Request for Quotation

Engineering, Procurement, Construction, Commissioning (EPC) and Operation and Maintenance (O&M) for two years for Rooftop Solar Photovoltaic Project at ISRPL, Panipat, India

Indian Synthetic Rubber Private Limited

August 2021

P0026750 Rev02

Contents

1 Bid Information Sheet

Table 1: RfQ for EPC and 2 years O&M of 2,918 kWp Rooftop Solar PV Plant

<table>
<tr><th>Document Description</th><th>Particulars</th></tr>
<tr><td>Site survey date</td><td><table><tr><td>Date</td><td>Time</td></tr><tr><td>24th Sept. 2021</td><td>10:00 AM to 5:00 PM</td></tr><tr><td>25th Sept. 2021</td><td>10:00 AM to 5:00 PM</td></tr></table>(Note: Contractor is requested to intimate the site survey date in advance to ISRPL)</td></tr>
<tr><td>Pre-bid Conference shall be at Virtual platform</td><td><table><tr><td>Date</td><td>Time</td></tr><tr><td>29th Sept. 2021</td><td>Slot1: 09:30 Hrs, Slot2: 11:30 Hrs
Slot 3: 14:00 Hrs Slot 4: 16:00 Hrs</td></tr><tr><td>30th Sept. 2021</td><td>Slot1: 09:30 Hrs, Slot2: 11:30 Hrs
Slot 3: 14:00 Hrs Slot 4: 16:00 Hrs</td></tr><tr><td>01st Oct. 2021</td><td>Slot1: 09:30 Hrs, Slot2: 11:30 Hrs
Slot 3: 14:00 Hrs Slot 4: 16:00 Hrs</td></tr></table>Mode: Video conferencing (MS Team, ZOOM etc.)

(Note: Contractor is requested to pre-book the date and time slot with ISRPL for the pre-bid conference)</td></tr>
<tr><td>Last date & Time of Submission of Response</td><td>Date: 9th Oct. 2021
Time: 17:30 Hrs</td></tr>
<tr><td>Contact person details for the tender</td><td>Mr. Varinder Kumar (For commercial queries)
E-Mail: varinder.kumar@isrpl.co.in
Mobile No: 7087026202
Desk Phone No: 0180-2529146
Mr. Sunil Hooda (for Technical Queries)
E-Mail: sunil.hooda@isrpl.co.in
Mobile No: 8930247864
Desk Phone No: 0180-2529502</td></tr>
<tr><td>Owner’s address for submission of Bids</td><td>Indian Synthetic Rubber Pvt. Ltd.
Opp. Naptha Cracker Polymer Terminal Gate,
P.O. Panipat Refinery, Panipat, Haryana-132140</td></tr>
</table>

2 Definitions and Abbreviations

In this "Bid Document" the following words and expression will have the meaning as herein defined where the context so admits:

Table 2: Definition

Terms	Definition
Applicable Laws	means the substantive or procedural laws of India, including all applicable legislations, acts, rules, notifications, guidelines, policy, laws, by-laws, statutes, orders, decrees, judgments, ordinances, directives, regulations, codes, requirements, permits, licenses, approvals, instructions, standards of any Government instrumentality, having the force of law.
Authorized signatory	shall mean a person authorized to represent the Bidder for this Bid.
Bid	Bid shall mean the Technical and Financial/Price Bid submitted by the Bidder along with all documents/credentials/attachments, formats, etc., in response to this tender, in accordance with the terms and conditions hereof.
Bid Deadline	Bid Deadline shall mean the last date and time for submission of Bid.
Bid Documents	Bid Documents shall comprise of the Request for Quotation and Contract.
Bid Security	Bid Security shall mean the security amount payable along with Bid.
Performance Security	Performance Security shall mean the irrevocable bank guarantee payable by successful bidder in accordance with Contract to be executed between Successful bidder and the Owner.
Bidder	Bidder shall mean Bidding Entity or a Consortium submitting the Bid. Any reference to the Bidder includes Bidding Entity / Consortium, Member of a Consortium including its successors, executors, permitted assigns and Lead Member of the Consortium jointly and severally, as the context may require;
Bidding Entity	Bidding Entity shall refer to such single entity, duly incorporated under the relevant Law, that has submitted the Bid in accordance with the provisions of this Bid Document;
CoD	CoD shall mean the commercial operation date for the Project.
Contract	means the agreement entered into between the Parties for execution of the Project Works & O&M for installation of 2,918 kWp and includes any amendments thereto made in accordance with the provisions hereof.
Contractor	Contractor shall mean the Successful Bidder which submits the Performance Security and executes the Contract with the Owner as per the terms & conditions specified therein in the Contract;
Day	means a calendar day and "year" means 365 days.
Designs	means the drawings and designs of the Works prepared by the Contractor in accordance with the Technical Specifications, the Owner's Requirements and other provisions of the Contract, in accordance with which the Contractor shall proceed with the execution of the Works.

Terms	Definition
Effective Date	Effective date is the date of signing of the Contract.
Owner	shall mean India Synthetic Rubber Pvt Ltd.
Letter of Award	Letter of Award" (LoA) shall mean the letter issued by the Owner to the Successful Bidder pursuant as per the provisions of this Bid document;
Notice Inviting Tender	Notice being issued in favour for submission of a Technical and Financial Bid in accordance with this RfQ
O&M	means Operation and Maintenance comprising of all designs, works, services and all the associated activities, including supply of Plant, Materials and other equipment, which are necessary for the Project O&M and as per the Bid documents
Plant Acceptance	means the check of Plant Acceptance criteria at the end of DLP
Project or Plant	means rooftop PV Plant of capacity 2,918 kWp which will work in grid connection mode.
Provisional Plant Acceptance	means the Performance Ratio test shall be performed after achieving CoD.
Site	means the Owner's premises where the Project will be installed.
Sub -Contractor	means any person appointed as a sub-contractor or a manufacturer or supplier of any goods, materials, equipment or services for the Works or any person to whom a part of the Works has been subcontracted in accordance with this Contract.
Subcontract	means any contract awarded to a Sub-Contractor.
Supplier	means any manufacturer who is engaged in the Business of Manufacturing Project Components and supplies all or part of Project components to the Project.
Total Contract Value	Shall mean the value quoted for undertaking the Project by Bidder as per the terms of the Bid documents.
Works	means all designs, works, services and all the associated activities, including supply of Plant, Materials and other equipment, which are necessary for the construction, erection, installation, testing and commissioning of the Project and includes rectification of Defects if any in the works.

3 Introduction

3.1 Background to Project

India Synthetic Rubber Pvt Ltd ('ISRPL' or 'the Owner') wishes to implement solar PV system in the premises of its manufacturing factory in Panipat due to both commercial and environmental reasons. Presently, the factory purchases electricity from Indian Oil Corporation Ltd. (IOCL).

The Owner plans to select a Contractor for Engineering, procurement, Construction and Commissioning (EPC) and two (2) years Operation and Maintenance (O&M) of rooftop solar project. The Successful Bidder will be required to execute the Project Contract with the Owner as per the agreed terms and conditions as specified in the Contract. The Successful Bidder will be required to undertake EPC of the Project considering the buildings specified by the Owner and provide O&M for two (2) years post commissioning of the project.

3.2 Site Overview

ISRPL is a joint venture company of Indian Oil Corporation Ltd (IOCL) and Taiwan Synthetic Rubber (TSRC), established in the year 2013 and situated at Panipat in Haryana state of India. The company is engaged in the manufacturing of synthetic rubbers.Table 3 shows details about ISRPL.

Table 3: About ISRPL

Item	Description
Coordinates	29.44˚ N, 76.88˚ E
Address	India Synthetic Rubber Pvt. Ltd. (A joint venture of IOCL and Taiwan Synthetic Rubber (TSRC)) Opp. Naphtha Cracker Polymer Terminal Gate, Panipat Refinery, Panipat – 132140, Haryana, India
Consumer type	Manufacturing / Industrial
Electricity supply	Main supply from IOCL and Diesel Generator (DG) as a backup only for driving emergency loads in case of IOCL power failure

4 PV Plant Overview

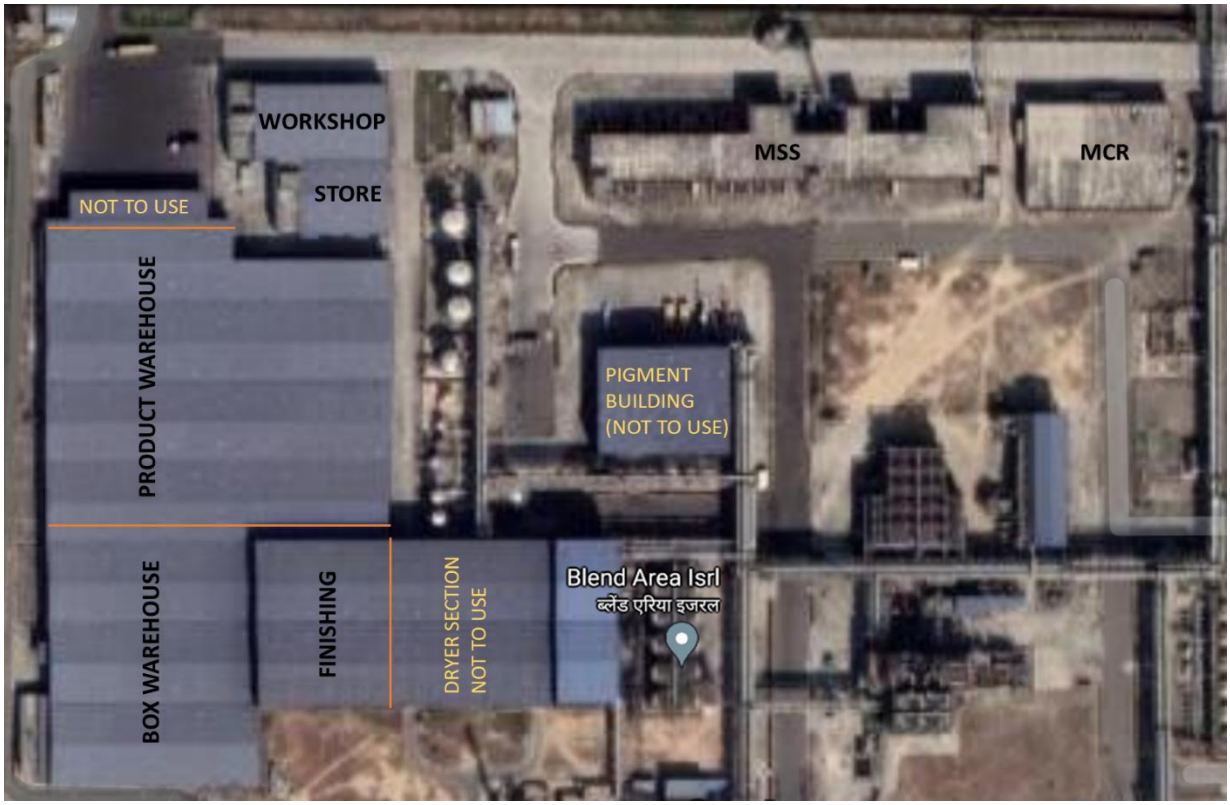
A Project capacity of 2,918 kWp is to be installed on the rooftops of the Owner. The list of buildings considered for installing roof mounted solar PV system shown in Table 4.

Table 4: Building details

S. N.	Building	Roof	Orientation	Roof area (m^2)	Height (m)	Estimated Rooftop PV Capacity, kWp
1	Main Control Room (MCR)	RCC / Flat	-	1,576	6	175
2	Main Sub-Station (MSS)	RCC / Flat	-	1,694	11	225
3	Workshop	Galvanized Iron (GI) sheet / Pitched (5.7^o)	North - South	1,250	10	110
4	Store			708	8	65
5	Product Warehouse			11,988	6	1,432
6	Box Warehouse			5,468	6	680
7	Finishing			2,356	12	230
	Total			**25,039**		**2,918**

Figure 1 identifies the buildings in the factory layout. The buildings are situated in an approximate radius of 250 m. The total roof area of the buildings considered for solar installation is approximately 25,039 m^2. Solar energy generated from each installation shall be utilized by the Owner in their factory premises of which rooftop solar PV generating unit is installed.

Figure 1: Factory layout



To achieve a cumulative capacity of 2,918 KWp, the EPC Contractor and the Project Owner/Owner's Engineer have to have mutual consent on the individual plant size and targeted roofs for solar installation. The requirement for solar PV system is to:

- Incorporate solar as an additional source of power and shall be connected at 6.6kV MV switchgear. Solar power integration shouldn't disturb the existing Auto and Manual changeover scheme of the 6.6KV switch Board.
- The generating power shall be fully integrated with the existing system and shall include line PT for metering, protection CT, metering CT, transformer protection, and required protections in accordance to bus-coupler operation mechanism.
- The solar PV system must operate safely without affecting existing electrical systems.

4.1 Electrical Characteristics

DC System: This shall essentially be applicable from solar PV Modules up to the Inverter. The operating voltage of Inverters shall essentially depend upon the Maximum Power Point Tracking (MPPT) range; however, the maximum system voltage shall be 1500 V. The PV Module of 72 cells has been proposed for complete rooftop solar plant. The exact no. of strings and no. of modules in a string should be decided during the detailed engineering. All individual input terminals of Inverter shall have disconnection facility. Solar grade DC cables shall be provided for interconnection between Modules and SCB and between SCB and input terminals of Solar Inverter. In case of string Inverter, string combiner box or string monitoring box can be avoided if Fuse, DC side SPD, and string level monitoring is available in the string Inverter. The Inverter receives varying DC input power from the Module due to varying nature of solar irradiance and

motion of Sun throughout the day & year, which is converted into AC power by its highly efficient Power Electronics Circuit working based on Multi MPPT mode and synchronizing to the Grid Frequency and Voltage.

AC System: The recommended point of connection shall be at 6.6 kV MV switchgear which is located in the Main Substation (MSS) Building. The step-up transformer for the solar Project will provide galvanic isolation and additionally now sitting idle the existing Automatic Power Factor Controller (APFC) equipment can be brought in use if required. The AC cables should be selected based on the power, voltage rating, route length and laying pattern and all AC cable shall be XLPE, FRLS & armoured. The generated power from each building shall be evacuated to the point of connection (PoC) at the MSS via underground cable trenches and overhead cable trays.

At inverters output end, there should be minimum overcurrent, type-II overvoltage, under/over frequency, insulation fault monitor and anti-island protections. The fault current contribution by the inverters is usually limited by the inverter control circuit and this should be based on IEC 61727 or IEEE 1547 and the typical range of short circuit current is between 100% and 200% of the rated inverter current. Additionally, in ACCBs, LV switchgear, and ICOG panel, there should be over current, over voltage, earth fault protections. Additionally, the transformer protections shall be built in to the ICOG panel. The Multi-Function Meter (MFM) is recommended at LV switchgear and ICOG panels.

The Owner has plan for future expansion of solar capacity (for approximately 1 MWp) in the factory premise, considering same adequate provision should be given in the AC side configuration of the plant.

