1. **SOLAR POWER PLANT**

1.1 General Scope of Work for Solar Power Plant.

1.1.1 The general scope of work involves Engineering, Procurement and Construction (EPC) of the grid-connected solar photovoltaic power plant with Plant Capacity of 1 MW.

1.1.2 The scope of work includes commissioning of the power plant. The Contractor shall construct and commission plant to deliver guaranteed plant performance.

1.1.3 Work includes Comprehensive Operation and Maintenance (O&M) of the plant wherein the plant shall generate at least equivalent to the Guaranteed Performance of Plant as defined in the concerned Schedule/ BOQ.

2. **CIVIL WORK:**

Design, fabricate, supply and installation of module mounting structures; civil footings / foundations of appropriate and anchoring of fixed tilt module mounting structure; work required for site development activities inclusive but not limited to area grading, excavation, cutting, filling and disposal of soil from site, levelling of land; RCC cable trenches & storm water drainage system, construction of room for inverter with electrical fixtures and proper air circulation, provide pipeline network with necessary control panel, pipe line, taps, flexible hoses etc. for washing of modules and gardening.

3. **MODULE MOUNTING STRUCTURE**

3.1 The technical specifications for mounting structures are as under :-

a. Support structure design and foundation or fixation mounting arrangements should withstand horizontal wind speed as per relevant IS Code/NBC.

b. The total load for roof top SPV should be less than 60 Kg/m².

c. The load bearing capacity and residual life of building must be checked and measures to strengthen structure, if required and economical, be taken.

d. The module mounting steel structure shall be Mild Steel Fixed Tilt as per IS 2061-1992 and galvanizing HDGI (Hot dip Galvanized) with 85 micron coating as per IS 4759 and should be designed as per the requirement of the installations and module configurations.

e. All fasteners, nut and bolts should be made of Stainless steel - SS 304 Grade, painted with rust free paint and should allow easy replacement of any module.

f. The minimum clearance of the structure from the roof level should be 300-400 mm.

g. The material shall be corrosion resistant and electrolytically compatible with material used in module frame.

h. The structures shall be designed to allow easy replacement of any module. Each structure should have angle of inclination as per the site conditions to take maximum insulation.

i. Modules shall be mounted towards south facing and at a suitable inclination (28°) to maximize annual energy output.

3.2 **FOUNDATION BASE**

The legs of the structures should be made with GI Channels and fixed with foundation as described in provisional lump sum.

a. Design calculation shall be done through STADD analysis and contractor shall submit the design review and approval of engineering in-charge.

4. **DC DISTRIBUTION BOARD (DCDB)**
a. DCDB shall be provided in between PCU and Solar Array. It shall have MCCB of Suitable rating for connection and disconnection of array section. It shall have meters for measuring Array voltage and Array current.
b. Type II Surge Arrestor should be incorporated for surge protection as per IEC 60364-5-53 with meters for measuring the array voltage and array current.
c. The DC distribution box shall be of IP65 rating made of thermo plastic/CRCA sheet.
d. The junction boxes shall have suitable cable entry points with cable glands of appropriate sizes for both incoming and outgoing cables.
e. Suitable markings should be provided on the bus bar for easy identification, and cable ferrules shall be fitted at the cable termination points for identification.

5. SOLAR CELLS AND PV MODULES

The technical specifications of PV Module for use in Grid Solar Power plants will be as under:

a. Supply, installation, testing & commissioning of SPV modules shall be on the Vendors scope.
b. The PV Modules used in the solar power projects must qualify to the latest edition of the International Electrotechnical Commission (IEC) PV module qualification test or equivalent BIS standards.
c. Solar PV minimum array capacity should not be less than 1 MW and should comprise of solar crystalline modules of minimum 320 Wp or more at standard test conditions, indigenously manufactured Solar PV Crystalline Silicon Terrestrial PV Modules IEC 61215 / BIS 14286.
d. The modules must conform to IEC 61730 Part 1 (Requirements for construction) & Part 2 (Requirements for testing for safety qualification) or Equivalent BIS.
e. PV modules to be used in a highly corrosive atmosphere (coastal areas, etc.) must qualify Salt Mist Corrosion Testing as per IEC 61701 / BIS 61701.
f. PV modules to be used in a sandy environment must qualify the IEC 600068-2-68 standards.
g. PV modules used in grid connected solar power plants must be warranted for output wattage, which should not be less than 90 % at the end of 10 years and 80 % at the end of 25 years.
h. The mechanical structures, electrical works and overall workmanship of the grid solar power plants must be warranted for a minimum of 5 years.
i. The V-I curve of each PV module with Sl. Nos. Should be submitted along with modules meeting the required specifications.

6. TEST CENTRES

a. The PV modules must be tested and approved by one of the IEC authorized test centres. In addition, a PV module qualification test certificate as per IEC standard, issued by ETDC, Bangalore or Solar Energy Centre MNRE will also be valid.

7. IDENTIFICATION AND TRACEABILITY

Each PV module must use a RF identification tag (RFID). The following information must be mentioned in the RFID used on each module. This must be laminated inside the panel and it must be able to withstand harsh environmental conditions.

