be stored before being over-written for the following parameters:

Table 5-15 Circuit Breaker Co-ordination parameters

Sr.	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 v > 103 %	At every Mid-night	30 days in meter / 90 days in PC
6	Date and time blocks of VT failure on any phase		

i. 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.

ii. Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment existing at the station provided by Bidder.

iii. The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be less than maximum 2 VA.

iv. 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.

v. 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.

vi. 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.

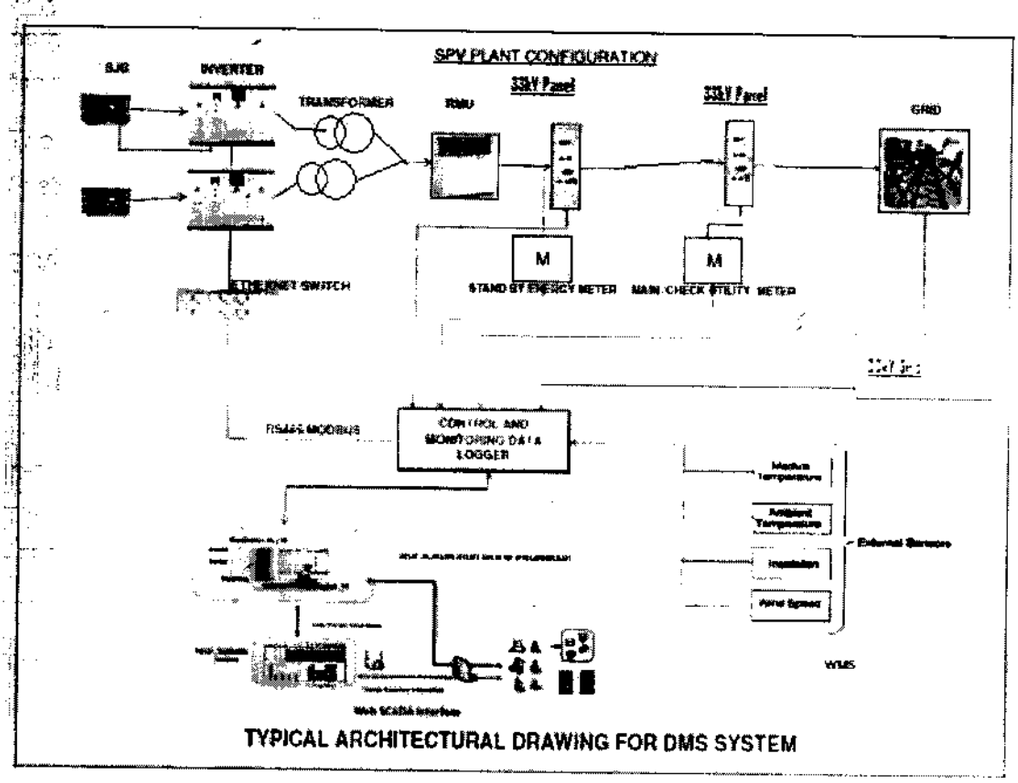
vii. The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.

viii. The meter shall have a unique identification code provided by the Company and shall be permanently marked on the front of the meter and stored in the non-volatile memory of the meter.

ix. The Company shall have the right to carry out surprise inspections of the Metering Systems from time to time to check their accuracy.

5.2.29 SCADA and Remote Monitoring System

i The plant shall be automatically operated and shall be controlled by microprocessor based control system SCADA. 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.



TYPICAL ARCHITECTURAL DRAWING FOR DMS SYSTEM

i 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.

ii 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.

iv. Reliable sensors for solar insolation, temperature, and other weather and electrical parameters are to be supplied with the data logger unit.

v. The data acquisition system shall measure and continuously record electrical parameters at inverter output, 33 kV ABT meter at evacuation point, ambient temperature near array field, control room temperature, AC and DC side

electrical parameters of each inverter, power characteristics of the HT side. Data acquisition of ABT Meter is under control of DISCOMs but the Contractor to provide TVM for the internal record.

vi. All data shall be recorded chronologically date wise. The data file should be MS Excel compatible. 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.

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

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

ix. SCADA shall provide following data at a 5-15 minute interval.

a. Power at 33 kV ABT meter at switchyard
b. Ambient temperature near array field.
c. Wind Speed
d. AC and DC side Power of each inverter
e. Solar irradiation/isolation
f. Voltage of the HT Side

x. Any other parameter considered necessary by supplier based on current prudent practice

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

- Exported Energy to grid at 33 kV
- Energy of each inverter
- Solar Radiation
- Temperature

xii. The SCADA server PC shall be of Industrial type, rugged & robust in nature to operate in a hostile environment. The PC shall have minimum Intel Core i7 processor having 2 X 500 GB HDD with 4 GB RAM. The PC shall also have 42" TFT Color monitor, DVD Drive with Writer, Floppy Drive, USB drive, Scroll Mouse and UPS for 4 hours Power back up.