The earthing system is divided into 3 parts; DC, AC and LA. Module and MMS earthing are considered under DC earthing, inverters, ACCBs and equipment at PoCs are considered under AC earthing and according to voltage level (6.6 kV and 800 V) separate earthing shall be provided by the Contractor, earthing of each LA is considered under LA earthing. The DC side earthing system is further divided in to 3 parts i.e. MCR and MSS form one DC earthing grid, Workshop and Store form one DC earthing grid and Product Warehouse, Box Warehouse and Finishing form one earthing grid. The required number of earth pits should be calculated to limit effective earth resistance under one (1) Ohm, in any event, within applicable norms and standards and good practice. The chemical earthing shall be provided by the Contractor.

ESE type LAs of 107m or more range recommended to protect complete PV array in the factory premise. The location of LAs should be recommended considering the coverage area, shadow impact and ease of installation.

The Owner is undertaking a harmonic study of existing electrical system. The ratings of equipment and plant configuration subject to change considering the harmonic test results. Any such requirements recommended by the Owner or Owner's Engineer shall be incorporated by the Bidder in its scope of works.

4.2 Interfacing Facilities

The EPC Bidder shall provide the interconnection at 6.6 kV. The Roof Top Solar PV Plant (RSPVP) shall be operational in synchronisation with the incoming power supply from IOCL. The general guidelines for the interconnection arrangement shall be as follows:

- Evacuation facilities from the point of generation at inverter end to the interconnection point (MV Panel) including the required metering, protection arrangement, and related other equipment at the interface point shall be new and properly designed as per relevant codes & standards.
- All the equipment required for interfacing such as DG-PV Controller (if required), Reverse Power Protection Relay (if required), Zero Grid Export feature, LV panels/switchgears etc. shall be provided by the Bidder.
- The interconnection shall be as per CEA Regulations 2010 on "Technical Standards for Connectivity of the Distributed Generation Resources" and amendments thereafter and any other applicable codes and standards.
- Metering arrangement shall be as per Central Electricity Authority (Installation and Operation of Meters) (Amendment) Regulations and amendments thereafter.
- Irrespective of the Solar PV Plant is connected in captive or net-metering mode, the proposed Connection shall be executed as per the technical requirement of respective Distribution Company (DISCOM).

4.3 Climatic Conditions

There has been no onsite monitoring of weather parameters till the time of releasing this document. Desktop assessment indicates that the following conditions may be considered by the Bidder for the project component selection and system design.

- All equipment shall be designed for 50˚C Ambient Temperature.
- Project location falls under Wind Zone- IV, where the basic wind speed is 47 m/sec (169.2 km per hour) as per IS-875:1987 (Part-3). All structures shall be designed for the minimum wind speed of 47 m/sec.
- The seismic forces shall be estimated as per the provisions of IS: 1893 Part 1.
- Relative humidity shall be considered 90%.

5 Scope of Work for Bidder

The scope of work shall include Designing, Planning, Engineering, Procurement (Manufacturing / Supply), Construction / Erection, Testing, and Commissioning of the 2,918 KWp Rooftop Solar PV Plant (hereafter called as RSPVP) as a Turnkey Contract according to terms and conditions set out herein. The Contractor shall also be responsible for operation and maintenance of the Project for a period of two (2) years.

The Turnkey Contract shall be in accordance with all applicable permits and regulations so that the solar PV plant fulfils the Captive requirement by the Government of India, Guaranteed Performance and the Technical Specifications presented in this document.

The Bidder or the Contractor shall be responsible for, but not limited to, the following scope of works:

- Basic Project planning, sequencing and scheduling, solar resource assessment, energy yield prediction, basic and detailed engineering, Project component selection, preparing engineering and construction drawings, availing planning permissions, and all other requirements as required for commissioning and interconnecting the RSPVP to the existing electrical distribution system in Captive mode.
- Supply, sourcing, procurement, transportation including requisite insurance of all solar PV plant equipment.
- Submission of the drawings and documents as per Master Deliverable List (MDL) agreed in between the Bidder and the Owner for approval of Owner or Owner's representative.
- The Contractor has to submit the MDL and L2 Project Schedule within five (5) days from the date of signing of the Contract.
- After the Owners approval then only bidder can proceed for the procurement of the major components of the solar PV plant.
- Short circuit calculation, relay coordination settings, detailed protection philosophy, Complete load flow study, fault level calculation, transient study and under frequency study to existing substation, to be carried out by Contractor for power to be fed to proposed Substation.
- Carry out the fault level calculation using state-of-art software such as ETAP or equivalent software.
- Any modifications required in Main Control Room / Electrical equipments / Switchgears of Solar PV Plant, as recommended by organizations as a result of Short circuit calculation, relay coordination settings, detailed protection philosophy, Complete load flow study, fault level calculation, transient study and under frequency study, shall be in Contractor's scope.
- The system equipment shall be selected after the Owner approval on short circuit study which has to be conducted by the bidder.
- All the interlocking to the existing system shall be hard wired and bidder shall provide the interlocking details with the existing system.
- The Data logger (both software and hardware) and Weather Monitoring System (WMS) shall be provided with a work station of suitable configuration and an additional display / dashboard (Preferably 42 inch LED) for data monitoring and display of plant performance parameters. The provided data logger shall be integrated with all the existing meters of the plant, solar plant and WMS. The required furniture's (table & chair) for the work station shall be provided by the Bidder. The workstation shall have original Windows 10 software.

- Obtaining permits and clearances from all local stake holders; Government Statutory Bodies, Electrical Inspectorate etc. as required for completion and commission of the plant.
- Assembly and construction of the entire solar PV plant, all pre-construction tests, site management and supervision, labour provisions, testing and commissioning of all equipment in steps including commissioning and interconnection of the RSPVP to the existing electrical distribution system.
- All the operations not expressly included, that are necessary for proper functioning of the solar PV plant and fulfilment of the guaranteed performance, rules, regulations, and applicable codes, being the meaning of necessarily all these things which are inherent to the Project and without which the solar PV plant would be unable to start operating in Captive mode in synchronization with existing system.
- Commissioning of the solar PV plant with Provisional Acceptance Test, seven (7) days Start-Up Performance Test, Monthly and Quarterly Performance Evaluations and Performance Tests as required by the Owner during the Defects Liability Period (DLP).
- Comprehensively warranting the entire solar PV plant against all defects through a DLP of two (2) years, transfer all component warranties to the Owner post completing the DLP.
- Further to commissioning of the RSPVP; training Owner's Personnel for Operation and Maintenance, hand-over the plant to Owner, provision of all the documentation necessary for the correct performance and maintenance for the life-time of solar PV plant.
- Operation and Maintenance of the PV plant post commissioning up to two (2) years (Defect liability Period). During the Defect liability Period of two (2) years, the Contractor shall supply all necessary equipment/ spares, materials, manpower for replacement of faulty equipment at their own cost. The EPC Contractor shall be the O&M Contractor for first two years from the Date of Commissioning (CoD). The O&M Contractor shall follow the plant HSE requirement and provide all the required harnesses, tools & tackles, consumables etc. at their own cost.
- As per plant HSE requirement, every work shall be supervised by the Contractor deployed Supervisors and will report to the concerned Person or representative of the Owner.
- The Bidder shall provide organogram for project execution, and HSE.
- The bidder shall provide a project schedule comprises all key milestones till Provisional Plant Acceptance.
- The Contractor shall make his own arrangement for material storage. The space shall be provided by the Owner. The security of materials is Contractor's responsibility.
- The Contractor has to make suitable arrangements for its own and its sub-contractor's employees during construction and O&M period.
- The Contractor shall make suitable arrangements for Owner and/or Owner's representative for witnessing Factory Acceptance Test (FAT) of key equipment. The list of equipment to be considered for factory witness shall be proposed by the Bidder along with Bid. The Contractor shall provide fifteen (15) days advance notice for factory inspection along with required documentation for Owner's approval.
- The Contractor shall provide a safety officer for complete construction period.
- The Bidder shall submit a separate Quotation for conducting O&M of the plant from 3rd year onwards along with the Bid.
- The Contractor shall remove left over construction materials, and debris from site within one week of achieving CoD.
- The Contractor shall make its own arrangements for material lifting to roofs. No existing ladder or stair case shall be used for material movement without Owner's permission.

- Any retrofitting works and roof strengthening works required for installation of solar projects shall be undertaken by the Contractor.
- The Contractor shall be responsible to transfer for the title of transfer to the Owner prior to Provisional Plant Acceptance.
- The Contractor shall depute licensed (with local distribution company) electrical contractor for performing the electrical HT side works.

6 Contractor's and Owner's Obligations

6.1 Owner's Basic Obligations

Unless specified/ described elsewhere in other sections of this document, the Owner shall be obliged to:

- Appoint a representative to communicate and cooperate regularly with the Contractor or its representatives in any manner on reasonable request by the Contractor.
- Review project designs, detailed engineering, drawings, equipment specifications and all Project management documents provided by the Contractor.
- Bear all statutory fees required to obtain and maintain authorization for interconnecting the plant to the Distribution system / Distribution Utility, if required.

6.2 Turnkey EPC Contractor's Basic Obligations

In addition to obligations of the Contractor specified elsewhere in other sections, the Turnkey EPC Contractor shall be bounded by the following basic obligations:

- Adherence to all the sections of this document along with all the drawings is essentially a key obligation of the EPC Contractor.
- The EPC Contractor shall independently conduct resource assessment and predict energy yields clearly specifying losses and degradation over Project lifecycle. The Owner/Owner's Engineer shall closely monitor these losses/ degradations and shall link these parameters with the Project performance.
- The EPC contactor shall be responsible for required Liasoning works with DISCOM/other local bodies as per requirement for approval and metering including any application, charges/fees that may be payable.
- Wherever standard codes are referred to in this document, the same shall be followed by the Contractor. Wherever standard codes are not mentioned, the latest relevant BIS, IS, NEC, IEEE and IEC codes and standard shall be followed.
- The Project being a Turnkey Contract, the scope shall include everything as required for successful implementation, commissioning and operating the plant for its lifecycle of twenty-five years. No variation shall be entertained on this account by the Owner.
- The Contractor shall perform works strictly adhering to technical documents and drawings approved by the Owner/Owner's Engineer as well as requirements established by the applicable technical regulations.
- The Contractor shall follow and perform all works in accordance to this technical document, State Solar policies and regulations, Ministry of New and Renewable Energy (MNRE) guidelines, CEA Regulations 2019 on "Technical Standards for Connectivity of the Distributed Generation Resources", "CEA (Installation and Operation of Meters) Amendment Regulations, 2019",
- The Contractor shall strictly follow the start-up and functional requirements of the Project; this shall essentially include all the material and construction equipment supply, implementation, testing and commissioning of the relevant systems as required for successful completion, and commissioning of the RSPVP.

The Contractor's obligations in respect of the Works shall include performing all works and provision of Contractor's Equipment for the Design, Engineering, Procurement, Construction, Installation, Connection, Testing, Start-up, and Commissioning of the Plant at the Site in accordance with the Laws and this document.

6.3 Permitting and Clearances

The permits, approvals and clearances required to be taken by EPC Contractor (wherever applicable) at different stages of implementation of the 2,918 kWp RSPVP have been presented in Table 5.

Table 5: Permits and clearances

List of Consents	Authority	Approval Stage
Registration of Project	State Nodal Agency (SNA) / MNRE / other relevant authorities	Prior to Construction
Building stability clearance certificate	Relevant Authorities	Prior to Commissioning
Labour registration, workman compensation policy, ESIC	Labour Ministry and other Relevant Authorities	Prior to Construction
Erection All Risk Insurance	Relevant Authorities	Prior to Construction
Approval from the Electrical Inspectorate for Drawing and Documents	Electrical Inspectorate	Prior to Commissioning
Approval from the Electrical Inspectorate for installation of meters	Electrical Inspectorate in-charge for Metering	Prior to Commissioning
Approval from the Electrical Inspectorate for synchronization of the Project	Electrical Inspectorate	Post Commissioning
Plant Commissioning Certificates	Electrical Inspectorate	Post Commissioning

In addition to above, the Contractor has to fulfil all the required criteria of the Owner to deploy manpower and perform the task in the premise of ISRPL. The Contractor shall contact Owner's representative and understand the minimum permits and clearances and health, safety and environment (HSE) requirements to perform any task in the premise of ISRPL. Additionally, the Contractor has to comply with Factories Act, 1948 along with Rules made thereunder. The Contractor shall be allowed to perform works at project site in the day time only i.e. sunrise to sunset due to safety reasons.

6.4 Procurement

The Contractor shall be responsible for proper receipt, inspection, unloading and security of all materials in accordance with the Laws and the Contract. The procurement shall be started after the Owner approval.

6.5 Installation

The Contractor shall complete design of the structural, civil, mechanical and electrical Works required for the installation of the Plant and secure approval of the same from the Owner prior to commencing execution at the Site. The Contractor shall install all Equipment in accordance with the Applicable Laws/ Rules. EPC contractor shall ensure that installation works shall not cause any disturbance to the activities conducted under the roof.

6.6 Testing & Commissioning

The Contractor shall conduct or manage inspections and tests, prepare and submit documentations to the Owner as per standard processes and procedures set forth in the Contract. The Contractor shall commission the Plant in accordance with the Owner's Requirements and the requirement laid down in this document and the Contract. The Contractor shall commission the Inverter with On-site Manufacturers' Representative. The Contractor shall commission the Support Structures in accordance with the Owner's Requirements and the procedure to ensure fully operational.

The Contactor shall perform all works in accordance with the Contract and in a manner so that the Works meet the associated requirements of the Owner and Distribution Utility. The Contractor shall provide all staffs, equipment and materials required to complete the Works, including everything necessary to achieve the agreed Plant Commissioning Date, save the specific requirements which are to be fulfilled by the Owner. The Contractor shall meet all applicable safety and performance standards set out by applicable Laws and Standards.

The Contractor shall maintain all As-Built Drawings on Site for review and shall provide the final set of "As-Built" drawings as per Section 6.12 & 13.17.

6.7 Interconnection

The Contractor's scope of work shall start from the point of Module supply and installation, supply of Module Mounting Structures and their installation including foundations and continue up to the point of interconnection at 6.6 kV level through Captive mode in synchronisation with existing system as per the system or policies or regulations requirements. The interconnection arrangement has to be such that the grid-tied RSPVP shall remain operational during grid-on hours. Supply, installation, testing and commissioning of all systems, equipment, materials etc. within the range of the Interconnection Point shall be in the scope of the EPC Contractor.

6.8 O&M

The EPC Contractor shall take full responsibility of comprehensive O&M, starting from CoD for a period of two (2) years. The EPC Contractor shall submit a comprehensive O&M Plan consisting of Plant Operation, Preventive, corrective and contingency maintenance philosophies. The Contractor shall prepare and submit all Operator's and Owner's training and Plant O&M Manuals.

6.9 Plant Performance Guarantee

The Plant Performance Test for Provisional Plant Acceptance will be conducted after commissioning and synchronizing of the Plant. The guaranteed performance for provisional plant acceptance shall be 78.6%. If the Contractor fails to achieve the Guaranteed Performance Ratio for the plant acceptance as per PR methodology mentioned in Section 11 the Contractor shall at its own cost rectify all the defects identified during the test and take necessary steps/efforts to pass the PR Test within the stipulated time span. The measurement uncertainty shall be ±3%. The LD for plant performance shall be applicable if the actual measured PR is below 97% of guaranteed PR for plant acceptance.