(i) Name of the manufacturer of PV Module
(ii) Name of the Manufacturer of Solar cells
(iii) Month and year of the manufacture for solar cells and module individually
(iv) Country of origin for solar cells and module individually (Make in INDIA only)
(v) I-V curve for the module
PARTICULAR SPECIFICATION  
TECHNICAL SPECIFICATION

(vi) Peak Wattage, Im, Vm and FF for the module  
(vii) Unique Serial No and Model No of the module  
(viii) Date and year of obtaining IEC PV module qualification certificate  
(ix) Name of the test lab issuing IEC certificate  
(x) Other relevant information on traceability of solar cells and module as per ISO 9000 series.

8. JUNCTION BOXES

a) General Requirements IP 65(for outdoor)/ IP 21(for indoor) as per IEC 529  
b) The junction boxes are to be provided in the PV array for termination of connecting cables. The J. Boxes (J Bs) shall be made of GRP/FRP/Powder Coated Aluminium /cast aluminium alloy with full dust, water & vermin proof arrangement.  
c) All wires/cables must be terminated through copper cable lugs. The J Bs shall be such that input & output termination can be made through suitable cable glands.  
d) Copper bus bars/terminal blocks housed in the junction box with suitable termination threads Conforming to IP65 standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry.  
e) Single compression cable glands. Provision of earthing. It should be placed at 5 feet height or above for ease of accessibility.  
f) Each Junction Box shall have High quality Suitable capacity Metal Oxide Varistors (MOVs) / surge arrestors, suitable Reverse Blocking Diodes.  
g) The Junction Boxes shall have suitable arrangement monitoring and disconnection for each of the groups.  
h) Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification

9. TRANSFORMER

9.1 Dry/oil type relevant 1250KVA minimum capacity, 0.4KV/11 KV, 50 Hz Step up along with all protections, switchgears, Vacuum circuit breakers, cables etc. along with required civil work. The transformer shall conform in all respects to the relevant Indian/International standards specifications with latest amendment thereof, some of them are listed below:-

<table>
<thead>
<tr>
<th>Indian Standard</th>
<th>Title</th>
<th>International Std.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 2026</td>
<td>Specification for Power transformer</td>
<td>IEC 1  76</td>
</tr>
<tr>
<td>IS : 335/1983</td>
<td>Insulating Oil for transformer</td>
<td>BS 1  148</td>
</tr>
<tr>
<td>IS : 3639 : 1968</td>
<td>Fittings and accessories for power</td>
<td>ASTM D-1275</td>
</tr>
<tr>
<td>IS : 2099 : 1986</td>
<td>High voltage porcelain bushings</td>
<td>IEC 296-1969</td>
</tr>
<tr>
<td>IS : 7421-1988</td>
<td>Low voltage porcelain bushings</td>
<td></td>
</tr>
<tr>
<td>IS : 3347</td>
<td>Dimensions for outdoor bushings</td>
<td>DIN 42531 to 33</td>
</tr>
<tr>
<td>IS : 12444</td>
<td>Specification for copper wire rods</td>
<td>ASTM B - 49</td>
</tr>
<tr>
<td>IS : 5/1961</td>
<td>Specifications for colors for ready mixed paints</td>
<td></td>
</tr>
<tr>
<td>IS : 6600/1972</td>
<td>Guide for loading oil immersed</td>
<td></td>
</tr>
<tr>
<td>IS : 3202</td>
<td>Climate Proofing</td>
<td></td>
</tr>
<tr>
<td>IS : 2147</td>
<td>Degree of Protection</td>
<td></td>
</tr>
</tbody>
</table>

9.2 Transformers should have all necessary protection features like silica gel breather, Buchholz relay, pressure relief device, magnetic oil level gauge, oil temperature indicator and winding temperature indicator

9.2.1 Checking Oil and winding temperature and colors of silica gel in the breather & Cleaning monthly

9.2.2 Testing of main tank oil for BDV and moisture content on quarterly basis.
9.2.3 Lubricating/Greasing all moving parts of OLTC mechanism. 5. Measurement of IR values with suitable megger according with rating.

9.2.4 Physical examination of diaphragm of vent pipe for any crack.

9.2.5 Testing OLTC oil for BDV and moisture.

9.2.6 Testing of Oil for dissolved gas analysis, acidity, tan-delta, interface tension.

9.2.7 Measurement of DC winding resistance.

9.2.8 Turns ratio test at all taps.

9.2.9 Over haul of tap change mechanism.

9.2.10 Changing the gasket set allocation as when leakage is found or gasket damaged.

9.3 TYPE & TEST CERTIFICATES

(A) TYPE TESTS:

(i) All the equipments offered shall be fully type tested from NABL Accredited Laboratory as per relevant ISS & technical specification.

(ii) The following type tests shall be carried out on the transformers in accordance with ISS: 2026/1977 as amended from time to time:

(a) Short Circuit Test.
(b) Lightening Impulse Voltage withstand test.

The rating and terminal marking plate shall exhibit the following details:

1. Make of Transformer.
2. Manufactured by M/s.
3. Type of Transformer - Conventional Type
5. KVA Capacity (Conv.)
6. Type of cooling ONANé é é ..