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

xiv. String Monitoring System: String Monitoring System designed exclusively for parallel connection of the photovoltaic field strings, allowing for protection in the case of breakdown & monitoring the entire photovoltaic field, by means of the following checks.

- Reading the string currents (10 channels available)
- Reading the total voltage of the field
- Checking the fuses positioned in the system, to protect the photovoltaic panels.
- Checking the state of the internal protection against over-voltages.

- Should be very low power consumption.

a. Monitoring of various parameters at string level should be made possible in the main control room at site by installing the suitable string monitoring system any fault at string level could be recognizable by that system.

b. A provision should be present for remote monitoring of the power plant at string detail over the web.

c. The Contractor shall provide to HPGCL the detailed specifications, and all administrative rights/ privileges/ passwords to the string monitoring system.

xv. Weather Station and Data logger

a. Contractor shall provide the data over remote web-server with rights to control or modify the same through appropriate arrangements.

b. Contractor shall provide necessary licensed software and hardware solution to offer monitoring of electrical parameters of grid and solar generator monitored at individual string level over remote web server. The Contractor shall provide all necessary accessories like power supply, connection cords, sensors, active SIM card with appropriate data plan etc. so as to make the system complete in all respect.

c. The cost of data plan during the project and O&M shall be borne by the Contractor. At the end of the O&M, the same shall be transferred to HPGCL at no extra cost.

d. It shall also have local data logging and communication through Bluetooth / Wi Fi and Ethernet port. Hardwire connection with Ethernet Port is also acceptable.

e. The Remote Monitoring System shall be capable of sustaining maximum – minimum temperature, rainfall, wind gusts and UV radiation. The enclosure shall be IP65 for outdoor installation / IP21 for indoor installation.

f. The Remote Monitoring System shall have capability to log and send data from weather sensors.

g. The data shall be available for every minimum 15 minutes interval.

h. The system shall have sufficient internal memory storage to retain data for one complete year, and shall have provision of expanding memory through external memory card / USB drive.

i. The system shall be able to communicate wirelessly in a close proximity

j. The Contractor shall provide to the Company the detailed specifications, and all administrative rights/ privileges / passwords to the string monitoring system.

k. The Contractor shall provide following measuring instruments with all necessary software & hardware compatible with the Data logging and web based monitoring system.

i. **Pyrometer**: The Contractor shall provide two no. of pyranometers for measuring incident global solar radiation, one each on the horizontal surface and in the same orientation (inclination and azimuth) as the photovoltaic modules. The pyranometers shall have following specifications mentioned in Table 5-16.

Table 5-16 Specification of Pyranometers

Sr.	Particulars	Specification
1	Class	II
2	Spectral Response	0.31 to 2.8 micron
3	Sensitivity	Approx. 9 micro - volt/w/m2

4	Time response (95%)	Max 15 sec.
5	Non linearity	±0.5%
6	Temperature Response	±2%
7	Temperature Response	Max ±2%
8	Tilt error	±0.5%.
9	Zero offset thermal radiation	±7 w/m2
10	Zero offset temperature change	±2 w/m2
11	Operating temperature range	- 40 deg. to +80 deg.
12	Uncertainty(95% confidence Level)	Hourly- Max-3%
13	Daily-	Max -2%
14	Non stability	Max ±0.8%
15	Resolution	Min + / - 1 W/m2
16	Input Power for Instrument & Peripherals	230 VAC (If required)
17	Output Signal	Analogue form which is compatible with the data

ii. Temperature Sensor: The Contractor shall provide suitable nos. of RTD type temperature sensors with required weather shield as per Indian Standard, so as to individually and simultaneously measure both, ambient temperature, and module temperature. To measure module temperature, the temperature sensors shall be located on the back of representative modules and on front glass surface. Care must be taken to ensure that the temperature of the cell in front of the sensor is not substantially altered due to the presence of the sensor. Instrument shall have a range of -5°C to 60°C.

iii. Anemometer and Wind Vane: The Contractor shall provide double cup anemometer on tubular type made up of hot dipped Galvanized Iron. Velocity range upto 65 m/s, accuracy limit of 0.1 m/s. the anemometer shall have valid calibration certificates which should be produced during one month of the installation.

iv. 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.

v. The data acquisition system shall measure, continuously record power at PV module ambient temperature near array field, cell temperature, wind velocity, AC and DC (string level) side power of each inverter, power characteristics of the HT side, fault messages, alarms etc. in Indian Standard Time.

vi. All data shall be recorded chronologically date wise. The data file should be MS Excel compatible. 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. Representation of monitored data in graphics mode or in tabulation form. All instantaneous data can be shown in the

Computer Screen.

vii. Provision should be available for Remote Monitoring and Data Retrieval over web server. Moreover, Successful Bidder shall also provide one no. of PC with required hardware and licensed copies of software to make it fully functional for normal operation and data logging through Bluetooth / Wi Fi / RS port from the site. Internet connection can be in the name of HPGCL. However, all the charges to be paid by the Contractor during the O&M period including initial one-time cost.

viii. The Bill of Materials associated with the equipment must clearly indicate especially the details about the PC and other accessories.

ix. The Data Acquisition System should be housed in appropriate enclosure to sustain outdoor environment as per generation design guidelines laid for enclosures. The same shall have provision of locking the same to prevent unauthorized operation. Remote Monitoring System (RMS) shall provide following data at a 15 minute interval.