The PR during defect liability period i.e. for year 1 and year 2 shall be calculated annually using the formula given in Section 11.3 There shall not be any PR test conducted at the end of year 1 and year 2, the calculation will be on the basis of recorded data through data logger for complete year from the CoD. The Contractor shall ensure correct working of all sensors, energy meters, measuring instruments and data logger up to the satisfaction of the Owner throughout the defect liability period. The guaranteed PR for year 1 shall be 78.0% and for year 2 shall be 77.4% respectively. If the calculated measured annual PR is lower than guaranteed annual PR, the O&M Contractor shall be liable for monetary compensation to the Owner for loss in revenue due to lower generation for that relevant year e.g. if for Year one (1), PR Test to be conducted at the end of Year one (1), the Contractor achieves 95% of the Guaranteed PR value, then the Contractor will compensate to the Owner for this 2% (97% - 95%) shortfall of the PR leading to the lower generation for the Year one (1). At the end of the PR guarantee period, i.e. during the Year two (2) PR Test, if the Contractor after the rectification is unable to meet 97% of the Guaranteed PR for the Year two (2) and instead achieved 95% of the Guaranteed PR, then the Contractor will compensate to the Owner for this shortfall of PR leading to the lower generation for the entire plant life (up to 25 year) calculated from the Year two (2) as per the procedure agreed in the Contract. The electricity tariff of INR 9.00 per kWh shall be applicable for calculating compensation amount to be paid by the O&M Contractor for the shortfall in PR. The specific energy generation value of 1,376 kWh/kWp corresponds to PR value of 78.60%, which shall be considered for the calculation for LD. The PR value up to second decimal shall be considered for all calculations.

6.10 Commissioning

The Plant shall be commissioned means the plant shall be electrically charged and starts supplying solar power. The date on which the Plant is charged electrically and starts supplying power is called date of commissioning or commercial operation date (CoD). The DLP and O&M of the Plant shall start from the CoD.

6.11 Provisional Plant Acceptance Criteria

The Provisional Plant Acceptance Certificate shall be issued by the Owner upon successfully:

- Achieve mechanical completion;
- Achieve commissioning of the total project capacity;
- Achieve guaranteed PR;
- Clearance of all punch points;
- Submission of as-built drawings and documents (2 sets of hard copy of all drawings and documents, and soft copy of all drawings and documents in a flash drive);

- Transfer of title to the Owner;
- Submission of a performance bank guarantee applicable for O&M period; and
- Submission of O&M plan for Owner's approval.

6.12 Plant Acceptance and Handing Over –Taking Over

The Plant shall be accepted and the Plant Acceptance Certificate shall be issued by the Owner to the Contractor upon successful in meeting guaranteed PR and plant availability. Once Plant Acceptance Certificate is issued, the Plant shall be handed over by the Contractor and to be taken over by the Owner upon successful completion of all tasks to be performed at Site on equipment supplied, installed, erected, commissioned and guaranteed PR achieved for year 1 and year 2 by the Contractor in accordance with provision of the Contract. During handing over of complete Project, the Contractor shall submit the following for considering final payment and release of BG:

- All As- Built Drawings and documents as per the contract coordination procedure set out for the successful completion of the Project (two sets of hard copy and a set of soft copy in appropriate format; both pdf and editable file formats).
- Final Engineering Documents (as-built or detail engineering, whichever is final) with detailed specification, schematic drawing, circuit drawing, cable routing plans and test results, manuals for all deliverable items, Operation, Maintenance and Safety Instruction Manual and other information about the Project.
- Bill of materials for as-built.
- Inventory of recommended and mandatory spares and tools and tackles.
- Clearing dues if any to be paid by the Contractor with respect to applicable penalties, LDs etc.

6.13 Payment Terms

The Owner shall make payment of EPC cost as per following milestones:

- Upon completion of detailed engineering and approval of all design documents: 5% of total Project cost;
- Upon receipt of PV modules at site and acceptance by the Owner: 25% of total Project cost;
- Upon receipt of all equipment at site and acceptance by the Owner: 10% of total Project cost;
- Upon achieve of mechanical completion of the Project and confirmed by the Owner: 25% of total Project cost;
- Upon Provisional Plant Acceptance by the Owner: 35% of total Project cost.

All necessary & statutory tax shall be deducted from submitted bill amount at the rate prevailing during the time of payment and necessary TDS certificate shall be given.
Payment shall be made thru RTGS / crossed cheque (A/c Payee) within 30 days from the date of receipt of certified bills after deducting Income tax & any other applicable taxes at source at the rates prevailing at that time.

The Owner shall make payment of O&M cost quarterly.

7 Qualification Criteria

7.1 Eligibility

- A Bidder may be a private entity or a government-owned entity or any combination of such entities with the intent to enter into an agreement supported by a letter of intent or under an existing agreement in the form of a joint venture. The Bidder can have maximum two (2) members in a joint venture. In the case of a JV:
  - All partners shall be jointly and severally liable, and
  - The JV shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the partners of the JV during the bidding process and, in the event the JV is awarded the Contract, during contract execution.
- Each member in a consortium may only be a legal entity and not an individual person;
- The consortium member descriptions shall indicate what type of legal entity the member is and its jurisdiction of incorporation. A copy of certificate of incorporation shall be furnished by the bidding entity (including members of consortium) along with the bid in support of above.
- The Bid shall contain a legally enforceable JV Agreement entered amongst the Members in the Consortium, designating one of the Members to be the Lead Member. In the absence of a duly executed JV Agreement, the Bid will not be considered for evaluation and will be rejected.
- No change in project plans, timetables or pricing will be permitted as a consequence of any withdrawal or failure to perform by a consortium member;
- A Bidder shall not have a conflict of interest. All Bidders found to have a conflict of interest shall be disqualified. A Bidder may be considered to be in a conflict of interest with one or more parties in this bidding process if, including but not limited to:
  - they have controlling shareholders in common; or
  - they receive or have received any direct or indirect subsidy from any of them; or
  - they have the same legal representative for purposes of this bid; or
  - they have a relationship with each other, directly or through common third parties, that puts them in a position to have access to material information about or improperly influence the bid of another Bidder, or influence the decisions of the Employer regarding this bidding process; or
  - A Bidder participates in more than one bid in this bidding process, either individually or as a partner in a joint venture. This will result in the disqualification of all Bids in which it is involved.
  - A Bidder or any affiliated entity, participated as a consultant in the preparation of the design or technical specifications of the plant and services that are the subject of the bid.

7.2 Technical Eligibility Criteria

- The Bidder should have installed and commissioned rooftop solar photovoltaic power project (s) of at least 10 MWp capacity (on an aggregate basis) as a developer of the project or an EPC provider, which should have been commissioned within the last 36 months prior to the Bid Submission date.
- The list of projects commissioned within the last 36 months prior to Bid submission date, along with a copy of the Commissioning certificate and Work order / Contract / Agreement/ from the Client/project owner shall be submitted in support of this Clause.
- As evidence of his experiences, the Bidder shall include:

- Minimum three (03) nos. of completion certificates of min. 1MWp rooftop solar project from the end users

Or

- Minimum Two (02) nos of completion certificate of minimum 1.5 MWp rooftop solar power project from the end users.

Or

- At least one (01) no of completion certificate of minimum 2.2 MWp rooftop solar power project from the end users.

- The end user shall be industrial consumer and commercial or industrial or institutional Consumer /owner of the installed project.
- Performance of the plants as stated above which were designed, supplied, constructed, tested and commissioned by the Bidder on Turnkey basis to establish the Bidder's minimum required experience to Bid. The certificates shall be in English or Hindi language with mentioning the name of power plant, capacity, contract date and commissioning date of the power plant (make and model of components) supplied by the Bidder; issue date, name and address (Telephone/Fax/e-mail) of the end user duly signed in the official letter head.
- Bidders shall furnish documentary evidence as per the Format 5.

7.3 Financial Eligibility Criteria

- The Bidder shall have an annual turnover of INR 10 Crore in any one of the last three (3) financial years preceding the Bid Deadline, calculated as total certified payments received for contracts in progress or completed, subject to the condition that the Bidder should at least have completed one financial year.
- Submission of audited balance sheets or, if not required by the law of the Bidder's country, other financial statements acceptable to the Employer, for the last 3 years to demonstrate the current soundness of the Bidder's financial position.
- Bidders shall furnish documentary evidence as per the Format 6, duly certified by Authorized Signatory and the Statutory Auditor / Practicing Chattered Accountant of the Bidding Company in support of their financial capability.
- Bidders must not have defaulted under any of the applicable Acts like, Income Tax, GST Act, PF & ESI Act or any other Act which as per the nature of contract is required (Declaration/Return Copies to be furnished).

7.4 Other Eligibility Criteria and Qualification Criteria

- If any Bidder ceases to meet the other eligibility criteria or the Qualification Criteria set out in the tender at any time after the Application Due Date and on or after the Bid Due Date, then such Bidder shall be disqualified, and its Bid shall be liable for rejection.
- The Owner reserves the right to seek information and evidence from Bidders regarding their continued eligibility and continued compliance with the Qualification Criteria at any time during the Bid Process. Each Bidder shall undertake to provide all the information and evidence sought by ISRPL.

7.5 Instructions

- Bidder must meet the eligibility criteria independently as a Bidding Company or as a Bidding Consortium with one of the members acting as the Lead Member of the Bidding Consortium.
- In case of a Bidding Consortium the Financial Eligibility criteria as indicated in Clause 7.3, shall be fulfilled by the Lead Member while the Technical Eligibility Criteria shall be fulfilled by any member or through the combined experience of all consortium members.
- Only Technical consortium is allowed for submission of Bids. Financial Consortium is not allowed in this Bidding Process.
- All members of the consortium should be registered as company only.
- Bidder including its member of the consortium can submit one bid only.

8 Instructions to Bidders

8.1 Validity of Bid

The bids shall be valid for a period of 120 days from date of Bid Submission.

8.2 Bid Security and Performance Bank Guarantee during Construction and O&M

- The Bidder shall submit a Bid Security of INR 5.0 Lakh in the form of Demand Draft (DD) / Cheque / Bank transfer issued by any scheduled Bank of India payable in favour of Owner.
- Bids not accompanied with requisite Bid Security shall be considered as nonresponsive and such Bids shall be summarily rejected. In case of a Consortium, the Lead Member shall furnish the Bid Security on behalf of the Consortium Members as per the Consortium Agreement.
- Successful Bidder's Bid Security will be discharged upon the Bidder acknowledging the Letter of Award and furnishing the Performance Security in the form of Bank Guarantee, pursuant to the terms and conditions mentioned in this tender.
- Refund of Bid Security to unsuccessful bidders shall be made within Thirty (30) days from the date of selection of Successful Bidder.
- Refund of Bid Security will not be made to successful bidder if the bidder has not taken up work within stipulated time. The Bid Security may be encashed in any of the following circumstances by the Owner:
  - If a Bidder withdraws its Bid during Bid validity period or
  - In case of a successful Bidder if the Bidder fails:
    - to furnish Performance Security in accordance with provisions of Contract. Or
    - If the bidder/his representatives commit any fraud while competing for this Contract. Or
    - If the Bidder fails to sign the Contract after the issuance of Letter of Award as per the provisions of tender. Or
    - If the Bidder is found to have a Conflict of Interest as per the provisions of this tender.
- The Bidder shall submit a Performance Security of 10% of total Contract Value in the form of an irrevocable and unconditional bank guarantee issued by any scheduled Bank of India payable in favour of ISRPL and payable at Panipat or Noida.
- The Performance Security or the Performance Bank Guarantee shall remain valid till one (1) month post Plant Acceptance and Handing Over – Taking Over from the date of issuance of Letter of Award. The minimum claim period of Bank Guarantee shall be for three (3) months from the date of completion of Bid validity period.
- Refund of Performance Bank Guarantee shall be made within Thirty (30) days from the date of Plant Acceptance and completion of Handing Over – Taking Over.

8.3 Pre-Bid Conference and Site Survey

- A Pre-Bid conference of the Bidders shall be convened at the designated date and time through virtual mode as mentioned in the Notice Inviting Tender. Attendance of the Bidders is optional but

highly encouraged. However, Non-attendance at the pre-bid meeting will not be a cause for disqualification of a bidder.

- The Owner shall also facilitate Site survey at the designated date, time and place set out as mentioned in the Notice Inviting Tender. It is the responsibility of the bidder to undertake its own technical due diligence of the site. The Bidder is advised to visit and examine the site where the plant is to be installed and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into a contract for the provision of plant and services. The costs of visiting the site shall be at the Bidder's own expense.
- The purpose of the pre-bid meeting will be to clarify any issues regarding the tender and Contract including in particular, issues raised in writing and submitted by the Bidders.
- Owner is not under any obligation to entertain/ respond to suggestions made or to incorporate modifications sought for. Owner will not bear any responsibility or liability arising out of non-receipt of the information regarding amendments in time or otherwise.

8.4 Bid Rejection Criteria

The following reasons will lead to outright rejection of bids. However, Owner has sole authority to reject any bid, after evaluation, in case of not meeting any other techno-commercial requirement of this tender.

- No correspondence by any bidder shall be entertained till such time decision in the matter is taken unless otherwise specifically asked for by the Owner.
- Bidder not meeting financial/technical qualifying Criteria shall be rejected.
- Non submission of Bid Security.
- Any bid submitted after tender due date shall not be opened for evaluation. The decision of Owner shall be final and can be rejected without assigning any reason.
- Non-submission of copies of requisite certificates / documents shall render the bid non-responsive and shall be liable for rejection.
- Conditional bids are liable to rejection.

8.5 Amendment of Bidding Document

At any time prior to the deadline for submission of bids, the Owner may amend the Bidding Document by issuing addenda.

8.6 Language of Bid

The Bid, as well as all correspondence and documents relating to the bid exchanged by the Bidder and the Owner, shall be written in the English language.

8.7 Cost of Bidding

The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Owner shall not be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process

8.8 Currencies of Bid

- All amounts in the Bid should be stated in Indian Rupee (INR).
- The prices quoted by the Bidder shall be fixed (not formula based).

8.9 Signing of Bid

- Each Bid must be typed or written in indelible ink and should be physically signed by the Bidder or its authorized signatory. The name and position held by the Person signing the Bid must be typed or printed below the signature.
- All pages of the Bid must be physically initialled by the Bidder or its authorized signatory. If any printed and published documents are being submitted, only the cover and the last page shall be initialled.

8.10 Conflict of Provisions

In the event that there exists a conflict between any term, condition, or provision contained within this RFQ document, and in any term, condition, or provision contained within the General Conditions of Contract (GCC), the term, condition, or provision contained within this RFQ document shall prevail. Further, in case of any conflict of provisions mentioned in Special Conditions of Contract (SCC) and General Conditions of Contract (GCC), provisions of SCC shall prevail, i.e., will supersede GCC.

8.11 Safety precautions & Environment

Contractors have to provide all-necessary personal protective equipment's such as helmet, safety shoes, safety goggles & hand gloves etc. to their labours/workman.