Volts at HV Frequency Hz 50
No Load LV Impedance Volts %
No Load Amperes HV Vector group
Ref. LV Core & winding wt. in Kgs.
Phases HV Wt. of oil in Kgs.
LV Total wt. of X-mer in Kgs.
Makers S. No.
Oil in Ltrs.
Date of despatch
Untanking Wt. in Kgs.
Guarantee maximum temperature rise in oil 45°C.

9.4.1 INDOOR TYPE INVERTER:

One number of CENTRAL INVERTER UNIT

The output of the inverter system is to be connected with the grid at 11 KV system. The bidder /contractor should select the inverter (Central) as per its own system design so as to optimize the power output.

The technical specifications for inverter are as under:

(i) Nominal Voltage 415 v +/- 10 %, 3 phase, 50 Hz
(ii) Control Micro processor/ DSP
(iii) Switching Device IGBT / MOSFET
PARTICULAR SPECIFICATION
(TECHNICAL SPECIFICATION)

(iv) Grid freq. Synchronization +/− 3 Hz or more
(v) Ambient temperature -20°C to +50°C
(vi) Humidity 95 % non-condensing
(vii) Protection of enclosure IP 20 (Indoor rated)/IP 65 (Outdoor rated)
(viii) No load losses < 1% of rated power
(ix) Inverter Efficiency >97 % (without inbuilt galvanic isolation)
>93 % (with inbuilt galvanic isolation)
(x) Power Factor Control Range >0.9 lead or lag
(xi) THD < 3 % (at rated power)
(xii) Maximum Input voltage THD1000 V DC
(xiii) Maximum Noise Level 75 dB DC injection Less than 0.5% of nominal load current 75 dB standards.
(xiv) Inverter should have internal protection arrangements against any sustainable fault in feeder line and against the lightening on feeder.
(xv) Should have insulating transformer.
(xvi) Inverter generated harmonics flicker, DC injection limits, Volt range, frequency range and anti-islanding measures should follow latest CEA Guidelines / IEC 62116 / BIS Code.

9.4.1.2. 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

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

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

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

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

9.4.1.3. Earthing of Inverters:

DC side of each inverter shall be earthed to distinct earth pit through adequate size conductor as per IS 3043-1987. The size of conductor shall be as per the maximum fault current of DC system.

9.4.2. Technical requirements of PCU

PCU shall confirm to the following standards and appropriately certified by the Signature of Bidder labs:

i. Efficiency measurement: IEC 61683 / IS 61683
ii. Environmental Testing: IEC 60068-2 / Equivalent IS
iii. Product safety: IEC 62109 (1&2)
PARTICULAR SPECIFICATION
(TECHNICAL SPECIFICATION)

v. Interconnection PV Invertors: IEC 62116
vi. Electromagnetic Interface : IEC 610002, 3, 6
vii. Ingress Protection : IP 54 & IP 21
viii. Batteries: As per relevant BIS Std.
ix. Cables : IEC 60227 / IS 694 (UV resistant, DC rated, plug & play)
x. Earthing / Lightening : IEC 62561 / IS 3043 : 1986
xii. Circuit Breakers : IEC 60947 1, 11, III / IS 60947, EN 50521
xiii. Junction Boxes & Enclosures : IP 65/ IP 21
xiv. Meters : As per DISCOM guidelines / IS 16444
xv. Grid Connectivity : As prevalent in the state / as per CEA / CERC regulation & grid code (amended upto date)
xvi. EMC, harmonics, etc.: IEC 61000 series, 6-2, 6-4 and other relevant Standards.
xvii. Recommended practice for PV - Utility interconnections: IEEE standard 929 -2000 or equivalent
xviii. Protection against islanding of grid: IEEE1547/ UL1741/ IEC 62116 ore equivalent
xix. Reliability test standard: IEC 62093 or equivalent

9.4.2.1. 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) < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%
- Optional VAR control
- Unit wise & integrated Data logging
- Dedicated Prefabs / Ethernet for networking

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

i. DC power input
ii. DC input voltage
iii. DC Current
iv. AC power output
v. AC voltage (all the 3 phases and line)
vi. AC current (all the 3 phases and line)
vii. Power Factor
viii. Inverter on
ix. Grid on
x. Inverter under voltage/ over voltage
xi. Inverter over load
xii. Inverter over temperature

9.4.2.3 Documentary Requirements & Inspection

i. The bill of materials associated with PCUs should be clearly indicated while delivering the equipment.
ii. 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.
iii. The Employer or its authorized representative reserves the right to inspect the PCUs/Inverters at the manufacturer's site prior to dispatch.