- Power, Current and Voltage at individual solar PV strings (Instantaneous)
- Ambient temperature near array field, cell temperature measured at module front and back surface
- Wind Speed
- Cumulative AC and DC side Power of each inverter
- Cumulative AC and DC energy of each inverter

a. Solar irradiation/isolation over horizontal and in-plane of the module
b. Voltage, frequency and other important electrical parameters etc. in the local grid.
c. Any other parameter considered necessary by supplier based on current prudent practice
d. All data shall be recorded chronologically date wise. The data file should be MS Excel compatible. 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. Representation of monitored data should be in graphics mode or in tabulation form. All instantaneous data should be shown in the Computer Screen.
e. RMS 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.
f. RMS shall be provided with independent solar PV based power supply along with maintenance free battery having 3 days autonomy.
g. The RMS shall be compatible to the requirements for measuring and reporting the performance-ratio of the power plant.
h. The contractor shall provide all administrative rights/ privileges/ passwords of the RMS system to HPGCL.

i. The Bidder shall submit the data sheet with technical specifications of the RMS system in the Bid.

5.2.30 Testing Instruments for Electrical & Electronic:

The Contractor 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.

5.2.31 Electronic LED Display Board:

The Contractor shall provide an electronic LED Display board that can display the Solar PV plant parameters like total generation till date, daily generation, instantaneous generation, instantneous frequency, etc. The LED display board has to be erected at a height of 8 feet above ground level and should be large enough to be read from a distance. The LED display board is to be placed between the Control Room and the main gate, the exact location of which will be provided by the Company/ Consultant after award of the project.

5.3 DETAILED CIVIL AND OTHER NON-ELECTRICAL WORK

All material, installations, fixtures, accessories etc. to be provided shall be as per the relevant IS specifications. These shall be of best quality and of standard manufacturer as approved by the Engineer-In- Charge (EIC) on site, when there are no standard specifications.

The fresh OPC cement (Ultratech /Ambuja /Binani /JK Lakshmi) and TMT steel reinforcement bars Fe 415 (TATA /Jindal /RINL /SAIL /Electrotherm) shall be used confirming to relevant IS specifications. In case the material make is not specified, the Contractor has to refer list of the approved manufacturers of the Company. In case there non availability of approved manufactures, Company's/ Consutlant's approval/consent needs to be taken.

The Contractor has to prepare bar bending schedule and cement consumption for the total project in advance and has to submit to the Company and Consultant in hard copy and soft copy. The Contractor has to keep the fullproof records of purchase and consumption along with original purchase bills of Cement and Steel as per the Company procedures and rules. The Contractor has to provide best workmanship with skilled manpower for all the civil items as per the standard specifications/ best practice as approved by the Engineer In Charge (EIC) on site. The booklet Standard Specifications for Civil Works will be applicable wherever there is dispute in the items of civil works. The Company will not supply any material for this work.

5.3.1 Topographical Survey:

The Contractor shall do topographical survey of the proposed site at not more than 25 m 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.

5.3.2 Soil Test:

i For Soil test, refer **Annexure-2** and Contractor shall treat it accordingly. Contractor is advised to and is solely responsible to carry out detailed Geotechnical investigation to ascertain soil parameters of the proposed site for the planning / designing / construction / providing guarantee / warranty of all civil work including but not limited to foundations / piling for module mounting structures, HT lines, 33 kV switchgear equipment etc. The Contractor shall carry out soil investigation through Government approved / NABL certified soil consultant. These reports shall be furnished to the Company and Consultant prior to commencing work. All RCC works shall be provided of required grade of concrete as per relevant IS specifications as well as based on soil data considering appropriate earthquake seismic zone, wind velocity, whether effect, soil characteristics etc.

ii 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 and submission of detail reports along with recommendation regarding suitable type of foundations for each bore hole along with recommendation for soil improvement where necessary. The Contractor shall provide certificate of foundation design and Module Mounting Structure (MMS) design from competent chartered structural engineer in support of the foundation and MMS design proposed by him.

5.3.3 Foundations:

The foundations should be designed considering the weight and distribution of the structure and assembly, and a maximum wind speed of 170 km per hour. Seismic factors for the site also have to be considered while making the design of the foundation. Epoxy paint/ Bituminous paint to be applied to all foundations below ground level that come in contact with excavated soil. All enclosed areas below plinth level have to be aback-filled with sand/ murram that has to be compacted so as to achieve proctor density of 95%. Excavated soil cannot be used for back-filling without being approved for use after testing in Government/ NABL accredited laboratory.