Contractor shall have to strictly adhere to all the safety rules of ISRPL and always work with proper permit from the operational department.
1. Penalty for violating safety rules & procedures:
1.1 In case of different types of injuries:
a) First Aid Case (FAC) - Rs. 2000 per incident per person
b) Medical Treatment case (MTC) - Rs. 4000 per incident per person
c) Restricted Work Case (RWC) - Rs. 8000 per incident per person
For any subsequent recurring issues, the penalty will be doubled for each case.
The above penalties will be independent of any statutory penalties and/or other action against the service contractors.
Methodology for identification of violation of safety rules and regulations and recovery of penalty:
1. ISRPL's Occupational Health Centre (OHC) will declare any injury as First Aid Case (FAC), Medical Treatment Case (MTC), Restricted Work Case (RWC), Loss Time Injury (LTI) & (Fatality) FLT.
2. Investigation will be carried out within 24 hours by ISRPL's safety team. For major accidents (LTI / FLT) a cross functional investigation team will be formed by management.
3. ISRPL's Team Leader (TL) - Safety will check the nature & cause of such unsafe act or unsafe condition and whether contractor or contract workers are responsible or not.
4. Finance Department will deduct money from the Bills of the Contractor on the certification / confirmation of the ISRPL's Head - HSEF.

5. For violation of any safety rules and for unsafe act safety personnel at site will issue a penalty slip to the contractor representative at site with a copy to Team Leaders and Finance dept.
6. Contractor representative will have to sign in the penalty slip.
7. Contractor shall have to follow all the Environment related rules and regulations followed by ISRPL (as per ISO 14001:2015). ISRPL Environment Policy is to Protect, Utilize and manage our Natural resources in order to prevent Pollution and to continually improve the air breathe, the water we drink, and the earth we inhabit.

8.12 Labour Laws and Regulations

Contractor shall obtain necessary labour license from Licensing Authority under the "Contract Labour (Regulation & Abolition) Act 1970" and central rules made there under.
The provisions of the EPF & MP Act, 1952 and rules/Scheme framed there under shall be applicable to the eligible contractor and his eligible employees to be engaged for this job.
Contractor shall also comply with the provisions of the ESI ACT, 1948 and Rules framed there under in respect to the workers to be engaged for this job and have to obtain ESI Code No. from the local ESI Authorities for the said purpose and furnish the Code No. allotted by ESI authorities to the Engineer-in-charge before starting the job. The contractor shall obtain adequate insurance policy in respect of his workmen to be engaged for the work towards compensations as admissible under the Workmen's Compensation Act, 1923 and Rules framed there under upon death /disablement of a worker and the same has to be produced to the Engineer-in-charge before start of the work.
Additionally, the Contractor has to comply with Factories Act, 1948 and Rules framed thereunder.
The Contractor shall be allowed to perform works at project site in the day time only i.e. sunrise to sunset due to safety reasons.

9 Bid Submission and Evaluation

9.1 Submission of Bid

- The Bidder shall submit the Technical and Financial bid in two separate envelopes or two separate ZIP files in accordance with the requirements of the Bidding document.
- The Technical Bid and Financial Bid, and the Schedules, and all documents listed shall be prepared using the relevant Formats. The formats must be completed without any alterations to the text, and no substitutes shall be accepted.
- In addition to the original of the Bid, one soft copy for technical and separate soft copy for financial bid in .pdf format (by CD/DVD/Flash Drive) shall be submitted within the date and time as mentioned in the Notice Inviting Tender. OR
- The soft copy (.pdf format) of the technical bid in a .ZIP file shall be sent on email id **Varinder.kumar@isrpl.co.in & Sachin.verma@isrpl.co.in** and soft copy (.pdf format) of financial bid in a .ZIP file shall be sent on email id: **offer1@isrpl.co.in** within the date and time as mentioned in the Notice Inviting Tender without marking copy to anyone.

9.1.1 Technical Bid - ENVELOP 1 or email id **Varinder.kumar@isrpl.co.in & Sachin.verma@isrpl.co.in** in case of online submission of Bid.

The technical bid shall comprise of the following:

- Format 1: Cover Letter
- Format 2: Performance Security
- Format 3: Bidder Information Sheet
- Format 4: JV Information Sheet
- Format 5: Technical Eligibility Criteria
- Format 6: Financial Eligibility Criteria
- Format 13: Records of the Bidder
- Format 14 : Present commitments
- Format 15 : Deviations

Any other documents asked for in this RFQ document but format is not available, the Bidder is can submit on his own format. ENVELOP 1 shall be a ZIP folder in case of online submission of Bid.

9.1.2 Financial Bid - ENVELOP 2 or email id **offer1@isrpl.co.in** in case of online submission of Bid.

The Bidder has to submit separate financial bids for EPC and O&M for two (2) years. The Financial Bids submitted by the Bidder shall comprise the following:

- ENVELOP 2(a): Financial Bid for EPC up to commissioning and Provisional Plant Acceptance;
  - Format 7: Financial Bid Cover Letter
  - Format 8: Price Schedule 1 - Equipment and Component Supplied
  - Format 9: Price Schedule 2 - Design Services
  - Format 10: Price Schedule 3 - Installation and other services up to plant commissioning

  - Format 11: Price Schedule 4 - Mandatory Spare parts
- ENVELOP 2(b): Financial Bid for two (2) years O&M, starting from date of commissioning;
  - Format 12: Price Schedule 5 – Operation and Maintenance [O&M]

- Any other documents asked for in this RFQ document but format is not available, the Bidder is can submit on his own format. ENVELOP 2(a) and ENVELOP 2(b) shall be a ZIP folder in case of online submission of Bid.
- The prices shall be exclusive of GST/CGST inclusive of all applicable statutory taxes & duties and will be remains firm & fixed for entire period of contract.

9.2 Evaluation of Bids

- The Bid will first be evaluated to determine responsiveness to the Request for Quotation (RFQ). A Bid shall be considered responsive only if:
  - the Bid is received by the Bid Due Date, including any extension thereof;
  - it is signed, sealed and marked as stipulated in RFQ;
  - it contains the following information and documents (complete in all respects) as requested in this RFP:
    - ENVELOP 1 – Technical Bid
    - ENVELOP 2 – Financial Bid
- The Owner shall evaluate and determine whether the Bidders have submitted responsive Bids. The decision of Owner shall be final with respect to selection of qualified bidder. If required, Owner may request for clarification or additional documents from the Bidder.
- The Owner shall first tabulate the Total Contract Value quoted by each qualified Bidder that has submitted a substantially responsive Financial Proposal.
- In the course of tabulation, the Owner shall check for arithmetical errors in each Financial Proposal being evaluated. If there is a discrepancy between words and figures quoted as the Total Contract Value, then the amount in words shall prevail.
- The selection of the qualified bidder shall be a techno-commercial decision based on price negotiation, and agreed terms and conditions as per the contract.
- If 2 or more qualified Bidders have the same Quoted Project Cost, then the Bidder whose turnover, as calculated in accordance with the RFP, is higher shall be the Successful Bidder. The decision of Owner shall be final.

9.3 Award of the Project

- After selection the Successful Bidder, the Owner will issue the Letter of Award (LOA) to the Successful Bidder in duplicate:
  - declaring it as the successful Bidder;
  - accepting its Financial Proposal;
  - requesting it to fulfil the condition specified in the tender
  - requesting it to pay the Performance Security in accordance with the tender;
  - Subject to fulfilment of the conditions specified in the RFP, requesting it to execute the Contract within specified timelines.
- Within 7 days of receipt of the LOA, the Bidder declared as the Successful Bidder shall sign and return, as acknowledgement, the duplicate copy of the LOA.

- If the duplicate copy of the LOA duly signed by the Successful Bidder is not received by the stipulated date, the Owner may, unless it consents to an extension, without prejudice to any of its rights under the Bid Documents or law, withdraw the LOA and encash the Bid Security.
- Upon withdrawal of the LOA issued to the Successful Bidder, the Owner has the discretion to select from other qualified bidders.

9.4 Execution of Contract

The Owner shall execute the Contract with the Successful Bidder within 30 days of issuance of the LOA to the Successful Bidder, upon the Successful Bidder satisfying the following:

- Submission of the Performance Security;
- If the Successful Bidder fails to satisfy the above conditions or fails to execute the Contract on or before the date stipulated in the LOA, the Owner has the right to disqualify the Successful Bidder and revoke the LOA. Owner may, without prejudice to any of its rights under the Bid Documents or law, encash the Bid Security.
- The Successful Bidder shall execute the Contract as per Form of Contract as annexed to General Conditions of Contract (GCC).
- If the Successful Bidder seeks to negotiate or seeks any deviations from the Form of Contract, the Owner may elect to disqualify the Successful Bidder and revoke the LOA issued to the Selected Bidder. If the Owner elects to disqualify such Bidder and revoke the LOA, then Owner may, without prejudice to any of its rights under the Bid Documents or law, encash the Bid Security.
- If, after the execution of the Contract, the Successful Bidder fails to fulfil any of the conditions precedent to the effectiveness of the Contract, the Owner may terminate the Contract and encash the Bid Security.

9.5 Special Conditions of Contract

a. SCOPE OF SERVICES

The scope of the services shall be as provided in Section 5.1 of this RFQ Document.

b. TIME OF COMPLETION:

The Successful Bidder for the Project will be required to complete the construction and commissioning of the Project within four (4) months from the effective date of the Project Contract. The contractor has to sign and revert within 72 hours from the date of issue of Contract by the Owner.

c. BLACKLISTING

Blacklisting of the vendor, in case such situation arises, then the standard policy of ISRPL shall be followed.

d. RISK CLAUSE

In case of non-execution/ non performance of the Contract by the Contractor, if ISRPL is forced to arrange the material/ services from alternate source, then additional cost incurred will be at contractor's account

e. DEFECTS LIABILITY

During the Defects Notification Period, the Contractor shall execute any work required to remedy Defects in accordance with the Conditions of the Contract. The response time for remedying defects on working days shall be within maximum twenty-four (24) hours from the time of intimation. In case of holidays, the Contractor shall respond on the next working day. Above all, the Contractor has to ensure guaranteed RSPVP availability and performance. Defect liability period shall be 2 years from the date if issue of completion certificate. During the defect liability period of Two (2) years, the contractor shall supply all necessary equipment/ spares, materials manpower for replacement of faulty equipment at their own cost.

a. PRICE ADJUSTMENT

A. Price Adjustment for delay

If the Contractor fails to comply with the Time for Completion /successful commissioning of Plant facilities then the Contractor shall pay to the Owner a sum equivalent to one (1%) per week (or part thereof) of the EPC Contract Price for the whole of the facilities as discount for delay for such default and not as a penalty, without prejudice to the Owner's, other remedies under the Contract subject to the maximum limit of five percent (5%) of Contract Price for the whole of the facilities. The Owner may, without prejudice to any other method of recovery, deduct the amount of such damages from any amount due or to become due to the Contractor. The payment or deduction of such damages shall not relieve the Contractor from his obligation to complete the Works, or from any other of his obligations and liabilities under the Contract. Once the maximum limit is reached, Owner may consider the termination of contract and/or shall have the discretion of getting executed the work from the Contractor with the maximum limit of Price Adjustment. Any such recovery on account of the Price Adjustment can be done from the running bills of the Contractor by the Owner.

The Owner shall at its sole discretion upon reaching the maximum Price Adjustment limit, as an alternative to the Price Adjustment at its option, get work executed from elsewhere at the risk and cost of the Contractor irrespective of the fact whether the scope of Contract is identical to the original scope of Contract and in case the Owner chooses the alternative course as mentioned, it will be entitled to recover compensation/ damages from the Contractor irrespective of maximum limit prescribed under above clause.

The Owner may give one (1) month notice to the Contractor, cancel the Contract without prejudice to the Owner's right under above clauses or any other provisions contained in the Contract to determine the Contract and claim damages from the Contractor.

B. Price Adjustment for Performance

During the Provisional Plant Acceptance, after providing three (3) chances for the PR demonstration, any shortfall in the Performance Ratio (PR) as determined through the PR Test Procedure specified in Section 11, will attract imposition of penalty. For every 1% shortfall in PR below the committed PR value, a penalty of 1% of the total EPC Contract Value shall be levied. The PR value of the recent PR test performed by the Contractor shall be considered for calculation of Price Adjustment.

In case the Contract Performance Security has already been encashed on account of any default / delays, the penalty amount will be recovered from any due payments to the contractor. In case the Plant PR Shortfall is more than five percent (5%) than the specified PR value, then the total plant will be accepted on as-is basis and the total Contract Performance Security submitted by the contractor will be forfeited and payments linked to Provisional Plant Acceptance will not be made.

The maximum limit of liability for Price Adjustment for Delay and Price Adjustment for Performance, shall be ten percent (10%) of total EPC Contract Value.

C. Price Adjustment during O&M period

Price Adjustment for Plant availability

During O&M Contract Year 1 and Year 2 of the Operational Term, the O&M Contractor shall achieve annual average Plant Availability of not less than ninety nine percent (99%) (the "Guaranteed Plant Availability"). Price Adjustment against plant availability shortfall shall be applicable for Year 1 and Year 2. If the O&M Contractor fails to achieve the Guaranteed Plant Availability, the O&M Contractor will be liable to pay discount @0.25% of the annual O&M contract value for every 0.1% shortfall in Guaranteed Plant Availability and such plant availability Price Adjustment will not exceed five percent (5%) of annual O&M contract value for that contract year. The availability Price Adjustment shall be calculated at end of each contract year and the same shall be adjusted from subsequent payment(s) due to O&M Contractor.

As per IEC 63019, an equipment is in an unavailable state when the equipment is not capable of operation because of operational or equipment failures, external restrictions, testing, work being performed, or some adverse condition. The unavailable state persists until the unit is made available for operation by being synchronised to the system in service state. The following formula shall be used for the calculation of system availability:

$$System\ Availability = 1 - \frac{1}{H_{ttp} * kW_{np}} * \sum_{incident} (H_{un} * kW_{dr})$$

Where,

- Theoretical total production hours (H_{ttp}): the hours in the period when sufficient sunlight exists to allow the inverters to reach the input voltage needed to operate. The minimum irradiation is set at 50 W/m^2 measured on the lowest of the installed plane of array pyranometer / radiation sensor.
- Array power (kW_{np}): the expected DC power of the array for the entire solar generating facility determined by the sum of each module nameplate kWp rating.
- Component unavailability hours (H_{un}): the hours in the period when solar irradiance is sufficient to power the inverters, yet an inverter within the facility is not available to generate power due to an equipment fault or failure.
- Derated system power (kW_{dr}): the kilowatts of lost system power due to inverter unavailaibality. Derated system power will be calculated from the period the system entered the derated state until it returns to a fully operational state. The value for derated system power will be calculated by the amount of unavailable DC nameplate capacity for the period and is determined by sum of each modules nameplate KWp rating for that given unavailable inverter. Any string combiner box (SCB, if

applicable) outage should not mean that the corresponding capacity is excluded from the calculation, it counts towards unavailability.
Note: any testing equipments and work being performed as part of maintenance activity under O&M contract shall be performed within 1% of agreed unavailability limit.

Price Adjustment during O&M period against breakdown of other Infrastructure of Plant which doesn't affect the generation of power, directly such as but not limited to civil infrastructure, water supply system/network, other Infrastructure developed by the Contractor as a Scope of Work for the Project shall be penalized @ INR 1000/day, per incident of breakdown reported beyond Five (5) Days of such reporting. Cumulative value of such penalty shall be limited to 5% of yearly O&M cost.

The Price Adjustment as specified on account of delays and on account of deviations in Functional Guarantees as above shall be assessed and levied independent of each other.

The maximum limit of liability for Price Adjustment for Performance and Price Adjustment for Availability or breakdown, shall be ten percent (10%) of total O&M Contract Value, then the total Contract Performance Security submitted by the Contractor will be forfeited and further quarterly payments of O&M services will not be made.