9.5. METERING – Energy accounting

a. Bidder shall provide ABT compatible interface meters as main meters based on voltage, point and period of supply and tariff category.

i. As per provisions of Grid code Part -5, Section 16, clause 16.12.2., two sets of high precision ABT compatible energy Meter/Import-Export Meter of Class 0.2s with associated set of metering equipments are to be installed at generating point.

ii. For 33Kv generator, 2 Nos. Of combined CT-PT units of Class 0.2s accuracy shall be provided by the developer at point of injection to serve to main meters and check meters for billing purpose, at developers cost.

iii. The developer has to get the equipment tested as per Annex:V from Central Power Research Institute (CPRI) or any National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited lab before installation at site, as per parameters defined in MPEGC Part-5, Sec-16.

iv. The GM (O&M/City) shall have to certify the meters, metering equipments as per grid standards in consultation with meter testing division before installation at site.

v. Main meter shall always be maintained in good condition at developers cost.

vi. Main meters shall always be maintained in good condition and shall be open for inspection by any person authorised by the nodal agency.

vii. The concerned licensee may provide check meters of the same specifications as main meters.

viii. The main and check meters shall be periodically tested and calibrated by the concerned licensee in the presence of other party involved. Main and check meters shall be sealed by both parties. Defective meter shall be replaced immediately.

ix. Reading of main and check meters shall be taken periodically at appointed day and time by authorized officer of the concerned licensee, the generator and the customer or his representative, as the case may be.

x. Meter reading shall be communicated to SLDC, the open access customer, and the generating company or trader, as the case may be, by the licensee, within 24 hours of meter reading.

xi. Readings of the check meters shall be considered for billing purposes when main meters are found to be defective or stopped.

xii. Both the main meter and check meter shall be tested for accuracy if difference between the readings of main and check meters vis-à-vis main meter reading exceed twice the percentage errors permissible for relevant accuracy class.

xiii. If an open access customer requires the licensee to provide main meters he shall provide security deposit to the licensee and shall pay for hiring charges. The meter shall be maintained by the licensee.

xiv. Meters shall be provided as per CEA Regulations.

xv. The location of meter and height of meter display from floor shall be as per Indian Standard on Testing, Evaluation, Installation and Maintenance of ac Electricity Meters i Code of Practice.

xvi. For outdoor installations, the meters shall be protected by appropriate enclosure of level of protection specified in the Indian Standard on Testing, Evaluation, Installation and Maintenance of ac Electricity Meters i Code of Practice.

xvii. Acceptance Test For ABT Meters

xviii. Limits of error as per IS 14697:1999.

b. Influence Quantity test for voltage, current and frequency variation as per IS 14697:1999.
c. Capability of recording frequency in every 15 minutes. Load survey data of meter may be verified.

d. Capability of meter for recording of Reactive High & Reactive low parameters with voltage range as defined in ABT regime (Reactive High for voltage > 103%, Reactive low when voltage is < 97%).

e. Recording of Import and Export energy for every 15 Min.

f. Recording of midnight energy for Active and Reactive Parameters.

g. For Metering Equipment

i) 33 Kv CT

   a. Accuracy test (determination of Error)
   b. Verification of terminal polarity.
   c. OVIT Test.
   d. HV test on secondary winding.

ii) 3 phase 33 Kv PT

   a. Accuracy test (determination of Error).
   b. Verification of terminal / polarity.
   c. High Voltage power frequency test on secondary winding.
   d. Induced over voltage test.

9.6. SCADA – Data Monitoring & Acquisition

(i) SCADA system of PCU shall clearly depict the single line diagram of the plant on the monitor. Mimics shall be provided with radio buttons to show the following parameters:

   a. Solar radiation (W/m2)
   b. PV module back surface temp
   c. Ambient temp
   d. Inverter output power (3 phase)
   e. Line and phase currents
   f. Cumulative energy exported

(ii) SCADA system shall perform following control operations :-

   a. Inverter ON/OFF
   b. Set point editing through a proven password mechanism
   c. Mimic control through PC keyboard operation

(iii) SCADA shall also conform to following features :-

   SCADA system shall incorporate integrated system control and data acquisition facilities. The use of a local operator interface and latest technology features shall be incorporated to enable viewing of instantaneous parameter metering, changing of operator modes and review of system logged events.

   Further, with PC based latest software technology, solar plant shall be monitored remotely via satellite link.

   The major SCADA features incorporated in to the control system are listed below.
a. Operator interface of latest technology: Instantaneous grid, array, inverter, AC, and metering of all parameters.
b. Integrated AC, DC data point logging: Instantaneous logging of all parameters. Including AC parameters, generator run hours and energy details.
c. Fault and system diagnostics with time stamped event logging.
d. Selectable event logging resolution for enhanced diagnostics.
e. Remote SCADA features with specific needs of station monitoring and remote communication.
f. Remote system access software, secured transmission of data and central PC facility.

9.7. LT PANEL

i. LTP DB shall have EDO ACBS (Electrically operated Draw Out Air Circuit Breaker) for ensuring necessary isolation between PCU and transformer.

ii. ACB is microprocessor based electronic trip (ET) systems with thermal memory, overload, short circuit protection and also has protection against earth leakage faults.

iii. LTPDB also equipped with Transient Voltage Surge Suppressor (TVSS) for protection against transient voltage surges.

iv. Digital Ammeter and Digital Voltmeter with their inbuilt selector switches and Digital Load manager which performs as a multifunction meter shall be provided on the front side of the cubicle.

v. LTPDB is also provided with a Breaker Control Switch for electrically operating the ACB. NO and NC contacts for ACB are provided to communicate the On, OFF and Trip status to SCADA.