5.3.4 Designing of components:

i The Contractor 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 Company for its review/ suggestions / approval.

ii The Contractor shall obtain and study earthquake and wind velocity data for design of module mounting structure, and considering all parameters related to the weathers conditions like Temperature, humidity, flood, rainfall, ambient air etc.

iii RCC structures for control room, Pre-fabricated inverter rooms, Watchman's cabin shall be strictly as per relevant IS standards.

5.3.5 Storage, Construction Power and Water:

The Contractor shall also plan for transport and storage of materials at site and shall arrange for its own construction power and water. However the contractor can avail construction power connection from DISCOM by applying for temporary connection for which he has to bear the cost. The Company will help with supporting documents. The Contractor can avail construction water by drilling a borehole and extracting required water. All expenses for the same shall be borne by the Contractor.

5.3.6 Land Development and Cleaning:

The proposed site may be undulated or flat. However, the Contractor shall visit the site and do the topographical survey to ensure land development work such that land is perfectly flat. Also, the Contractor shall take reasonable care to ensure that the plant is aesthetically designed.

5.3.7 Storm Water Drainage System:

The Contractor has to design, submit and take approval from the Company /Consultant for disposal of storm water of the plant. It shall be designed in a manner such that rain water and water required for module cleaning can be easily drained off by providing sufficient slope to the drain. Storm water drain shall be of Trapezoidal section. The sides of peripheral drain shall be of brick masonry in C.M 1:5, which is backed up by cement mortar bed and all joints to be are filled up with cement mortar. Plastering in CM 1:4 is required. All other internal drains,i.e. on both sides of central roads, pathways to Inverter rooms, etc. are to be done by simply excavating the drain of required size with complete dressing and with required trapezoidal section in which no brick pitching is required. Also RCC hume pipe with concrete encasement is to be provided at crossing of road and drains and at required locations. Further, Drains can be of either Brick Lining type or precast type but in case of precast, the scoring velocity of water needs to be considered appropriately by the bidder during the design stage.

5.3.8 Watchmen / Security Cabin:

The Contractor shall provide one (1) number of pre-fabricated watchman's portable cabin near plant gate. The minimum size of watchman's cabin shall be of 1.2 metre x 1.8 metre and height of 2.4 metre with appropriate roof at the top. The Bidder shall provide detailed civil, electrical, plumbing, etc. drawings and equipment specifications for the security cabin in "(B) Technical Offer" of the Bid document. Location of the watchman's Cabin (Security Cabin) will be as directed by the Company.

5.3.9 Area Lighting:

i. Area lighting arrangement shall be made to illuminate the entire site at an appropriate lux level for night hours or bad light hours. Area lighting arrangement shall have adequate numbers of lights poles (50 mm diameter with 3 mm thick at 25 metre spacing) on the sides of peripheral roads, etc).

ii. The connector box shall be made of stainless steel, Dust & Vermin Proof, which is to be recessed at the base of each Yard Lighting system. The connector box shall have suitable brass or copper made connector terminal.

iii. The lighting fixtures with control gear shall be mounted on tubular poles of approved height and mounting arrangement.

iv. All the yard lighting towers and lighting fixtures shall be effectively grounded using

adequate size of GI earthing wires / GI earthing strips.

v. The lighting poles shall be concreted with 600 mm coping above ground level for pole protection with sufficient reinforced concrete foundation below ground.

vi. Solar Bollard lighting only on internal roads with height of 1 metre on both the sides of the roads with sufficient foundation to be provided at a distance of 15 metre from each other.

vii. The control gear box (non-integral type) shall be encased in the coping.

viii. Loop in – Loop out power cables shall be brought up to the control gear box through of adequate size for cable protection.

ix. The cables shall be properly glanded to the control gear box gland plate.

x. XLPE / PVC insulated armored Cu/Al cables of adequate size shall be used for interconnection and supply of power to Yard lighting systems.

xi. 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 connector box and at the entry point to MCB distribution Box for controlling the yard lighting system.

xii. The height of the area lighting fixtures should be at least 2.75 metres from ground.

xiii. Lighting fixtures shall be installed close to fencing.

5.3.10 Fencing:

Chain link fencing shall be provided to protect the plant. The minimum height of the fencing shall be 1.5m. The chain link of 50mm x 50mm diamond mesh of 10 gauge galvanized steel wire with 12 gauge barbed wires at top (02 numbers) is to be provided. The Contractor's scope shall be supplying, fabricating and fixing aligning vertical post of 75mm x 75mm x 6mm with cross bracing both side of ISA 45mm x 45mm x 5mm and both bracing shall be fixed by nut bolt assembly at intersecting point. Also line wire at top and bottom of chain link mesh of 8 gauge is to be provided. Chain link fencing shall be fixed in ground by the minimum reinforced foundation.