9.6 General Conditions of Contract

All other terms and conditions shall be as per General Conditions of Contract (GCC) attached as Annexure .In case of any discrepancies between the stipulations in General Conditions of the Contract (GCC) and Special Conditions of Contract (SCC), the GCC shall stand superseded by the SCC to the extent stipulated hereinabove while balance portion of respective clauses of GCC shall continue to be applicable.

10 Formats

A separate Annexure is provided along with this RFQ document

11 Performance Test Measurement Criteria

This section details the procedure for conducting the Performance Ratio (PR) test for the solar PV project taking into account weather correction factors (ambient temperature & irradiance) in the calculations and demonstrates guaranteed values for the same.

11.1 DC capacity calculation

The sum total of the nameplate values of the rated power of the PV modules actually installed and this is referred as installed DC capacity (P_{stc}). The rated power is at standard test conditions (STC).

11.2 PR test methodology for Provisional Plant Acceptance

The test on completion of EPC Contractor ('the Contractor') works by the Contractor shall include conducting a PR test. The duration of the test called 'Test Period' shall be for seven (7) days. The Contractor shall perform the PR test for the entire project capacity. The section below describes the methodology for calculation of weather-corrected PR

11.2.1 Parties to the test and responsibilities

The parties to the test are the Client, Owner's Engineer and the Contractor. All parties have to understand following test methodology before commencement of test.

The test will be executed by the Contractor. All relevant test data in raw file format, spreadsheets, and computations shall be provided to all other parties to the test for their review. The Contractor will supply raw data before any manipulation and highlight any gaps in the data. The final test report will be produced by the Contractor in the timeline detailed in the Contract.

During the test, any anomalies to this protocol will be documented. The resolutions to anomalies or variations to this protocol that occur during the test period will be documented and approved by all parties to the test in order to continue with the testing effort

11.2.2 Preparations before performing PR test

Before commencement of test, following activities need to be completed:

- Proper install of all primary measurement instruments;
- All installed primary measurement instruments are calibrated;
- Cold and hot commissioning to be performed successfully for each equipment;
- The test procedure shall be published, agreed and understood by all parties to the test;

An adjustment for availability is assumed in the calculation of the PR, whereby anytime there is an availability shortfall (i.e., such time resulting from (a) insured events and their replacement times; (b) main power supply instability; (c) interruptions caused by facility alterations initiated by the Client; and (d) force majeure) all data during such period of unavailability shall be excluded from the PR calculation

11.2.3 Minimum irradiance criteria

The Provisional Plant Acceptance test period is for seven (7) days long with the following minimum irradiance criteria:

- At least three (3) days must have irradiance measured in the Plane of Array (PoA), that is greater than 600 W/m^2 for three (3) continuous hours, between 11:00 hrs and 15:00 hrs;
- If there are not seven (7) days that meet these minimum irradiance criteria, the decision has to be taken by all the parties. There will not be any Price Adjustment triggered as a result of this weather-related test delay.

The data will be automatically collected using weather station and temporary loggers (if any) and instruments with a scan rate of at least one (1) minute. Manual data sheets will be used for any non-functioning logger data channel if there will be no increase in test uncertainty.

All collected data will be averaged into 15-minute records, and each record will be used to calculate performance results and evaluate contract guarantees. The calculation methodology is stipulated in section below.

11.2.4 Performing PR test

The following procedure shall be followed by all parties during PR test. Any modification of this procedure shall require mutual agreement between the Owner / the Owner's Engineer and the Contractor. The tilt angle for period of test shall be the same as the fixed tilt angle during normal plant operation. As there are two (2) different fixed tilt angles applicable for ISRPL, the weighted average irradiation has to be calculated considering PV module surface area.

The Owner shall ensure availability of a reliable grid and evacuation system to receive 100% generation before the start of PR test. Any loss of time and / or performance due to such reason shall not be the cause for re-run of the test and the effect of such interruptions shall be excluded from the test results.

During the PR Test, all incidents shall be recorded in a log including the results of the PR test every 15 minutes when the Project is in operation. All unsatisfactory results shall be recorded in the test logbook as well.

The results of PR test shall be daily signed by the Owner's representative and the Contractor's representative.

The PR test period will conclude with a review meeting. The results of final PR test report for entire test period shall be signed by the Owner's representative / Owner's Engineer and the Contractor's representative.

11.3 PR calculation methodology

The Performance Ratio is a metric used for the comparative performance of grid-connected PV systems irrespective of their orientation, technology and location. It is unit less and its definition is as follows:

$$PR_{corr} = \frac{\sum_i EN_{AC\_i}}{\sum_i \left[P_{STC} \left(\frac{G_{POA\_i}}{G_{STC}} \right) \left(1 - \frac{\delta}{100} \left(T_{cell\_typ\_avg} - T_{cell\_i} \right) \right) \right]}$$

Where:

PR_{corr}: Weather corrected PR

EN_{AC}: Measured AC electrical generation

P_{STC}: STC-rated capacity of the array in kWp

G_{STC}: STC irradiance, i.e., 1000 W/m^2

G_{POA}: Measured PoA irradiance (kW/m^2)

i: a given point of time

T_{cell}: Cell temperature computed from measured meteorological data (˚C)

$T_{cell\_typ\_avg}$: Average cell temperature computed from one year (or measured period) of weather data using the project weather file (˚C) [as per Owner's or Owner's representative's produced cell temperature data from assumed weather database and PVsyst simulation]

δ: Temperature coefficient for power (%/˚C, negative in sign) that corresponds to installed modules.

PR shall incorporate all losses attributed to the quality of the physical and electrical components selected, climatic conditions, and the quality of the installation. However, the PR shall be measured 'net of losses' attributed to accumulated dust and soiling of the modules, hence the reference sensor shall maintain the same level of dust and soiling as the Plant in question and shall therefore receive the same level of maintenance and cleaning as the PV modules.

In addition, the data shall be sorted to eliminate erratic data points caused by force majeure or instability in the grid and/or evacuation system.

For the purpose of conducting the tests on completion, the PR shall be calculated as the average production measured over the period of time of maximum seven (7) days for the number of day's minimum radiation criteria meets. To pass Provisional Plant Acceptance test, the measured PR shall be at least 97% of the guaranteed PR.

The 15-minute interval for recording of data may vary according to data logger system actually installed at site.

11.3.1 Exclusion

Energy data during the time period where irradiance / module temperature data is incorrect / missing should be ignored for PR calculation. The data points for irradiance values at which all the inverters are not operational during stable grid condition hours shall not be considered. All equipment, system downtime, grid down time and those periods during which the Project could not deliver electricity due to

risk event; should be excluded from PR calculations. Average the measurements from multiple redundant sensors (if available) to increase confidence in measured values.

11.3.2 Uncertainty

Uncertainty due to instrument and energy estimation errors: measurement errors in instruments (meter, pyranometer and thermocouple) and energy estimation errors (from PVSYST or any other yield estimation tool) should be taken into account while making a decision on the test results. Uncertainty in the PR measurement shall be 3%.

[Actual measured PR] >= [(1 - 0.03) x Guaranteed PR]

Data Gaps: Time periods with missing irradiance and/or temperature data should be excluded from PR calculation. All equipment should be operational during PR test.

11.3.3 Annual PR

The PR during defect liability period i.e. for year 1 and year 2 shall be calculated annually using the formula given in Section 11.3. There shall not be any PR test conducted at the end of year 1 and year 2, the calculation will be on the basis of recorded data through data logger for complete year from the CoD. The Contractor shall ensure correct working of all sensors, energy meters, measuring instruments and data logger up to the satisfaction of the Owner throughout the defect liability period.

12 Project Site Details for Bidder Reference

This section describes about ISRPL, buildings in the premise, accessibility, energy consumption, and climatic conditions.

The buildings in ISRPL premise are constructed with reinforced cement concrete (RCC) roof and pitched galvanized iron (GI) sheet roof in the factory premises. Table 6 shows the list of buildings considered for feasibility study of installing roof mounted solar PV system.

Table 6: Building details

S. N.	Building	Roof	Orientation	Roof area (m^2)	Height (m)
1	Main Control Room (MCR)	RCC / Flat	-	1,576	6
2	Main Sub-Station (MSS)	RCC / Flat	-	1,694	11
3	Workshop	Galvanized Iron (GI) sheet / Pitched (5.7°)	North - South	1,250	10
4	Store			708	8
5	Product Warehouse			11,988	6
6	Box Warehouse			5,468	6
7	Finishing			2,356	12
	Estimated Total			**25,039**	

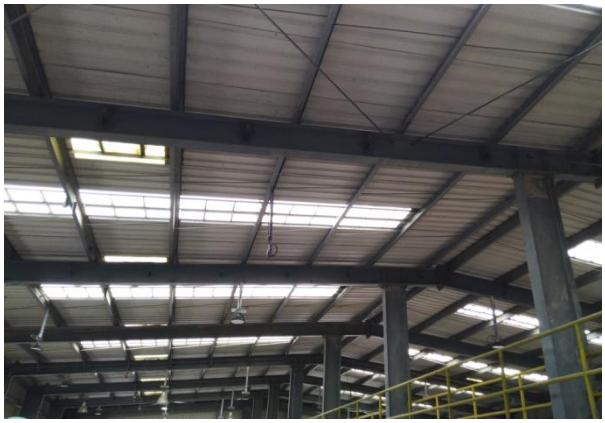
12.1 Roof conditions

The factory and the buildings are approximately 9 years old, with the latter considered to be in good condition and appear to be maintained with care. Figure 2 and Figure 3 show the representative photographs of the roofs considered for solar installation.

Figure 2: Flat RCC roof

Figure 3: Pitched GI sheet roof

Figure 4: Pitched roof support structure




12.2 Site access

The factory is approximately 125 km from New Delhi, India's national capital. It is also well-connected to other parts of the country via the National Highway, the Northern Railways and Indira Gandhi International airport in Delhi.

The site is well connected to Grand Trunk road by Panipat bypass corridor and Refinery road. All buildings in the factory premise are accessible by all-weather asphalt road. All the roofs are accessible through either staircase or monkey ladder. The solar PV project is proposed to be installed on the roof of the buildings shown in Table 4 and Table 6. The figures below are pictorial evidence of accessibility to site.

Figure 5: Road outside main gate

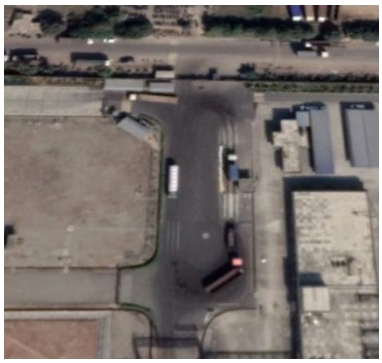


Figure 6: Concrete road

Figure 7: Asphalt road

Figure 8: Staircase

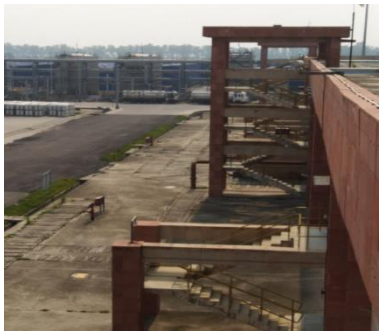
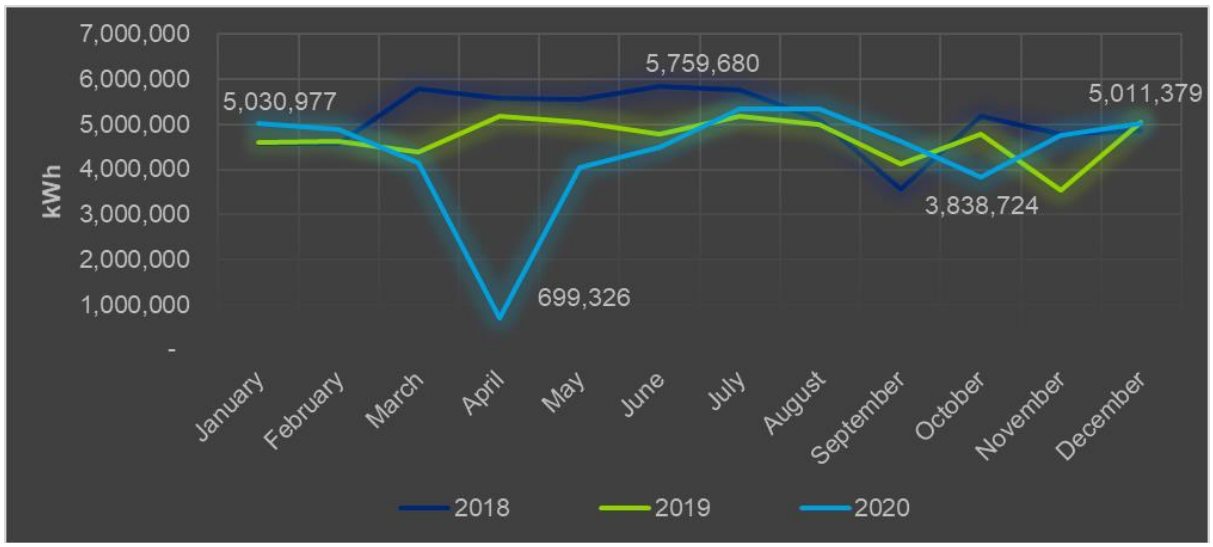


Figure 9: Monkey ladder

12.3 Power demand

The factory operates in three shifts for over 24 hours for each day of the week, including weekends. The factory receives all time main power supply at 33 kV from IOCL captive power generation plant. Additionally, there are two numbers DG sets of 1500 kVA each serves as power backup. The power outage from main supply is rare and usually for few minutes. Figure 10 shows the monthly electricity consumption data provided from the Client. The electricity consumption during March to July 2020 does not represent realistic scenario in usual case due to minimum or part load operation of the factory during lockdown period due to COVID-19. The monthly consumption varies in the range of 3.8 million units (MU) to 5.8 MU. The electricity consumption is comparatively lower in last quarter of calendar year due to lower production. The consumption doesn't vary much for remaining months of the year. The calculated average power demand is estimated at 6.7 MW.

Figure 10:Electricity consumption



13 Technical specification

This specification defines the minimum requirements for the design engineering, procurement (manufacturing / supply), construction / erection, testing and commissioning of RSPVP.

13.1 PV module

- The total solar PV array capacity should not be less than allocated capacity (2,918 kWp) and shall comprise of mono c-Si PERC solar PV modules of minimum 535 Wp and above wattage and module efficiency of 20.7% or above.
- The glass shall be minimum 3.2mm thickness with anti reflection coating, high transmission, low iron tampered glass.
- The frame shall be minimum 35mm height and made up of anodized aluminium alloy.
- Protective devices against surges at the PV module shall be provided. Low voltage drop bypass diodes shall be provided.
- PV modules must be tested and approved by one of the IEC authorized test centres, NABL accredited laboratories and as per guidelines of MNRE.
- The module frame shall be made of corrosion resistant materials, preferably having anodized aluminium.
- The bidder shall carefully design & accommodate requisite numbers of PV modules to achieve the rated power.
- Other general requirement for the PV modules and subsystems shall be the Following:
  - The rated output power of any supplied module shall have positive tolerance in range of 5 Wp or above.
  - The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary by more than 2% (two per cent) from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
  - The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weatherproof lid with captive screws and cable gland entry points or may be of sealed type and IP-65 or higher rated.
  - I-V curves at STC should be provided by the Contractor.
- Modules deployed must use a RF identification tag laminated within the PV module and suitable to remain intact for the life of the PV module. The following information must be mentioned in the RFID used on each module. This should be inside the laminate only.
  - Name of the manufacturer of the PV module.
  - Name of the manufacturer of Solar Cells.
  - Month & year of the manufacture (separate for solar cells and modules).
  - Country of origin (separately for solar cells and module).
  - I-V curve for the module Wattage, Im, Vm and FF for the module.
  - Unique Serial No and Model No of the module.
  - Date and year of obtaining IEC PV module qualification certificate.
  - Name of the test lab issuing IEC certificate.
  - Other relevant information on traceability of solar cells and module as per ISO 9001 and ISO 14001.