9.8. HT PANEL

i. The 33 Kv from HV side of the transformer shall be fed to grid with proper metering, protection and switchgear which can be done by Metering, Relays and Circuit Breakers located in HT panels. In power plants at all three locations, one outgoing VCB to grid and one Bus PT panel for measurement of bus voltage and protection against abnormal bus voltages.

ii. All these HT panels shall be combined with a common bus bar which is internally connected among these panels.

iii. These HT panels shall be mounted on a well constructed and raised platform located in switch yard area. In addition to these HT panels, a Remote Annunciation Panel (RAP) shall be provided for remote monitoring and control of HT panels which is located inside control room.

iv. Each Vacuum Circuit Breaker (VCB), Current transformer (CT), Relays and Metering equipment like Digital Ammeter and Load Manager. Bus PT panel comprises of Potential Transformer, Over voltage and Under voltage relay and Digital Voltmeter.

v. Enough space shall be provided on either side of the HT panel for future expansion.

vi. Protective Relays:

a) Over current and Earth fault relay: A microprocessor based numerical relay for protection against instantaneous/ IDMT faults like over current, short circuit current, overload, earth faults and instantaneous earth faults should be used.

b) Master Trip Relay: This relay is the main relay which activates the trip circuit of the breaker upon the trip signals received by other relays.

c) Trip Circuit Supervision Relay: This relay is also of electro mechanical type and this supervises whether the trip circuit is healthy or not.

d) DC Failure Relay: Whenever DC supply fails to HT panels, this relay gets activated and indication will be given in HT panels and alarm and indication will be given in RAP.
PARTICULAR SPECIFICATION
TECHNICAL SPECIFICATION

e) Transformer Alarm Relay: This auxiliary relay is meant for Transformer protection and gives alarm against faults occurred in transformer such as Buchholz relay alarm, OTI alarm and WTI alarm.

f) Transformer Trip Relay: This relay is for actuating the breaker to trip against trip signals from transformer for Buchholz relay trip, WTI trip and OTI trip.

g) Transformer Alarm/Trip Relay (Tat): This relay is meant for both alarm and trip signals from transformer against PRD alarm, PRD trip and LOLA alarm faults.

h) Metering Equipment: Digital Ammeter with inbuilt selector switch and Load Manager shall be provided in incomers and outgoing panels.

i) Bus PT Panel: Bus PT panel is a separate panel adjacent to incomers and outgoing feeders, connected to bus for measuring the bus voltage and to protect against abnormal bus voltages. The core meant for measurement is connected to Digital Voltmeter with inbuilt selector switch and other core which is protection core is connected to Over voltage/Under voltage relay.

j) Remote Annunciation Panel (RAP):
   - RAP is provided to monitor and control the HT panels remotely i.e., from control room to ensure the reliability and safety for the operating personnel. This cubicle shall have number of windows for displaying all types of faults and those windows turns red on fault. Out of these windows, there will be separate indications meant for Incomer -1, Incomer -2, for outgoing panel, for Bus PT and some left as spare.
   - RAP also equipped with buzzers to give alarm on faults. Out of these, one works on DC supply and other works on AC supply. 110V AC supply is required for windows and buzzer. 1-phase 230V AC supply is required for buzzer for DC failure, space heater and panel illumination lamp.
   - RAP shall have Indication lamps each for incomers and outgoing panels to indicate its status like VCB On, VCB Off, Test position, Service position Trip circuit healthy, DC fail and Spring charged condition. RAP will also have three Breaker Control Switches (BCS) for remote control of incomers and outgoing HT panels.

vii. VCBs of HT panels can be tripped or closed using these switches. But, the operation of these T-N-C switches depends on the electrical interlocks that shall be made among the incomers and outgoing panel.

viii. Earthing Truck:

    Earthing trucks are provided along with the HT panels, even though these are not a part of power flow in the plant, because these panels are meant for protecting the working personnel performing maintenance on HT panels. When operator performs maintenance works on bus bar of HT panels gets electrified if any one closes the downstream breaker. So, to avoid such instances, earthing trucks for bus bar earthing are provided in the place of outgoing breaker to earth the power supply immediately and it also produces alarm and indication for operator. For this, a 3 phase PT is provided to sense the voltage for indicating and for buzzer when the line gets power supply. Cable earthing trucks are used in the place of incomers and bus bar earthing trucks are used in the place of outgoing panels for safe maintenance on the bus bar and HT panels. The necessary DC supply will be provided through battery and battery charger to the HT panel.

9.9. EARTHING SYSTEM

Grounding as per IS 3043: 1986

a. Each array structure of the PV should be grounded properly.
b. All metal casing/shielding of the plant should be thoroughly grounded in accordance with Indian electricity Act./IE Rules.
c. All the earthing in the plant shall comply with IS 3043 -1987 reaffirmed in 2006
d. A minimum of two separate dedicated and interconnected earth electrodes must be used for the earthing of the solar PV system support structure with a total earth resistance not exceeding 01 ohms.

e. The earth electrodes shall have a pre-cast concrete enclosure with a removal lid for inspection and maintenance. The entire earthing system shall comprise non-corrosive components.

9.10. LIGHTNING ARRESTORS

a. The lightning arrester shall be heavy duty station class type, discharge class III, conforming to IEC specification

b. The required number of suitable lightning arrestors shall be installed in the array field.

c. Lightening protection shall be provided by the use of metal oxide varistors and suitable earthing such that induced transients find an alternate route to earth.

d. Protection shall meet the safety rules as per Indian Electricity Act.

e. Concrete foundation for holding the lightning conductor, in position, to be made after giving due consideration to maximum wind speed and maintenance requirement at site in future.

