Enclosure 2 to Corrigendum 4 dated June 03, 2021 to Tender Specification BHEL PSSR SCT 1959

List of Approved Makes (07 PAGES)

Civil and Structural Supply portion		
i) Building Materials		
Sl.No	**Item Description**	**Category-I**
1	Flush doors	Kutti Flush Doors & Furniture Co. Pvt. Ltd.
		Shakti Met Dor Ltd
		Green Ply Industries Ltd
		National Plywood Industries Pvt
		Kitply
		Premier Doors
		Ply House
		Diamond Flush Doors
		Vidharbha Vaneer Industries
		Wood Crafts-Pondicherry
		Western India Plywood
		Goodavari Plywood
		Art Plywood
		P J Timber and Ply (Niki Door)
		Basic Hitech
		Steel Tech Industries
2	Plywood products, particle boards	Novapan Particle Boards
		Kitply
		Nuwood Particle Boards
		Green Ply Industries Ltd
		Century Plyboards(I) Ltd (CPIL)
		Swastik
		IPM
		Bhutan Boards
		Indian Wood& wood Products
		Sonear
3	Steel doors, Windows and ventilators	Shakti Met Dor Ltd
		Steeltech Industries
		Godrej Boyce
		NCL Secclor Ltd.
		San Harvice
		Multiwyn
		Supersteel Delhi
		Doorwyn
		Deccan Structural System

The sub vendor list furnished is tentative/indicative. Any new vendor may also be included during the execution stage with approval from M/s NLC.

		Agew steel manufacturer pvt ltd
		Chamundeshwari
		Rani Shutters, pondy
		Royal Fabricators
		Vinayaga,Chennai
		Metal Tech Constructions
		Clean Air system
4	Aluminum doors, windows, partitions	Alfab Products
		Ajith India Pvt. Ltd.
		Ajith India Ltd.
		Kalco-Alu Systems pvt ltd.
		Godrej
		Aardee
		Indal
		Noble Associates
		Glaze India
		Harsha Aluminium Company
		Ajith Aluminite
		Shakti Aluminium
		Satya Surya Aluminium Industries
5	FRP Doors	Meena FRP,Pondy
		Limras FRP doors,Coimbatore
		Ideal Fibre Glass Industry, Bangalore
6	Water proofing compounds/ construction chemicals	FOSROC
		SICA material of Construction
		Sika India Pvt ltd
		STP limited
		CICO
		Accoproof
		Dr Fixit
		Rofee
		Magnum & Co
		Impermo
		Fairmate
		Baucheme
		TS Waterproofing

The sub vendor list furnished is tentative/indicative. Any new vendor may also be included during the execution stage with approval from M/s NLC.

7	Paint and distempers	Berger paints
		Snowcem
		Asian Paint
		J&N paints
		Shalimar Paints
		ICI
		Nerolac
		Spectrum Decors
		Supa Coat
		Garware
		Indian Paints
8	Hardware Fittings and Fixtures.	H&R Johnson Limited
		Godrej Industries Ltd
		Parryware
		Hindware
		Acme
9	Metallic Floor Hardener	Ferro Chem India
		Sika India
		Dolphin Floats pvt ltd
10	Water stops-[PVC/Rubber]	PVC Water Stops Seal-Tata Rubber corporation
		Kanta Rubber Pvt. Ltd.
11	Expansion Joints	STP Limited
		Krishna Conchem Products limited
		Choksey Chemicals Pvt Ltd.
12	Water proof cement paints and exterior emulsion paints	Super Snowcem India Ltd.
		M/s NITCO Paints Pvt. Ltd.
		Asian Paint
		Berger paints
		J&N Paints
		Shalimar Paints
		Nerolac
		Supercem
		Indian Paints
13	Metal cladding system	Pennar Industries
		Lloyds Insulation

The sub vendor list furnished is tentative/indicative. Any new vendor may also be included during the execution stage with approval from M/s NLC.