- The Bidder shall provide RFID reader suitable for reading RFID tag of modules.

Codes and Standards

The Project shall conform to the relevant standards and certifications shown in Table 7.

Table 7: Applicable Indian and international Standards for PV module

Standard	Description
IEC 61215/ IS 14286	Design Qualification and Type Approval for Crystalline Silicon Terrestrial Photovoltaic (PV) modules
IEC 61701	Salt Mist Corrosion Testing of Photovoltaic (PV) Modules
IEC 61853- Part 1/ IS 16170: Part 1	PV module performance testing and energy rating - Irradiance and temperature performance measurements, and power Rating
IEC 62716	PV modules – Ammonia (NH_3) Corrosion Testing (As per the site condition like dairies, toilets)
IEC 61730-1,2	PV module Safety Qualification – Part 1: Requirements for Construction, Part 2: Requirements for Testing

Warranties

PV modules are having both product and performance warranties. Product warranty is defined as the manufacturer should warranty the PV modules to be free from the defects and/or failures specified below for a period not less than 10.5 years from the date of sale to the original customer or from the date of CoD whichever is later:

- Defects and/or failures due to manufacturing;
- Defects and/or failures due to quality of materials; and
- Non-conformity to specifications due to faulty manufacturing and/or inspection processes. If the PV modules fail to conform to this warranty, the manufacturer will repair or replace the modules.

As per the performance warranty, the predicted annual degradation of power generated not exceeding 2.5% in 1st year and not more than 0.7% from 2nd year to 25th year.

13.2 Inverters

As PV array produce direct current electricity, it is necessary to convert this direct current into alternating current and adjust the voltage levels to match the grid voltage. Conversion shall be achieved using an electronic Inverter and the associated control and protection devices. All these components of the system are termed the “Power Conditioning Unit (PCU)”. In addition, the PCU shall also house MPPT (Maximum Power Point Tracker), an interface between Solar PV array & the Inverter, to the power conditioning unit/inverter should also be DG set interactive. If necessary. Inverter output should be compatible with the grid frequency. Typical technical features of the inverter shall be as follows:

Table 8: Inverter General Technical Particulars

Parameters	Description
Switching devices	IGBT/MOSFET
Control	Microprocessor /DSP

Parameters	Description
Rated capacity	100 kW above
Maximum DC voltage	1500 V
MPPT	Multiple
Nominal AC output voltage and frequency	800 V, 3 Phase, 50 Hz
Output frequency	50 Hz
Grid Frequency Synchronization range	+/- 5 Hz
Ambient temperature considered	-20˚C to 50˚C
Humidity	95% non-condensing
Protection of enclosure	IP-65 and outdoor
Grid Frequency Tolerance range	+/- 5 Hz
Grid Voltage tolerance	-20% to +15%
No-load losses	Less than 1% of rated power
Inverter efficiency (minimum)	>97% (without in-built galvanic isolation)
THD	< 3%
PF	0.8 lag ~ 0.8 lead
Protections	Over current and over voltage protections at both DC and AC sides of Inverter. Minimum type-II SPD or higher shall be acceptable.

- PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown;
- The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder;
- Built-in meter and data logger to monitor plant performance through external computer shall be provided;
- Anti-islanding (protection against islanding of grid): The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard;
- The Contractor shall be responsible for limiting DC injection into the grid and load as per the CEA/state regulations;
- The PCU/ inverter generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to the utility services should follow the latest CEA (Technical Standards for Connectivity Distribution Generation Resources) Guidelines;
- The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068-2 (1,2,14,30)/ Equivalent BIS Std;
- The MPPT units environmental testing should qualify IEC 60068-2 (1, 2, 14, 30)/ Equivalent BIS std. The junction boxes/ enclosures should be IP 65 (for outdoor)/ IP 54 (indoor) and as per IEC 529 specifications;

- The PCU/ inverters should be tested from the MNRE approved test centres/ NABL/ BIS/ IEC accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses.

Table 9: Applicable Indian and international Standards for Inverters

Standard	Description
IEC 62109-1, IEC 62109-2	Safety of power converters for use in photovoltaic power systems – Part 1: General requirements, and Safety of power converters for use in photovoltaic power systems Part 2: Particular requirements for inverters. Safety compliance (Protection degree IP 65 for outdoor mounting, IP 54 for indoor mounting)
IEC/IS 61683 (as applicable)	Photovoltaic Systems – Power conditioners: Procedure for Measuring Efficiency (10%, 25%, 50%, 75% & 90-100% Loading Conditions)
IEC 62116/ UL 1741/ IEEE 1547 (as applicable)	Utility-interconnected Photovoltaic Inverters - Test Procedure of Islanding Prevention Measures
IEC 60255-27	Measuring relays and protection equipment – Part 27: Product safety requirements
IEC 60068-2 / IEC 62093 (as applicable)	Environmental Testing of PV System – Power Conditioners and Inverters
Fuses	
IS/IEC 60947 (Part 1, 2 & 3), EN 50521	General safety requirements for connectors, switches, circuit breakers (AC/DC): • Low-voltage Switchgear and Control-gear, Part 1: General rules • Low-Voltage Switchgear and Control-gear, Part 2: Circuit Breakers • Low-voltage switchgear and Control-gear, Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units • EN 50521: Connectors for photovoltaic systems – Safety requirements and tests
IEC 60269-6	Low-voltage fuses - Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems

13.3 Module Mounting Structure

- Hot dip galvanized MS mounting structures may be used for mounting the modules/ panels/arrays on RCC roofs. Each structure should have angle of inclination as per the site conditions to take maximum insolation. However, to accommodate more capacity the angle inclination may be reduced until the plant meets the specified performance ratio requirements.
- The Mounting structure shall be so designed to withstand the speed for the wind zone of the location where a PV system is proposed to be installed (i.e. 47 m/s for Panipat). It may be ensured that the design has been certified by a recognized Lab/ Institution in this regard and submit wind loading

calculation sheet for approval. Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed.

- For pitched roofs, the supports for PV module mounting structure shall be taken from the main rafter (grid location). In case the supports are taken from purlins, the concentrated load should not exceed 75 kg at any support on the purlins. It is recommended a detail structural analysis considering actual materials properties at present and the existing load on the roof support structure during detail engineering phase of the Project.
- For RCC roof, the module mounting structure shall be designed considering 100 kg/m^2 as the load bearing capacity of roof.
- The mounting structure steel shall be as per latest IS 2062: 1992 and galvanization of the mounting structure shall be in compliance of latest IS 4759.
- Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts. Aluminium structures also can be used which can withstand the wind speed of respective wind zone. Protection towards rusting need to be provided either by coating or anodization.
- The fasteners used should be made up of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels
- Regarding civil structures the bidder need to take care of the load bearing capacity of the roof and need arrange suitable structures based on the quality of roof.
- The minimum clearance of the structure from the roof level should be 300 mm, for RCC type roof and 100 mm for pitched roof.
- MMS for pitched roof shall be of long aluminium rail with required accessories to take support from existing rafter or purlin of the roof.
- The Contractor shall perform a water leakage test of the pitched roof post mechanical completion prior to commissioning. The Owner shall select a sample roof area for water leakage test. The Contractor shall perform a water leakage test for 24 hours.

Codes and Standards

The Project shall conform to the relevant standards and certifications shown in Table 10

Table 10: Applicable Standards for Module Mounting Structures

Standard	Description
IS 800: 2007	Code of Practice for General Construction in Steel
IS 801	Code of Practice for Cold formed light gauged Steel
IS 875: Parts I-V	Code of Practice for design loads
IS 808	Hot rolled steel beams, channels and angle sections.
IS 1730	Dimensions for steel plates, sheets and strips for structural and General Engineering Purpose.
IS 816	Code of practise for use of metal arc welding for general construction in mild steel.
IS 822	Code of procedure for inspection of welds.
IS 2062	Specification of Steel for General Structural Purposes

Standard	Description
IS 2629	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
ASTM B308 / B308M	Standard Specification for Aluminium-Alloy 6061-T6 Standard Structural Profiles
ASTM B221	Standard Specification for Aluminium and Aluminium-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
ASTM B429	Standard Specification for Aluminium-Alloy Extruded Structural Pipe and Tube
AWS D1.2	Structural Welding Code, Aluminium.

13.4 ACCB and LV switchgear

- ACCB shall combine the AC power from PCU/ inverter and should have necessary surge arrestors. Interconnection from ACCB to mains at LV Bus bar while in grid tied mode.
- All switches and the circuit breakers, connectors should conform to IEC 60947, part I, II and III/ IS 60947 part I, II and III.
- The changeover switches, cabling work should be undertaken by the Contractor as part of the project.
- All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase 800 V.
- The panels shall be designed for minimum expected ambient temperature of 50˚C, 90% humidity and dusty weather.
- All indoor panels will have protection of IP54 or better. All outdoor panels will have protection of IP65 or better.
- Should conform to Indian Electricity Act and rules (till last amendment).
- All the 800 V AC devices / equipment like bus support insulators, circuit breakers, SPDs, VTs etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions
  - Variation in supply voltage : +/- 10 %
  - Variation in supply frequency : +/- 5 Hz

Codes and Standards

The Project shall conform to the relevant standards and certifications shown in Table 11

Table 11: Applicable Standards for ACCB and LV switchgear

Standard	Description
IEC 60947, part I, II and III /IS 60947 part I, II and III.	Low - Voltage Switchgear and Control gear
IS 13947	Low Voltage AC Switchgear and Control Gears Specifications
IS:13032 - 1991	Miniature circuit breaker boards for voltages up to and including 1000 volts AC.
IS 8623	Low Voltage AC Switchgear and Control gear assemblies
ISIIEC 82271-201 : 2001	High-Voltage Switchgear and Control gear part 201 AC insulation-

Standard	Description
	enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
IS 4237	General requirements for AC Switchgear and control gear for voltage not exceeding 1000 V.
IS: 6875(Part-1)-1973	Control switches (switching devices for control and auxiliary circuits including contractor relays) for voltages up to and including 1000 V AC and 1200 DC : General requirements and tests.
IS: 8828 - 1978	Miniature air break circuit breakers for voltages not exceeding 1000 volt.
IS 2147	Degree of protection for enclosures for low voltage Switchgear and control gear.
IS 5082	Electrolytic Copper / Aluminium
IS 14697	AC Electric Meters
IS 3043	Earthing
IS 2551	Danger Notice Plates
IS 2516	Circuit Breakers, voltages up to 1000 Volts
IS 4064	Air Break Switches, Air Break Disconnectors, for voltages not exceeding 1000V AC.
IS 375	Marking & Arrangement for Switchgear, Bus Bars, main connections and auxiliary wiring.

13.5 HV Switchgear

- The general construction of the HV Switchgear shall be factory assembled with fabrication processed on CNC type or equivalent machines.
- The switch boards shall be dead front totally enclosed, cubicle type suitable for floor mounted free standing indoor installations. The design shall be totally dust - tight damp-proof and vermin proof offering degree of protection not less than IP-42 for indoor applications and IP-54 for outdoor applications.
- Switchboards shall be in compliance to form 4 as per IEC. Separate segregated compartments shall be provided for breakers, Isolators, bus bars, cable box, voltage Transformers, wire ways, relays, and instrument and control devices. Switchboard shall be compartmentalised design and shall be provided with hinged doors in front and back with facility for padlocking doors.
- The panel shall have Vaccum Circuit Breaker(VCB) and same shall be drawing out type, motor operated with independent closing and shunt tripping from a suitable DC supply source. Breaker truck front panel shall house mechanical ON/OFF push actuators, manual & motorised mechanism, spring charge status, operation counter and any other provision as required to carry out safe operation.
- There will be bottom entry of the cables at the panel.

- 6.6 kV switchgear panel shall be equipped with metering and protection relays as indicated in drawings. Protection relay shall be numerical type and multifunction meter shall be digital with an accuracy class 0.2S.
- Circuit breakers shall be equipped with manual spring charge facility for closing the breaker as an alternative to motorized operation.
- The panel shall be equipped with Numerical relay for over current, earth fault, REF protection, Transformer OTI alarm and trip, Transformer WTI alarm and trip, MOG alarm.
- Breaker panels shall be compact in construction and metal enclosed with sheet steel of suitable thickness.
- All the metallic parts shall be suitably thick and shall use high tensile steel which shall be suitably treated & painted.
- 6.6kV Switchgear and panels shall be equipped with all the protections as required to complete the commissioning and for safe operations. 6.6 kV surge arrestors shall also be provided at the outgoing feeder.
- 6.6 kV bus shall be constructed in such a way that by operating one breaker preferably or as mutually agreed during detailed engineering (bus coupler) all inverters can be switched off during non-generating hours with the auxiliary system operational. The parties shall jointly discuss with the Original Manufacturers in case Supplier is unable to seek the relevant Warranties as agreed in the Contract.
- The bus bars shall be of high conductivity electrolytic copper, air insulated and housed in a separate compartment segregated from all other compartments supported by epoxy insulators. Busbars should have uniform cross sections with suitable capacity for carrying rated current continuously and short circuit current for specific time duration without overheating. All the bus bars shall be provided with colour coded heat shrinkable sleeves.
- Instrument Transformers shall be suitable for measuring and protection. Appropriate error limits, burden shall be selected for specified class of instrument Transformers. The CT and PT design and construction shall withstand system thermal and dynamic overloads.
- The switchboard shall be provided at the bottom throughout its entire length with adequately sized copper earth bus to carry the fault current for the same duration as short time rating of the circuit breaker. Earth bus shall have two earthing connection facility at its both ends of earthing conductor.
- All the Incoming and outgoing feeders shall be provided with multifunctional meter, which shall have an accuracy class of 0.2S with provision of measuring Import and export of energy. All relays shall be numeric type.
- Each breaker vertical shall be equipped with local/remote selector switch, emergency stop, TNC switch, indicating lamps showing breaker ON, OFF, TRIP, spring charge, trip circuit healthy, breaker in TEST/SERVICE position. Additionally, annunciation window with hooter shall also be provided.
- Space heaters shall be provided with each breaker vertical and there shall be provision for connecting 240V AC power at the panel.
- The Contractor shall submit all relevant calculations and drawings/ data sheets/ guaranteed parameters of the 6.6 kV Switchgear to the Purchaser for approval prior to commencement of manufacture.
- The Contractor shall ensure that all spare cable entry holes inside the cubicle be sealed with proper size rubber grommets.
- A continuous 75mm x 10mm GI earth bus shall be provided running along the full lengths of the panels.