5.3.11 Main Entrance Gate:

An all-weather main gate with width of at least 6 metre and 2 metre height with sliding roller at bottom shall be erected at the entrance of the plant site. The gate shall be designed such that it should have aesthetic view by creating Arch type structure above the gate in which the Company's name shall be embossed. Adjacent to main gate there should be small pedestrian gate of 1.2 metre x 2 metre size.

5.3.12 Roads:

All internal roads shall be of Asphalt type. The Contractor has to design as per relevant IS, submit and take approval from the Company / Consultant for Asphalt Road. Asphalt Road shall connect Control Room, Switchyard, all Invertor rooms and main gate. Asphalt road shall also be provided at periphery of the entire plant area. An asphalt road shall have sufficient courses like a subgrade, subbase, base courses, and surface course as per IS specifications. The width of asphalt road shall be of 4 metres and with sufficient thickness for access of heavy equipment like transformers/ Inveters/ Switchyard equipment during construction as well as subsequent maintenance.

5.3.13 Landscaping and Sun Dial (Solar clock):

Landscaping of one (1) meter width on both sides of the road after shoulder from main gate till the Control Room is to be provided by the Contractor. It is recommended to use aesthetically pleasing plants and shrubs suitable to the local soil and climatic conditions. A Sun Dial (Solar Clock) of maximum 2 metres diameter showing hour markings is to be provided in front of RCC Control Room cum Conference Room for 6 MW Solar PV Plant.

5.3.14 Underground RCC / Sintex water tank:

The Contractor shall design the tank as per relevant IS codes, submit and take approval from HPGCL. The Contractor shall plan for one wash of all solar PV modules on weekly basis. For this, the Contractor shall construct and operate 60,000 litre capacity RCC/Sintex water storage tank. The contractor shall provide sufficient valves, plumbing fixtures and cleaning arrangement for tank from inside. If RCC tank is preferred then, design of RCC water tank shall be such that it shall resist Earth pressure and Water pressure and satisfy all IS codes.

5.3.15 Water supply:

The contractor shall have to drill two (2) numbers of bore holes for water supply, pipeline for carrying water from bore hole to storage tank. 2 numbers of Electric panel for bore holes and total water cleaning system. The cleaning system shall consist of:

a. New Tanker with pump and water jet and pipeline. Tanker with pump and water jet and pipeline shall be handed over to the Company after completion of the O & M period. All sort expenditure related to this shall be borne by the Contractor
b. Pipe line network with valves. All necessary arrangement for cleaning of the solar panels shall be in the scope of the Contractor.

5.3.16 Prefabricated Inverter Room and RCC Control Room cum Conference Room:

i. All prefabricated structures shall strictly adhere to relevant IS standards towards construction, design, workmanship, materials and ergonomics. At the same time, it shall take into account the convenience and user needs.
ii. The Contractor shall provide to the Company detailed civil, electrical, plumbing, etc. drawings and equipment specifications for the inverter/ control room and take approval from the Company/ Consultant. The drawings of panels with the make of components should be approved from the Company.
iii. Pre-fabricated/ Reinforced Cement Concrete (RCC) Invertor Rooms: The Contractor has the option to construct either Pre-fabricated or RCC based Inverter Rooms. The details of each are as below:

Pre-fab Inverter Room shall be of adequate size and of be of standard manufacturer with sufficient lighting points and RCC cable trenches with oil painted edge angle and checker plate covers and shall have exhaust chimney and also sufficient ventilation. All prefab inverter room shall be laid on RCC plinth with sufficient foundation and reinforced grade slab with finished Kotah /Vitrified /Ceramic tile flooring and 100 mm skirting of same tiles. The plinth shall be minimum 450 mm high from formation level of the plant. Plinth protection shall be given throughout perimeter of width 1.2m with rough kotah on its top for Inverter rooms and Control cum Conference Room. Sufficient steps at the entry of the room with finished Kotah on its top and ramp shall be provided for shifting

the equipment in the rooms for all Inverter rooms, and Control cum Conference Room. Rooms shall be designed such that structural components shall not be visible from inside or outside after wall cladding work is completed. Rainwater pipe at various locations with gutter at the top shall be provided to discharge rainwater.

iv. RCC frame structure for Inverter Rooms shall have adequate size of footing, pedestal columns, plinth beam, grade slab with reinforcement as per relevant IS specifications considering seismic zone, wind and soil detail etc. The RCC Inverter Rooms shall have RCC cable trenches with oil painted edge angle and checker plate covers and shall have exhaust chimney and also sufficient ventilation. Flooring of Inverter Rooms shall be provided with finished Kotah /Vitrified /Ceramic tile flooring and 100 mm skirting of same tiles. Interior part of walls shall be applied with 12mm plaster above which two (2) coats of putty and distemper paint have to be applied. The exterior part of walls of Inverter Rooms shall be provided with 20mm plaster above which three (3) layers of weatherproof paint shall be applied. The plinth of the Inverter rooms shall be minimum 450mm high from the formation level of the plant. Plinth protection shall be given throughout the perimeter of width 1.2 m with rough kotah on its top. Also, Termite proofing is required before preparation of grade slab. Terrace water proofing treatment with china mosaic/bitumen layer is to be provided. The Inverter Rooms should have a terrace that is accessible through proper painted MS ladders.