9.10.1. Cables and Wires

All cables and connectors to be used for installation of solar field must be of solar grade which can withstand harsh environment conditions for 25 years and voltages as per latest IEC standards.

9.10.2. DC CABLE

The DC Cables in a solar PV plant to be used in the following areas :-

a. Interconnecting SPV modules
b. From SPV Modules upto String Monitoring Unit(SMU)
c. From SMU upto the Inverter

9.10.3. HT CABLE

HT cable should meet following specifications and requirements as given in 7.10.4 below.

9.10.4. CODES

i. IS : 7098 Cross linked polyethylene insulated PVC sheathed cable for (Part - II) working voltage from 3.3KV upto & including 33 KV

ii. IS : 3961 Recommended current ratings for cables

iii. IS : 3975 Low Carbon Galvanized steel wires, formed wires and tapes for armouring of cables.

iv. IS : 4905 Methods for random sampling.

v. IS : 5831 PVC insulation and sheath of electrical cables.

vi. IS : 8130 Conductors for insulated electrical cables and flexible cords.

vii. IS : 10418 Specification for drums for electric cables.

viii. IS : 10810 Methods of tests for cables.

ix. ASTM-D -2843 Standard test method for density of smoke from the burning or decomposition of plastics.

x. ASTM-D-2863 Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.

xi. IEC-754 (Part-I) Test on gases evolved during combustion of electric cables.


xiii. IEC -332 Tests on Electric cables under fire conditions.

xiv. Part-3 : Tests on bunched wires or cables (category -B)
9.11. LT CABLE

a. Cabling on AC side (LT)

LT Power Cable shall be 1.1 kV, Armoured, unearthed grade, double core/multi-core, stranded Cu/Al conductor as mentioned, XLPE insulated with PVC outer sheath made on PVC compound. All other details shall be as per Indian Standards, IEC 60189: IS 694/ IS 1554/IS/IEC 69948.

b. All electrical cables / wires to be laid/fixed in Conduit.

c. Proper laying of cables shall be ensured in appropriate cable trays, pipes / trenches as per site requirement.

9.12. SURGE PROTECTION DEVICES

Surge Protection Devices for protection against surge currents and voltages shall be provided. Internal surge protection shall consist of three MOV type surge-arrestors connected from +ve and -ve terminals to earth. Surge Protection Devices (SPD) should conform to IEC 61643-12 and shall have discharge capability of at least 10 kA at 8/20 micro second wave.

9.13. CONNECTORS

Connectors should have the specifications as under :-

1000V (IEC/CEI), 600V (UL), with safety clip that requires a tool to unlock (NEC2008 compliant) certified for applications with modules according to IEC 61730, Safety class II, Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment -with Minimal voltage drop, High current-carrying capacity, Minimal power loss, Minimal contact resistance, High durability contacts withstand up to 1 million mating cycles, Operating temperatures up to 350°C,higher temperatures permitted for short periods.

9.14. CCTV

CCTV Cameras along with monitoring stations (sufficient numbers) and all other accessories required for its proper operation must be installed to have complete coverage of the following areas :-

(i) Main entry: Covering all the entry/exit for 24 hrs
(ii) Along the Plant Perimeter: Covering complete perimeter of Plant Area to capture all possible intrusion
(iii) Control Rooms: Covering Entry/Exit and activities within Control Rooms. Contractor has to propose the locations and number of cameras required for the Plant during bidding, however Employer’s decision on number of cameras shall be final.
(iv) Monitoring stations of the CCTV Network shall be installed in Main Control Room.
(v) 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.
(vi) Camera shall be colour, suitable for day and night surveillance (even under complete darkness) and network compatible.
(vii) It should 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.

(viii) The system shall support video analytics in respect of the following:
   a. Video motion detection
   b. Object tracking
   c. Object classification

(ix) 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

9.15. WEATHER MONITORING STATION

The contractor is required to install necessary equipment to continuously measure the Solar Radiation and other climatic conditions through a weather monitoring station.

The major categories of site-specific assessment required are :-
   a. Global Solar Radiation (GSR)
   b. Diffuse Solar Radiation (DSR)
   c. Sunshine Duration
   d. Atmospheric Turbidity
   e. Temperature & Humidity
   f. Wind Speed

Simultaneously, measurement of the generation of DC power as well as AC power from the plant must be done. Such measurement facility should be placed as close as possible to the solar plants. A common measurement facility may be allowed to be used by the plants located within a radius of five kilometres from this facility. Online arrangement would have to be made by the Developer for submission of above data on regular basis.

9.16 TELEMETRY DATA TRANSMISSION SYSTEM

Bidder shall install Telemetry system for real time data monitoring by MP SLDC.