- Suitable arrangement shall be provided at the two ends for connection to the Plant earthing system.
- Each panel and the equipment mounted on each panel shall be securely connected to the earth bus.
- For this purpose, the earth wire shall be looped from equipment to equipment and both ends of the earth wire shall be connected to the earth bus.

Codes and Standards

The Project shall conform to the relevant standards and certifications shown in Table 12

Table 12: Applicable Standards for HT switchgear

Standard	Description
IS 2516	Circuit Breakers.
IS 2705	Current Transformers
IS 3156	Potential Transformers
IS 13118	HV Circuit Breakers

13.6 Inverter Duty Transformer

- The inverter duty transformer, 3500 kVA, 6.6/0.8 kV rating shall be considered.
- The inverter duty transformer should be provided with separate galvanically isolated low-voltage windings for each Inverter. These shall be of converter duty and suitable for operation with pulsed Inverter.
- The inverter duty transformer should be rated for a maximum temperature rise of 50°C by oil temperature and 55°C by winding temperature with a daily average ambient temperature of 50°C.
- The inverter duty transformer shall have ONAN type cooling arrangement.
- The inverter duty transformer shall have off circuit tap changer with suitable numbers of taps
- The inverter duty transformer bushing shall be of solid porcelain.
- The Contractor shall submit all relevant calculations and drawings/ data sheets/ guaranteed parameters of the inverter duty transformer to the Purchaser for approval prior to commencement of manufacture.
- The inverter duty transformer tank should provide rigidity and dynamic ability to withstand pressure due to short circuit current. It should be capable of bearing all stresses during transportation and operation without any deformation.
- Low carbon steel grade plates that have been stiffened and reinforced may be used. Oil tight welds and joints shall be provided and measures should be taken to prevent internal corrosion of plates.
- Pressure Test: Fully assembled transformer with its radiators, conservator and other fittings shall be capable of withstanding a pressure equivalent to twice the normal head of liquid or 35 kN/m^2 in addition to the normal pressure, for one hour and measured from the base of the tank.
- Inspection opening and cover must be provided with handling equipment for easy access to bushing connections.
- The cover design shall avoid stagnant water and facilitate easy flow of gas bubbles towards the Buchholz relay.
- Design of magnetic shall be such as to avoid static discharge development of short circuit within itself or in earthed clamped structure.
- Core shall be of non-aging, high grade and low loss Cold Rolled Grain Oriented (CRGO) Silicon steel.

- The maximum permissible flux density for the laminations under the specified over voltage and frequency condition shall not exceed 1.5 tesla.
- Winding conductor should be electrolytic grade copper, free from scales and burrs.
- To avoid shrinkage during operation, windings shall be subjected to shrinkage treatment.
- The winding assembly should be full vacuum dried and then impregnated immediately in transformer oil.
- Oil will be pure hydrocarbon mineral oil, clean, free from moisture, and have uniform quality throughout.
- For the first oil filling of each Transformer, 10% extra oil of total quantity of oil in non -returnable shall be supplied.
- Sufficient number of radiators shall be made to meet the requirement of temperature rise.
- Radiators shall be detachable type directly mounted or separately mounted. Flanged, gasketed and bolted connections shall be used for connecting the radiators to the tank.
- Radiators shall be individually tested for leakage and pressure test etc. before connecting to tank.
- Each radiator shall have top and bottom shut off valves, top filling plug, bottom drain plug, lifting lugs, thermometer pockets at inlet and outlet pipes, air release devices, earthing provisions, filter valves and all other necessary accessories required.
- Radiator valves must indicate open and close direction clearly.
- Marshalling box fabricated using cold rolled sheet of at least 1.6 mm thickness shall be tank mounted, with a sloping roof. The box shall be tank protection of IP 65 as per IS: 2147.
- All the incoming cables shall enter the marshalling box from bottom.
- All outgoing connections from the transformer shall be connected to the marshalling box. It shall be enclosed in a metal casing and be weather and dust proof with a minimum of IP 65 certification.
- The temperature indicators shall be mounted at about 1600mm from ground level.
- Conservator with oil level gauge and plain silica gel breathing device shall be mounted integral with the tank in such a manner that the lowest oil level bushings remain under the head of liquid under all times.
- Volume of the conservator shall meet the requirement of expansion of total oil in Transformer and cooling equipment from minimum ambient to oil temperature of 90ºC.
- The oil filling hole shall have a cap and suitable drainage valve to completely drain the oil.
- One end of conservator shall be bolted to facilitate cleaning.
- Breathers shall be mounted at approximately 1400 mm above ground level.
- Pressure release devices operating at a static pressure below the hydraulic pressure of the tank shall be provided at all appropriate locations. The device shall also be equipped with potential free contact for alarm/trip and connected to the marshalling box.
- To avoid discharge spraying from the pressure release devices on the tank, the discharge shall be taken through pipes away from the Transformer.
- The Buchholz Relay shall be a double float relay as per IS 3637 with shut off valves on either side.
- Pot cocks at the top and bottom of the relay drain plug. An inspection window and calibrated scale for measurement, terminal box with oil tight double compression type brass gland.
- The angle of inclination should be between 3° and 7°.
- All valves shall be of gun metal only and of sluice type provided with hand wheels. The valves shall have padlocking facility in closed and open condition.
- Open and closed position shall clearly be mentioned on the valves.
- They shall be provided with blanking plates or screwed plugs.

- 150 mm dial type thermometers and 150 mm diameter dial type indicator shall be provided for oil and winding respectively. Minimum two potential free contacts for alarm and trip signals shall be provided. Temperature sensing equipment shall be connected through capillary tube.
- Temperature indicator dials shall have linear gradations to clearly read at least every 2ºC with ±1.5% accuracy or better.
- Transformer shall be equipped with protections like MOG, PRV, Buccholz relay, Explosion vent, OTI & WTI. Minimum two potential free contacts for alarm and trip contacts shall be provided for each protection.
- Transformer shall be having PS class CT for REF protection.
- Transformer shall be having CT installed at its neutral for Earth fault protection.
- The transformer foundation, fencing and oil soak pit (if required) for the transformer shall be constructed as per latest guidelines of CEA and applicable standards.
- The transformer shall be provided with a local control station for outdoor installation (IP-65) with canopy and having mushroom head stay put type Emergency Stop push button.

Codes and Standards

The Project shall conform to the relevant standards and certifications shown in Table 13

Table 13: Applicable standards for inverter duty transformer

Standard	Description
IS 2026	Power Transformers
IEC 61378 -1	Converter duty Transformers
IS 3639	Fittings and Accessories for Power Transformers
IS 2099	Specification of HV Porcelain Bushing
IS 7421	Specification of LV Porcelain Bushing
IS 10028	Practice for selection, installation & maintenance of Transformers
IS 335	New Insulating oils
CBIP1	Manual on Transformers
IS 3637	Buchholz Relay
IS 5561	Specification for terminal connector
IS 6600	Specification for overloading of Transformers
IS: 2147	Marshalling Box

13.7 Data Acquisition System / Plant Monitoring

- Data Logging Provision for plant control and monitoring, time and date stamped system data logs for analysis with the high quality, suitable PC. Metering and Instrumentation for display of systems parameters and status indication to be provided.
- Data logger shall be with Zero export feature and a control loop to ensure that the plant is switched-OFF when the main supply is OFF and back-up generator is ON.

[1] CBIP-Central Board of Irrigation and Power,

- **Solar Irradiance:** An integrating pyranometer / solar cell based irradiation sensor (along with calibration certificate) provided, with the sensor mounted in the plane of the array. Readout integrated with data logging system.
- **Temperature**: Temperature probes for recording the Solar panel temperature and/or ambient temperature to be provided complete with readouts integrated with the data logging system
- The following parameters are accessible via the operating interface display in real time separately for solar power plant:
  - AC Voltage.
  - AC Output current.
  - Output Power
  - Power factor.
  - DC Input Voltage.
  - DC Input Current.
  - Time Active.
  - Time disabled.
  - Time Idle.
  - Power produced
  - Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage.
- All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and read on the digital front panel at any time and logging facility (the current values, previous values for up to a month and the average values) should be made available for energy auditing through the internal microprocessor and should be read on the digital front panel.
- PV array energy production: Digital Tri Vector Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided. The Metering arrangement shall be as per Central Electricity Authority (Installation and Operation of Meters) (Amendment) Regulations, 2019. The Energy meter along with CT/PT should be of 0.2s accuracy class.
- Computerized DC String/Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box or separately.
- String and array DC Voltage, Current and Power, Inverter AC output voltage and current (All 3 phases and lines), AC power (Active, Reactive and Apparent), Power Factor and AC energy (All 3 phases and cumulative) and frequency shall be monitored.
- Computerized AC energy monitoring shall be in addition to the digital AC energy meter.
- The data shall be recorded in a common work sheet chronologically date wise. The data file shall be MS Excel compatible. The data shall be represented in both tabular and graphical form.
- All instantaneous data shall be shown on the computer screen.
- Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.
- Provision for instantaneous Internet monitoring and download of historical data shall be also incorporated.
- Remote Server and Software for centralized Internet monitoring system shall be also provided for download and analysis of cumulative data of all the plants and the data of the solar radiation and temperature monitoring system.
- Ambient / Solar PV module back surface temperature shall be also monitored on continuous basis.

- Simultaneous monitoring of DC and AC electrical voltage, current, power, energy and other data of the plant for correlation with solar and environment data shall be provided.
- Remote Monitoring and data acquisition through Remote Monitoring System software at the Client location with latest software/hardware configuration and service connectivity for online / real time data monitoring / control complete to be supplied and operation and maintenance / control to be ensured by the bidder.

13.8 Metering

The multi-function energy meter (0.2s class) shall be installed for the measurement of import/Export of energy in line.

Codes and Standards

The Project shall conform to the relevant standards and certifications shown in Table 14

Table 14: Applicable Indian and international Standards for Energy Meters

Standard	Description
IS 16444 or as specified by the DISCOMs	A.C. Static direct connected watt-hour Smart Meter Class 1 and 2 — Specification (with Import & Export/Net energy measurements)
CEA regulations	CEA regulation for Installation and Operation of Meters and the amendments thereafter

13.9 Protections

The system should be provided with all necessary protections such as over current, over voltage protections, earthing, Lightning, and grid islanding and not less than the requirements mentioned below:

13.9.1 Lightning protection

The SPV power plants shall be provided with lightning & overvoltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc. The entire space occupying the PV array (DC side) and balance of system components (includes AC side components) shall be suitably protected against lightning by deploying required number of lightning arrestors. Lightning protection should be provided as per NFC 17-102:2011 standard. The protection against induced high voltages shall be provided by the use of SPD type II and suitable earthing such that induced transients find an alternate route to earth.

13.9.2 Surge protection

Internal surge protection shall consist of SPD type II, surge-arrestors connected from +ve and -ve terminals to earth (via Y arrangement).

13.9.3 Earthing protection

- Each array structure of the PV yard should be grounded/ earthed properly as per IS:3043-1987. In addition, the lighting arrester/masts should also be earthed inside the array field. Earth Resistance shall be tested in presence of the representative of Department as and when required after earthing by calibrated earth tester. PCU, ACDB and DCDB should also be earthed properly.
- Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential

13.9.4 Grid Islanding

- In the event of a power failure on the electric grid, it is required that any independent power-producing inverters attached to the grid turn off in a short period of time. This prevents the DC-to-AC inverters from continuing to feed power into small sections of the grid, known as "Islands." Powered Islands present a risk to workers who may expect the area to be unpowered, and they may also damage grid-tied equipment. The Rooftop PV system shall be equipped with islanding protection. In addition to disconnection from the grid (due to islanding protection) disconnection due to under and over voltage conditions shall also be provided.
- A manual disconnect 4-pole isolation switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall be locked by the utility personnel.

Codes and Standards

In addition to the technical specifications mentioned above, the Project shall conform to the applicable, codes, standards and certifications but not limited to the list shown in Table 15.

Table 15: Applicable Indian and international standards for system protection

Standard	Description
IEC 62561 Series (Chemical earthing) (as applicable)	IEC 62561-1: Lightning protection system components (LPSC) - Part 1: Requirements for connection components IEC 62561-2: Lightning protection system components (LPSC) - Part 2: Requirements for conductors and earth electrodes IEC 62561-7: Lightning protection system components (LPSC) - Part 7: Requirements for earthing enhancing compounds
IS:3043-1987	Code of practice for Earthing
NFC 17-102:2011	Protection against lightning - Early streamer emission lightning protection systems
BFC 17-102:2011	Lightening Protection Standard
IEC 60364-5-53/ IS 15086-5 (SPD)	Electrical installations of buildings - Part 5-53: Selection and erection of electrical equipment - Isolation, switching and control
IEC 61643-11:2011	Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods

13.10 AC and DC Cables

- Cables of appropriate size to be used in the system shall have the following characteristics:
  - Shall meet IEC 60227/IS 694, IEC 60502/IS1554 standards
  - Temp. Range: –10°C to +80˚C
  - Voltage rating:
    - DC side – 1.5 kV
    - LV AC side – 1.9/3.3 kV
    - HV AC side – 6.6 kV (UE)
  - Excellent resistance to heat, cold, water, oil, abrasion, UV radiation Flexible
  - Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire solar system to the minimum (2%)
  - For the DC cabling, XLPO insulated and sheathed, FRLS, UV-stabilized single core multi-stranded flexible copper cables shall be used; Multi-core cables shall not be used.
  - For LV AC cabling, XLPE, FRLS & armoured single or, multi-core multi-stranded flexible copper/Aluminium cables shall be used; Outdoor AC cables shall have a UV-stabilized outer sheath.
  - For HV AC side A2XCEFY cabling shall be used.
  - The cable between the LV switchgear to the transformer shall be Copper conductor cable only.
  - The cables (as per IS) should be insulated with a special grade PVC/XLPE compound formulated for outdoor use. Outer sheath of cables shall be electron beam cross-linked XLPO type and black in colour.
  - The DC cables from the SPV module array shall run through a UV-stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5 mm.
  - Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers
  - All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm; the minimum DC cable size shall be 4.0 mm^2 copper; the minimum AC cable size shall be 4.0 mm^2 copper. In three phase systems, the size of the neutral wire size shall be equal or half to the size of the phase wires.
  - Cable Routing/ Marking: All cable/wires are to be routed in a GI cable tray and suitably tagged and marked with proper manner by good quality ferule or by other means so that the cable easily identified. In addition, cable drum no. / Batch no. to be embossed/ printed at every one meter.
  - Cable Jacket should also be electron beam cross-linked XLPO, flame retardant, UV resistant and black in colour.
  - All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, salt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. DC cables used from solar modules to array junction box shall be solar grade copper (Cu) with XLPO insulation and rated for required voltage level as per relevant standards only.
  - The ratings given are approximate. Bidder to indicate size and length as per system design requirement. All the cables required for the plant shall be provided by the bidder. Any change in cabling sizes if desired by the bidder shall be approved after citing appropriate reasons. All cable schedules/ layout drawings shall be approved prior to installation.

- Multi Strand, Annealed high conductivity copper conductor PVC type 'A' pressure extruded insulation or XLPE insulation. Overall PVC/XLPE insulation for UV protection Armoured cable for underground laying. All cable trays including covers to be provided. All cables conform to latest edition of IEC/ equivalent BIS Standards as specified below:
- BoS item / component Standard Description Standard Number Cables General Test and Measuring Methods, PVC/XLPE insulated cables for working Voltage up to and including (1.5kV DC / 3.3kV AC / 6.6kV AC), UV resistant for outdoor installation IS /IEC 69947.
- The total voltage drop on the cable segments from the solar PV modules to the inverter shall not exceed 2.0%.
- The total voltage drop on the cable segments from the solar grid inverter to the PoC building distribution board shall not exceed 3.0%.