v. RCC Control Room cum Conference Room: It shall be of adequate size for fixing the panels, battery banks etc. with a) Conference room; b) SCADA Room with Work station with Desktop and Chairs; c) Store Room with Wardrobes; d) Pantry unit of sufficient size with sandwich type of platform with plumbing fixture and exhaust fan;
e) Toilet unit for Gents and Ladies; f) RCC cable trenches with covers and cable trays and all openings of cable entry shall have vemin proofing; g) False ceiling shall be provided in conference room, SCADA room, Store room and Passage etc.; h) Furniture like conference table, chair and sofa etc.; i) Lighting points and fixtures; and Plumbing fixtures. This Control Room cum Conference Room should have a terrace that is accessible through proper RCC stairs.

vi. Control Room should have appropriate area for fixing necessary panels and battery banks, RCC cable trench with necessary trays with cover at top, necessary lighting points and should having sufficient height and ventilation. Conference Room also have adequate size SCADA cabin with necessary 2 numbers of work station with drowers of Godrej/ Durian/ Zuari make, 2 numbers Computer and 1 number of LED TV of 48 inch of Sony/ Phillips / Samsung make, 4 numbers of chairs for workstation and split A.C of 1 Ton of Voltas/ Hitachi/ Samsung/LG make for operating staff for work station. Conference Room shall also be equipped with conference table of 15 persons with Power Sockets with 15 chairs of Godrej/ Durian/ Zuari/ Usha/ Lexus and sofas. In conference cum control room, except control room (where panels are fixed) all other rooms like SCADA cabin, conference room, store, pantry and passage shall have false ceiling of Gypsum board tiles with Armstrong suspended channel system. False ceiling shall be fixed such that at no place suspended ceiling system should be visible. Conference room shall be equipped with printer with scanner, landline phone, refrigerator (150 litre), projector and screen of 2m x 2m. All material, installations,

accessories to be provided shall be of best quality and of standard manufacturer as approved by the EIC/ the Company. All units of the Control cum Conference Room shall have marked signage of SS sheet of 1mm along with engraving words and filled with black color.

vii. Flooring and skirting for Control cum Conference room: Best quality vitrified tile flooring having min size of 600 mm x 600 mm x 8-10. mm thickness with 100 mm skirting of same tile of standard manufacturers as approved by EIC or as per approved make of the Company.

viii. RCC frame structure shall have adequate size of footing, pedestal columns, plinth beam, grade slab with reinforcement as per relevant IS specifications considering seismic zone, wind and soil detail etc. The exterior walls of Control cum Conference Room shall be provided with an exterior cladding of Aluminum Composite Panels (ACP). The plinth of the RCC Control room cum conference room shall be minimum 450 mm high from the formation level of the plant. Plinth protection shall be given throughout the perimeter of width 1.2 m with rough kotah on its top. Also. Termite proofing is required before preparation of grade slab. Terrace water proofing treatment with china mosaic/bitumen layer is to be provided.

ix. Prefab Inverter Rooms and RCC Control Cum Conference Room shall have sufficient number of lighting points /ACDB /MCB board along with fans, exhaust fans and lights of standard makes. All lighting points along with Fans, Lights shall be installed properly of standard makes.

x. Air Conditioner for Control Room cum Conference Room:

The control room shall be equipped with appropriate numbers of fans of Bajaj, Khaitan,Usha make for effective heat dissipation. The SCADA cabin shall have one (1) number split type air conditioning units of 1-ton capacity. Conference room shall have minimum 2 numbers of 1.5-ton capacity of split type of air conditioning unit. Make of the split type air conditioning units shall be of Samsung/ Voltas/ Videocon or Hitachi make.

xi. Conference room: Conference room shall have

i. Pantry unit of required size with platform and sink with proper plumbing fixture.
ii. False ceiling shall consist of 15mm thick mineral fibre having 600mm x 600mm tile size resting on silhouette grid. It shall be of Armstrong or equivalent make.
iii. Conference table: Conference table designed for 15 persons with 15 revolving chair of Godrej or equivalent make. It shall have electrical sockets at suitable intervals.

xii. RCC Store Room: Store room shall be of adequate size for storing the spares, equipments, T&P etc. It should have proper ventilation and having shelf arrangement for placing the spares, one table with three chairs and one almirah to store any expensive and delicate items ie. Control Cards & circuit boards etc.

xiii. RCC Office Room: Office room shall be of adequate size with all the amenities such as one no. AC, one table, one executive chair and three visitor chairs, two almirahs equipped with one no. PC of current configuration with table, printer with scanner and landline phone.