The Data Acquisition facility (Telemetry) for transfer of telemetry data to SLDC/Sub LDCs should be established along with communication facility in accordance with the guidelines of State Load Dispatch Centre, JABALPUR.

   a. The ABT meters should have AMR facility for providing meter data to SLDC. To do this one has to install modem and SIM (capable of working on both GPRS & GSM network) enabled at the interface point and integrating the meters with the AMR system of Secure make installed at SLDC which has the static IP address 117.239.195.194, for data transfer between energy meter and AMR system at SLDC over the GSM/GPRS communications network.

   b. The integration of ABT meters with AMR system could be done with the help of M/s Secure or any other competent vendor. After integration of ABT meters with AMR system, one has to obtain a confirmation from SLDC that the meters are integrated with AMR system and data of ABT meters are being successfully downloaded through AMR system.

   c. DC Battery & Charger

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

9.17. 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.

9.18. POWER EVACUATION

The evacuation voltage shall be at 33 kV AC (three phase) wherein evacuating point cum metering point shall be installed at 33 kV interconnection point within the boundary of solar plant.

ABT meter to measure net power evacuation shall be installed at 33 kV interconnection point on four pole structure near solar PV plant boundary.

9.19. CODES AND STANDARDS:

<table>
<thead>
<tr>
<th>CODES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 94 V</td>
<td>Fire Resistant/ flammability</td>
</tr>
<tr>
<td>UL 746C</td>
<td>UV Resistant</td>
</tr>
<tr>
<td>IEC 62262</td>
<td>Mechanical Impact Resistance</td>
</tr>
<tr>
<td>IS 2147/IEC 60529</td>
<td>Enclosure Protection</td>
</tr>
<tr>
<td>IEC 61643-12</td>
<td>Surge Protection</td>
</tr>
<tr>
<td>IEC 62208</td>
<td>Enclosure for low voltage Switchgear and control gear assemblies</td>
</tr>
</tbody>
</table>

NOTE: 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.

9.20. OPERATION & MAINTENANCE

Bidder shall be responsible for Comprehensive operation & maintenance of the SPV plant as per Sch A. After successful operation of plant for 11 MONTH after commissioning towards performance demonstration, as detailed in technical specification including supply and storage of all spare parts, consumables, repairs/ replacement of any defective equipment etc.

i. Deputation of qualified and experienced engineers for taking care of O&M activities.
ii. Cleaning of Solar Module on weekly basis and wipers can be used to remove the accumulated dirt and bird droppings.
iii. Task of the operators is to check periodic logging of the voltage, current, power factor, power and energy output of the Plant. The operator shall monthly record the energy output, down time, etc.
iv. Monitoring the performance of the Solar Power Plant and regular maintenance of the whole system including Modules, PCUs, transformers, overhead line, outdoor/indoor panels/ kiosks etc. are necessary for extracting and maintaining the maximum energy output from the Solar Power Plant.

9.20.1. Performance parameters:
The Plant performance will be evaluated through Performance Ratio (PR) test as per
IEC 61724 and as per the Capacity Utilization Factor (CUF).

The initial acceptance of the Plant will be evaluated during commissioning by
measuring PR for continuous 7 days. However, contractor must demonstrate the PR
for a period of 30 days as per the PR test procedure.

During O&M contract, the Plant performance will be evaluated based on annual
Capacity Utilization Factor. Second year onwards linear degradation of the module
output (i.e., 0.80% of DC capacity at STC per year) shall be considered for the
calculated CUF every year.

Solar modules must have the rated output of not less than 80% by the end of 25th year
and not less than 90% by the end of 10th year of operation as per MNRE standards.
Manufacturer test certificates shall be submitted.

During the O&M period, the bidders need to maintain 90% uptime of the Plant to
achieve the proposed CUF at the end of each year. Any routine repair, replacement,
overhauling, etc. are to be performed during night times so that no generation loss will
be there in day time.

Bidders are expected to make their own study of solar radiation profile and other
related parameters of the area & make sound commercial judgment about the
Performance Ratio and CUF. It shall be the responsibility of the Bidder to assess the
corresponding solar insolation values and related factors of solar Plant along with
expected grid availability.

The Bidder should access all related factors about the selected Site for the Project
before giving commitments of PR and CUF of the proposed Project. The Contractor
shall be responsible for achieving required PR and CUF.

9.20.2. The bidders are free to install additional DC capacity any time during O&M period, with
proper consent by the Employer, to meet the desired performance parameters with no
additional cost to the Employer.

9.20.3. WARRANTY

The mechanical structures, electrical works including power conditioners/ inverters/
charge controllers/ maximum power point tracker units/ distribution boards/ digital
meters/ switch gear/ storage batteries, etc. and over all workmanship of the SPV
power plants/ systems must be warranted against any manufacturing/ design/
installation defects for a minimum period of 05 years.

9.21. COMMERCIALS OF SOLAR POWER PLANT AS PER CERC - CENTRAL ELECTRICITY
REGULATORY COMMISSION

The benchmark capital cost norm for Solar PV projects for FY 2016-17 shall be INR 530.02
lakhs/MW, with breakup is as follows:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Particulars</th>
<th>Capital Cost</th>
<th>% of Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PV Modules</td>
<td>328.39</td>
<td>61.96%</td>
</tr>
<tr>
<td>2</td>
<td>Land Cost</td>
<td>25</td>
<td>4.7%</td>
</tr>
<tr>
<td>3</td>
<td>Civil and General Works</td>
<td>35</td>
<td>6.6%</td>
</tr>
<tr>
<td>4</td>
<td>Mounting Structures</td>
<td>35</td>
<td>6.6%</td>
</tr>
<tr>
<td>5</td>
<td>Power Conditioning Unit</td>
<td>35</td>
<td>6.6%</td>
</tr>
</tbody>
</table>
10. **MANNING AND OPERATION OF SOLAR PLANT**

10.1 The Schedule lists out the items in brief and further amplified in succeeding Paras for efficient, smooth functioning of the system to meet the end use of satisfactory maintenance of plant.