Codes and Standards

The Project shall conform to the relevant standards and certifications shown in Table 16.

Table 16: Applicable Indian and international Standards for Cables

Standard	Description
IEC 60227/IS 694, IEC 60502/IS 1554 (Part 1 & 2)/ IEC69947 (as applicable)	General test and measuring method for PVC (Polyvinyl chloride) insulated cables (for working voltages up to and including 1100 V, and UV resistant for outdoor installation)
BS EN 50618	Electric cables for photovoltaic systems (BT(DE/NOT)258), mainly for DC Cables

13.11 Tools and Tackles and Spares

- Within one (1) month of Provisional Plant Acceptance, the Contractor shall free issue agreed spares and necessary tools and tackles. List of spares and tools and tackles to be supplied by the bidder for approval of specifications and make from owner during bidding.
- A list of requisite spares in case of PCU/inverter comprising of a set of control logic cards, IGBT driver cards etc. Fuses, MOVs / arrestors, MCCBs etc along with spare set of PV modules be indicated, which shall be supplied along with the equipment. A minimum set of spares shall be maintained in the plant itself for the entire period of warranty and Operation & Maintenance which upon its use shall be replenished.

13.12 Danger Boards and Signages

Danger boards should be provided as and where necessary as per IE Act. /IE rules as amended up to date. Three signage shall be provided at all key installation areas. Text of the signage may be finalized in consultation with Owner.

13.13 Fire Extinguishers

The firefighting system for the proposed power plant for fire protection shall be consisting of:

- Portable fire extinguishers for fire caused by electrical short circuits
- Sand buckets

- The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards.

13.14 Module Cleaning System

Suitable arrangement has to be made for wet cleaning of PV modules. The piping line and valves of adequate quantity for availing portable water at desired pressure at the PV array location suitable for PV module cleaning. The required tools for module cleaning such as wiper, hose pipe, soft cotton cloth etc. has also to be provided.

13.15 Drawings & manuals

- Two sets of Engineering, electrical drawings and Installation and O&M manuals are to be supplied. Bidders shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their bid along with basic design of the power plant and power evacuation, synchronization along with protection equipment.
- Approved ISI and reputed makes for equipment be used.
- For complete electro-mechanical works, bidders shall supply complete design, details and drawings for approval to Owner before progressing with the installation work

13.16 Planning and designing

- The bidder should carry out Shadow Analysis at the site and accordingly design strings & arrays layout considering optimal usage of space, material and labour. The bidder should submit the array layout drawings along with Shadow Analysis Report to Owner for approval.
- The Owner reserves the right to modify the landscaping design, Layout and specification of sub-systems and components at any stage as per local site conditions/requirements.
- The bidder shall submit preliminary drawing for approval & based on any modification or recommendation, if any. The bidder submits three sets and soft copy in CD of final drawing for formal approval to proceed with construction work

13.17 Drawings to be furnished by bidder after award of contract

The Contractor shall prepare list of documents as per Technical Specifications and furnish to the Owner or Owner's Engineer for approval of the same and Review of work schedule. Any part of the Facilities covered by or related to the documents to be approved by the Owner or Owner's Engineer shall be executed only after the Owner's or Owner's Engineer's approval thereof. The Contractor shall furnish the following drawings Award/Intent but not limited to and obtain approval:

- General arrangement and dimensioned layout
- Schematic drawing showing the requirement of SV panel, Power conditioning Unit(s)/ inverter, Junction Boxes, AC and DC Distribution Boards, meters etc.
- Structural drawing along with foundation details for the structure.
- Itemized bill of material for complete SV plant covering all the components and associated accessories.
- Layout of solar Power Array
- Shadow analysis of the roof

13.18 Safety measures

The bidder shall take entire responsibility for electrical safety of the installation(s) including connectivity with the grid and follow all the safety rules & regulations applicable as per Electricity Act, 2003 and CEA guidelines etc.

13.19 Display Board

The bidder has to display a board at the project site mentioning the following:

- Plant Name, Capacity, Location, Date of commissioning, estimated Power generation.
- The size and type of board and display shall be approved by Engineer-in-charge before site inspection.

13.20 Solar PV Module Cleaning System

The EPC Contractor shall provide the complete Module Cleaning System under this package. The adequate water pipeline network shall be designed on the rooftops for gravity flow as per appropriate Indian Standards with necessary specials like elbows, couplings, gate valves, air valves & scour valves. GI valves shall be used with specials couplings to ensure durability and ease of operation during O&M. If required a separate water tank and water pump of adequate capacity has to be provided.

There is potable water connection to each building. The water line on the roofs recommended considering each module is accessible for cleaning and the support structure used for walkway mounting shall be used for mounting water line. Adequate quantity of valves shall be provided on each roof so that water can reach to each module with the help of flexible pipe. 1/2" UPVC pipe is recommended for water line. Water line shall be connected with the existing water connection of the respective building. RINA recommends that the Client assess that the quality of the water to be supplied for module cleaning purposes meets with the requirements of the module manufacturer. In general, the water suitable for module cleaning should be:

- Water must be free from grit and physical contaminants that could damage the panel surface;
- Water must be free of floating oil or other immiscible liquids, floating debris, excessive turbidity, and objectionable odors;
- De-ionized water should be used to clean the modules. If de-ionized water is not available, rainwater or tap water can be used. Tap water must be of low mineral content with total hardness less than 75ppm;
- In case mineral content of water used is more than 75ppm but less than 200ppm the water must be squeezed off to prevent scale build up over module surface;
- Water with mineral content of more than 200ppm should NOT be used. Calcium should not exceed: 75 mg/ml;
- Chlorides should not exceed 200 mg/ml and water electrical conductivity should be < 250 mS/cm.

It is advisable to clean module surface twice a month or twenty times a year depending on the level of dust accumulation. The quantity of water required per cleaning or for one cleaning cycle is approximately 16 m^3. Water pressure should not exceed 35 bar (500psi) at the nozzle. Use of high-pressure hoses for cleaning may exert excess pressure and damage the modules. Temperature of water used for cleaning

should be same as ambient temperature at the time of cleaning. Cleaning should be carried out when the modules are cool to avoid thermal shock which can potentially cause cracks on it.

13.21 Battery and UPS

The Contractor shall provide a battery and UPS system adequate to provide backup power supply to data logger and Switchgears as per the Project requirements and Vendor recommendation.

13.22 Miscellaneous

In addition to all the standard equipment following supporting systems shall also be provided as required to complete the job.

- Power factor shall be maintained at the interconnection point as required by the State Utility. Although Inverters may operate at wide range of power factor, the Contractor shall provide capacitors / reactors if required by Grid regulations.
- Prior to actual parameterization of the Relays, the Contractor shall furnish detailed Calculations & Coordination for the Protection Relays to the Purchaser for approval.
- For MV level evacuation, approval of Switchyard and installation from local electrical inspectorate and to obtain final safety certificate.
- Liasioning with State Electricity Board and the Purchaser.
- Supply and installation of cable trays as required.
- For MV level evacuation, Supply, installation, testing and commissioning of control cables in Switchyard, as required.
- Firefighting equipment as per local standards.
- For MV level evacuation, Fencing, trenches, gravel filling of the complete Switchyard and Transformer.

13.22.1 Site Preparation

Site preparation shall cover all work as required for installation of a rooftop solar PV plant as per standard industry practices and shall include but not limited to the following activities:

- Cleaning of roof area e.g. removal of debris, temporary structure, structures considered to be partially or fully removed during design stage etc.
- Any civil or structural work required to enhance roof strength.
- Power and water arrangement for construction.
- For material storage, adequate platforms shall be provided on Site for storing galvanized structural members. These shall be placed over wooden rafters to avoid any deflection or corrosion of galvanization. PV modules and all other materials/ equipment shall be stored in compliance with manufacturer's guideline as required.
- Clearing area identified for cable routing, earthing conductor routing, and earth pit.
- Clearing area identified for water pipeline routing for PV module cleaning over the rooftop.
- Make provision for roof access and material lifting.

13.22.2 Ladder, Stair Case, Walk Way, Roof Guard Rail and Life Line

All the provisions shall be made for accessing complete solar PV plant area including PV Array area, Inverter and all other equipments. In case of sheet roof or RCC roof, adequate space of 1.0 m to 1.5 m shall be provided from all the external edges. As required as per best industry practice, to ensure the safety of personnel working at site during construction as well as O&M phase of the plant e.g. ladder, stair case, walkway, roof guard rail and life line shall be provided. The support for walkway mounting shall be taken from purlins of the roof similarly as module mounting is recommended. The walkway width shall be minimum 400 mm and design suitably for daily movement of persons.

13.22.3 Plant Layout: Inter-row Spacing for PV Mounting Structures

In addition to optimising the inter-row pitch for minimum shading, adequate inter-row spacing shall have to be maintained for cleaning of modules and accommodating walkway as per requirement. Although this will depend on the strategy adopted for module cleaning and shall be finalised during detailed engineering (subject to approval of the Owner).

13.22.4 Civil Infrastructure

All relevant Standards required for civil works shall be strictly adhered to. Civil works required for construction of Main Control Building shall include, but not limited to the following:

- RCC work shall involve appropriate design standards and design mix and cement reinforcement in accordance with relevant Indian standards. Reinforcement Steel shall be HYSD CRS of grade Fe 500. Industrial best practices shall be followed for bending and fixing of bars for concrete reinforcement.
- For all civil super structure works, ordinary Portland cement (OPC)/ Portland Pozalano cement (PPC) of 43/ 53 grade shall be used. Aggregate in general designate fine and coarse inert material shall confirm to IS383 or any other relevant standard applicable for India.
- Water supply: uPVC / HDPE pipes shall be used for water supply and plumbing works. The piping shall include all the required valves, stop cocks etc.
- In case of outdoor installation of Inverter, the Inverters shall be under appropriately sized sheds.
- After drilling the contractor shall insure that there will be no any water leakage in the shed and conduct the water proofing leakage test over the sheds.
- Nitobond EP or installing the leg member of the MMS directly on the RCC column or slab of the roof with the help of suitable wedge anchor bolt e.g., HILTI wedge anchor bolt.
- All outdoor MS structures to be used shall be galvanised with proper zinc coating having a minimum thickness of 85 microns for thickness more than 5 mm and 65 microns for thickness less than 5 mm. The Contractor shall ensure that all such structures are properly aligned and levelled. The Contractor also has to ensure, for cases where limited fabrication is required to be done at site, that the following aspects are taken care of:
  - Drilling of holes on structural steel members is done with proper drilling machine which cannot be make any harm over the placed materials or equipments below the shed. The drilling cannot be done through the use of gas cutting sets.
  - Cutting of structural steel members is done with proper tool and not through the use of gas cutting sets.
  - No rusted nuts/ bolts/ washers are used for fastening of members.

– In cases, where use of black metal is permitted by the Purchaser, no structural member shall be used without application of proper primer and paint.

13.23 Key Items, Minimum Technical Requirements and Preferred Makes

A list of key items, minimum technical requirements and preferred makes are given in Table 17.

Table 17: Key items, minimum technical requirements and preferred makes

Items	Item description	Preferred make
PV module	Mono c-Si PERC, 535Wp or above, 1500V	Canadian/JA/Jinko/Trina/Tier-1
Inverter	Grid-tied, string inverter, 100kW or above, 1500V DC, 800V AC, 3-ph, 50Hz, multiple MPPTs, SPD type-II (DC and AC)	SunGrow/Huawei/SMA/Ingeteam/Delta/reputed make
DC cable	1Cx6mm^2, Cu, XLPO, FRLS, 1.5kV grade	Leoni/Lapp
MC4 connectors	IP67	Staubli/Leoni/MC
AC cable	Al, 1.9/3.3kV grade, XLPE, FRLS AR	Polycab/Seichem/RR Kabel
AC Combiner Box	36kA MCCB, 800V, type-II AC SPD, earth fault protection, Red-Yellow-Blue (RYB) indicators, IP 65	L&T make MCCB / reputed make panel
LV switchgear	36kA MCCB, 50kA ACB, 800V, type-II AC SPD, earth fault protection, MFM, RYB indicators, IP 4X	L&T make MCCB and ACB / reputed make panel
HV Switchgear	6.6KV, 40KA	Siemens Make
Transformer	Inverter duty transformer 3.5MVA, 0.8kV / 6.6kV	VoltAmp / Essener / reputed make
ICOG panel work in existing panel)	6.6kV, 40kA, 1250A VCB and relay panel with transformer protection, energy meter, IP 4X, Supplier shall ensure proper matching of bus bar size and configuration	L&T make VCB / reputed make panel
Data logger and Weather Monitoring System (WMS)	The Data logger and Weather Monitoring System (WMS) shall be provided with a work station of suitable configuration (at least 1 TB hard disk, i7, 4GB RAM, 24" LED monitor) and an additional display / dashboard (at least 32") for data monitoring and display of plant performance parameters. The provided data logger shall be integrated with all the existing meters of the plant, solar plant and WMS. The required furnitures for the work station shall be provided by the Bidder. Pyranometer-2 nos., Module temperature	Datalogger – iPLON/SolarLog /Webdyn/ reputed make Pyranometer - Kipp&Zonen/ reputed make Others – reputed make

Items	Item description	Preferred make
	sensor- 2 nos.	
Control cable	Shielded RS485	Belden/reputed make
Earth pit	32mm diameter and 3m long Cu bonded rod, maintenance free earth enhanced material, cast iron pit cover and accessories.	Reputed make
Earth strip	25mmx6mm GI strip	Reputed make
Earthing cable (module and MMS earthing)	Module and MMS - 1Cx2.5mm^2, Cu cable PVC	Polycab / Seichem / RR Kabel / Reputed make
LA	ESE type, with 107m aerial distance	Reputed make
LA earthing cable	1Cx70mm^2, Cu cable PVC	Polycab / Seichem / RR Kabel / Reputed make
MMS (RCC roof)	Hot Dip Galvanized (HDG) MS, galvanization thickness should be at least 120 microns. HDG fasteners for MMS and Stainless Steel (SS)304 for module mounting.	Reputed make
MMS (pitched roof)	Long Aluminium rail of suitable size and with suitable accessories to mount on trapezoidal profile sheet roof and on purlins of the roof. SS304 for MMS and module mounting.	Reputed make
Cable tray	PosMAC of suitable size, with cover	Reputed make
Walkway	PosMAC suitably designed for required load and site design conditions	Reputed make
Ladder	Mild Steel (MS) suitably designed for required load and site design conditions	Reputed make
Lifeline	SS	Reputed make
Inverter mounting structure	Metal structure suitably designed for required load and site design conditions	Reputed make
Pipeline	uPVC, ½" and accessories	Reputed make
Fire extinguishers	Class E or CO_2 type	Reputed make
Signage	Photo luminescent & Weatherproof	Reputed make
Pneumarical Relay	Electrical Protection Relay	ABB , SIEMENS
Miscellaneous	Lugs, thimbles, sleeves, cable identification tags, wall anchors, conduits	Reputed make

Appendices

A. Layout

A separate attachment.

B. SLD

A separate attachment.