5.3.17 Toilets:

Two Toilet units, one for ladies and one for gents in Control Room cum Conference Room shall be constructed with following finish:

a. Floor : Vitrified tiles/ ceramic tiles

b. Dado: dado tiles shall be provided in Toilet units.

c. Door window: made out of aluminum sections, 6mm wired and float glass.

d. Ventilators: Mechanical exhaust facility with exhaust fans above it.

e. Plumbing fixtures : Jaquar/ DEE ESS/ Cera/ Perryware/ Kohler

f. Sanitary ware: Hindware/ Cera or equivalent make.

g. EWC: 390 mm high with health facet, toilet paper rolls holder and all fittings (for ladies and gents separately).

h. Two (2) numbers of Urinals (430 x 260 x 350 mm size) with all fittings of Cera/ Hindware make.

i. Wash basins: 02 Nos. (550 x 400 mm) with all fittings of Cera, Hindware make.

j. Bathroom mirrors (600 x 450 x 6 mm thick) hard board backing of Saint Gobain/ Godrej make in each bathroom.

k. CP brass towel rail (600 x 20 mm) with C.P. brass brackets for each bathroom.

l. Soap holder and liquid soap dispensers for each bathroom.

m. Water Supply for Pantry & Toilets: GI pipes (B class) Tata/ Jindal or make approved by the Company. Overhead water tank shall be of Sintex or equivalent make of 1,000-litre capacity with proper resting facility.

n. Drainage for Toilets: Drainage pipes shall be of PVC (6 kg/cm2) Supreme, Prince or equivalent make. Gully trap, inspection chambers, septic tank for 15 person separate for control cum conference room and also soak well to be constructed for above mentioned requirement.

5.3.18 Doors and Windows for Inverter rooms, Control room and Security Cabin:

Doors and windows shall be made of aluminum sections. All sections shall be 20 microns anodized. Sections of door-frames and window frame shall be of 1.2mm thick of Jindal, Tata or make approved by client. Door shutters shall be made of aluminum sections and combination of compact sheet and clear float/ wired glass. The control room shall require a sufficient number of windows/ louvers to provide ventilation/ fresh air circulations. All fixtures like door closure, handles, locks, stoppers for doors and windows shall be of Dorma/ Kich /Godrej make. All windows of conference room shall be covered by roller blind curtains.

5.3.19 Electrical Panel for Prefabricated Control Room cum Operator Room:

Electrical panels shall have electrical panel adequate inputs to take in from the centralized Push Button Switching Unit having suitable mimic with power flow indicator & status indicator of different PCU's. The Panel shall be floor-mounted type.

i All the measuring instruments such as feeder voltmeter, ammeter, frequency meter, Electronic Energy Meter (for measuring the deliverable units (kWh) for sale), selector

switches, Mimic etc. shall be in the front panel.

ii. All the Power cables shall be taken through backside of the Panel via sufficient /concrete cable trench and cable trays with cover at top.

iii. The Panel shall be fitted with suitable rating & size, HRC fuses/circuit breaker/isolators, indicators for all incomer and outgoing terminals, voltmeter & ammeter with suitable selector switches to monitor & measure the power to be evacuated.

iv. Nuts & bolts including metallic cubicle shall have to be adequately protected against atmosphere and weather prevailing in the area.

v. The dimension, weight, sheet thickness, painting etc. should be indicated by the Contractor. The bill of material associated with the equipment should be clearly indicated while delivering the equipment.

vi. Pre-fab Invertor Room shall be of adequate size and of standard manufacturer with sufficient lighting points and RCC cable trenches with covers and shall have exhaust chimney and also sufficient ventilation.

vii. All prefab invertor room/control room/conference room shall be layed on RCC plinth with sufficient foundation and Grad Slab. The plinth shall minimum 450 mm high from formation level of the plant.

viii. The Contractor shall provide to the Company detailed civil, electrical, plumbing, etc. drawings and equipment specifications for the inverter/ control room and take approval from client/consultant.

ix. The drawings of Panels with the make of components should be approved from the Company. All the design & drawing related to switch yard / interconnection with grid should be as per requirement of state electricity rules as approved by competent authority. Pre-fab structure shall have sufficient number of lighting point/ACDB/MCB boar.

x. The Contractor shall provide to the Company detailed civil, electrical, plumbing, etc. drawings and equipment specifications for the inverter/ control room and take approval from the Company.