10.2. The contractor shall advise his operating personnel to take all precautions and always be alert so as to prevent any accident. In case of any accident/injury, or partial disability, the contractor shall be solely responsible for setting all claims / compensation. Department will have a right to recover any sum indicated / claim by labour commissioner / Court directives. Contractor may get his personnel insured as desired by him at his own discretion & expenditure.

10.3. The tradesman deployed shall be ITI qualified and suitable experience in the field and assistant/helper shall be high school qualified with 5 years experience in relevant field and shall be able to maintain all documents. The contractor shall submit details of qualifications & experience before commencement of the work for approval of Engineer-in-Charge. Being Defence installation the contractor shall ensure the antecedents of personnel are known.

10.4 The plant operator will be responsible for the following:-

(a) Operation of Central AC plant including AHU, cooling tower, pump sets, electric panel & all connected equipments of central AC system.

(b) Maintaining of log sheets.

(c) Find out the faults and rectify.

11. **OPERATION ON COMMENCEMENT OF CONTRACT.**

11.1. The installations with an inventory of various items, equipment & electrical / sanitary fittings will be handed over for proper accounting & upkeep. The taking over on expiry of contract shall be all as per inventory and any damage/loss shall be made good by contractor before payment of final bill. GE's decision will be final and binding.

11.2. The tenderer shall submit names & addresses of the workers to be employed with their qualifications and police verifications for operation & maintenance of the plant for providing security passes by Engineer-in-Charge after necessary scrutiny/check by the Security Agency. In requirement, contractor shall get the same & no extra amount is deemed to be paid on this account.

11.3. The installation standing order issued by GE/Engineer-in-Charge will be strictly adhered to, any violation by the contractor's side will be severely dealt with including handing over them to police custody specially if any individual is found in intoxicated condition. Contractor shall ensure & strictly warn the individual on this account.

11.4. The installations is totally under the control of contractor with adequate space for stores, spares and T & P required for operation and maintenance. Plant shall be kept fully functional and contractor shall ensure replacement immediately at no extra cost to department.

11.5. The installation shall be frequently visited by the MES officer and need to emphasis for proper upkeep in a presentable state all the time. Surrounded areas in the fenced are up to 6 meter all round plant room shall be cleared of bushes / shrubs and grass to give a neat & clean appearance of the area under contractor's control.

12. **MAINTENANCE OF RECORDS:-**
12.1. The contractor shall be fully conversant with the daily, monthly, checks/ maintenance need on various equipment installed.

12.2. The operating staff shall maintain the following neatly:—

(a) Daily log sheet as per Performa.

(b) A register of record of periodical maintenance carried out date wise and will be signed both by contractor and Engineer-in-Charge.

(c) Necessary daily log sheets and periodical register shall be provided by the contractor without additional cost and quoted rate is deemed to include for the same and the register will become the property of the Govt.

(d) Attendance register and duty roaster.

12.3 **GENERAL:**

12.3.1. Blank

12.3.2 The particulars & state of installation covered under scope of the M & O Schedule are known to contractor since the same has been provided by him.

12.3.3. The staff on shift duty engaged for operating and maintaining the installation shall neither leave any installation unattended nor leave the premises unattended under any circumstances.

12.3.4. If during surprise checks by the representative of department, staff found missing during operating timings or installation found running un-attended, a penalty @ Rs 1000 /- per Hrs shall be recovered from the dues of contractor. More-over for the defects (not functioning of plant) shall be made good by the contractor at his own cost.

12.3.5 The contractor shall be personally responsible and shall instruct his staff to control the operations of the installations.

12.3.6 No unauthorised person will be allowed to enter the premises under security fencing.

13. **DRESS CODE** :

The operator engaged by contractor for the operation of plants (3 nos.) shall wear the dress as directed by Engineer in-charge. Pant and shirt shall be of similar colour for the entire operator. The name plate in black background and name written in white letter shall be worn by the operator on left side of the chest. The contractor shall be responsible to provide proper dress to all operators.

14. **SENSOR:** Contractor shall provide suitable nos. of RTD type temperature sensors with required weather shield as per Indian Standards, 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.

14.1. 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 shall be produced during one month of the installation.

14.2. 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. Contractor shall provide Instrument manual in hard and soft form.

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

14.4. 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.
14.5. All data shall be recorded chronologically date wise. The data file shall 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.

14.5. The Contractor shall submit the data sheet with technical specifications of the RMS system.

14.6. The PC shall be of Industrial type, rugged & robust in nature to operate in a hostile environment. The PC shall have minimum Intel Core 2 Duo processor having 2 x 150 GB HDD with 2 GB RAM. The PC shall also have 176 TFT Colour monitor, DVD Drive with Writer, Floppy Drive, USB drive, Scroll Mouse and UPS for 4 hours Power back up.