5.3.20 Module Mounting Structure (MMS):

i. The MMS should be designed for an optimum tilt angle (fixed / season / single axis tracking) so as to meet the offered NEEGG. The angle should be systematically optimized for maximum energy generation throughout the year based on location and local weather variables for each module technology.

ii. The MMS should be safe, and designed to allow easy replacement of any module and easy access to the O&M staff. It should be designed for simple mechanical and electrical installation, should support Solar PV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly and there should be no requirement of welding or complex machinery at site.

iii. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from Solar PV panels at the same time it will withstand severe cyclonic storm with wind speed up to maximum 170 kmph.

iv. The structure shall be designed for simple mechanical and electrical installation. It shall support Solar PV modules at a given orientation, absorb and transfer the mechanical

loads to the ground properly. There shall be no requirement of welding or complex machinery at site and is strictly not allowed.

v. Seismic factors for the site to be considered while making the design of the foundation/ramming etc. or any technology. The design of array structure shall be based on soil test report of the site and shall be approved from the Company/ Consultant.

vi. Modules shall be mounted on a non-corrosive support structures (EPDM rubber gasket is to be provided as separator) which is mandatory. The frames and leg assemblies of the array structures shall be made of hot dip Galvanized steel per ASTM A123.
All modules have to be appropriately grounded using continuous copper conductor as per appropriate IS but not less than cross section area of 6 sq. mtr.

vii. In case of galvanization of structures, specific requirement for thickness of galvanization should be at least minimum 80 microns at any point of the galvanized structure. Galvanization shall be measure with elcometer or the material can be sent for testing laboratory. No averaging is allowed for measuring the thickness of galvanization. Inner side galvanization with same specification of any hollow components of module mounting structure is mandatory.

viii. All fasteners shall be of Stainless steel - SS 304. Nut & bolts, supporting structures including the entire MMS shall have to be adequately protected against all climatic condition.

ix. Modules shall be clamped / bolted with the structure properly. The material of construction shall be Al / Steel. Clamps / bolts shall be designed in such a way so as not to cast any shadow on the active part of a module.

x. Modules shall be isolated electrically from the MMS through EPDM sheet of appropriate thickness and all the modules shall be separately earthed through proper earthling. Module to module earthling is mandatory. All modules have to be appropriately grounded using continuous copper conductor as per appropriate IS but not less than Cross section area of 6 sq. meter.

xi. Module mounting structures shall also be earthed through proper separate earthing.

xii. The material of construction, structural design and workmanship shall be appropriate with a factor of safety of not less than 1.5.

xiii. For multiple module mounting structures located in a single row, the alignment of all modules shall be within an error limit of 5 mm in vertical / horizontal line. However, total 10 mm tolerance allowed for mounting structures fixed in single row but shall not be allowed for modules fixed in a single mounting structure.

xiv. The Contractor shall provide to the Company the detailed design, specifications and calculations of the MMS and take approval from the Company/Consultant.

xv. The Contractor shall specify installation details of the Solar PV modules and the support structures with appropriate diagrams and drawings.

xvi. The Module Mounting Structure design shall be certified by a chartered structural engineer and it is mandatory.

xvii. The Contractor 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) above highest flood level at the site and (ii) minimum 500 mm.

xviii. The structures shall be designed for simple mechanical and electrical installation. It shall

support solar PV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly.

xix. String Cables should be passes from Pipes and Cable-ties shall be used to hold and guide the Pipes (cables/wires) from the modules to inverters or junction boxes.

xx. The Contractor shall provide to the Company the detailed design, specifications and calculations of the MMS.

xxi. The Contractor shall specify installation details of the Solar PV modules and the support structures with appropriate diagrams and drawings.

xxii. The Bidder shall be permitted ramming of the module mounting structure provided that they obtain consent of HPGCL. HPGCL shall provide such consent once it is convinced that such ramming shall not in any way deteriorate the strength of the structure and shall not reduce the structure's strength to enjoy a working life of more than 25 years.

xxiii. Civil foundation design for Module Mounting Structures (MMS) as well as control room, invertor room shall be made in accordance with the Indian Standard Codes and soil conditions, with the help of Chartered Structural Designer having substantial experience in similar work. The Successful Bidder shall submit the detailed structural design analysis along with calculations and bases/ standards in the Bid.

5.3.21 Structural Steel Work:

i. The structural steelwork required for termination incoming 33 kV line/ Cable, equipment supports, lighting masts and for shielding towers together with all foundation bolts shall be included by the Bidder in its scope of work. The steel work shall be fabricated from galvanized structural sections. Specific requirement for thickness of galvanization should be at least/ minimum 80 microns at any point on any component of module mounting structure when measured.

ii. The height of structures for incoming line shall be as per the design developed by the Bidder and drawings submitted.

iii. The incoming line gantry shall be designed on the basis of ACSR conductor/ Cable considered in the design and also considering that terminal tower will be located at a distance of not more than 100 meters from the incoming gantry at SPV power station switchyard. The Bidder shall take into account wind load, temperature variation etc. while designing the gantry structure. The column shall be provided with step bolts and anti-climbing devices.

iv. The entire structural steel work shall conform to IS: 802. The Bidder shall furnish design calculations for approval by the Company before procuring the material.

v. All structure pertaining to 33 kV switchyard have to be applied outdoor with white paint (lime wash).

5.3.22 Hardware

i. 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 ACSR/ AAAC conductor as per design.

ii. All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching insulators