		Tata Blue Scope Steel
		Multicolour steel india Pvt. Ltd
		Inter Arch Noida
		Lioyds Deck
		Everest
		Charminar
		Roof and Ceiling India Pvt. Ltd.Mumbai
		Colour Roof India Pvt. Ltd.
		Metal Craft Rollforming Industries ,Hyderabad
14	Glazing glass/Wired Glass	Triveni
		Saint Gobain Glass India Limited
		Modi Guard
		GSC Group
		Aluvations
		Asahi India Glass limited
		Navkush Enterprises
		NITCO
		Khajaria
15	PU Coating	Good Earth India Pvt limited
16	Plasticizer	Krishna Conchem Products Limited
		Sika India Pvt ltd
		C Mix India
17	SS Pipes	Apex Tube Pvt Ltd.
		Steel Tube Manufacturing Co.Pvt. Ltd.
		Divinie Tube Pvt. Ltd.
		Reliable Pipe and Tube Ltd. Ratnamani
ii) Sanitary and Water Supply Work (Internal) first Quality to be used)		
Sl. No.	**Item/System Description**	
1	PVC pipes & UPVC pipes and specials	Prince
		Finolex Industries Ltd.
		Supreme
		Dutron Polymers Ltd
		Centurion
		Appolo Pipes
		Kissan

The sub vendor list furnished is tentative/indicative. Any new vendor may also be included during the execution stage with approval from M/s NLC.

		True Bore
		Preimier
2	GI pipes & specials	Jindal Saw
		Bharat Steel Tube, New Delhi
		Tata Steel
		Jindal Pipes
		Tube Investments of India Ltd.
		India Steel Pipes
		Mahalakshmi Seamless Ltd.
		Indian Tube company ,Calcutta
		Kalinga Tubes limited,Cuttack
		Shivmoni Steel Tubes Ltd,Bangalore
		Jain Tubes,Ghaziabad
		Jindal Pipes
		Tata Heavy & Medium Class
		Swastik Pipes
		Hi Tech Pipes
		Zenith tube Co.Kolaba
		Gujrat Steel Tube
		Shekhar iron works ,Calcutta
		Khandelwel Tubes,nagpur
		Shri Lakshmi Metal udyog
3	W.C. pan wash basin, Urinals sink low down flushing Cistern & EWC	EID Parry,Chennai
		Hindustan Sanitaryware,Calcutta
		CERA
		H&R Johnson India Ltd.
		Nuchem Plastics Ltd. Faridabad
		Hindware
		Parryware
		Mahalakshmi Seamless
		Neyveli Ceramics,Tamil Nadu
		Raasi Ceramics-Secunderabad
		Commander Mumbai
		Bestolite Jasco Sales mumbai
		Duravit
4	Colour/ white glazed tiles,	Kajaria

The sub vendor list furnished is tentative/indicative. Any new vendor may also be included during the execution stage with approval from M/s NLC.

	ceramic tiles and Vitrified tiles.	
		H&R Johnson Tiles
		Naveen Ceramics
		Johnson
		Spartek
		Somani
		Bell Ceramics
		Nitco Ltd
		Nycer Company
iii) RCC Items		
Sl. No.	**Item/System Description**	
1	Cement	ACC Limited
		Ambhuja Cements Ltd.
		Ultratech cement Limited.
		J.K. Cement Ltd.
		Birla Corporation Ltd.
		Chettinad Cements.
		RAMCO Cements
		Tamil Nadu Cements
2	Structural Steel	Welspun corp Ltd Uttam Value Steels Ltd Topworth Steels & Power Pvt Ltd CG Ispat Ltd Goyal Energy & steel Pvt Ltd Jeevaka Industries Pvt Ltd KL steel Pvt Ltd Khyati Ispat Ltd Mahamaya Steel Industries Mahavir Steel Industries Nandan Steels & Power Ltd Prime Ispat Ltd Pushpak Steel Industries Pvt Ltd Ramsons castings Pvt Ltd Reliable sponge Pvt Ltd Shri Bajrang Alloys Ltd Splendid Metal Products Ltd Vandana Ispat Ltd Vandana Rolling Mills Ltd Madhav StelCo Pvt Ltd Shyam Metallics & Energy Ltd Gravity Ferrous Pvt Ltd Shri Rathi Steel Ltd BMM Ispat Ltd Anjani steels Ltd

The sub vendor list furnished is tentative/indicative. Any new vendor may also be included during the execution stage with approval from M/s NLC.

		Electrosteel Steels Ltd Kamachi Industries Ltd Shivali Udyog Ltd Vandana Global Ltd Fortune Metaliks Ltd Top worth Urja & Metals Ltd Steel Exchange India Ltd Real Ispat & Power Ltd M S Agarwal Foundaries Pvt Ltd Shri Bajrang Power & Ispat Ltd Prakash Ferrous Industries Pvt Ltd MS Metals & steels Pvt Ltd JSW steel Ltd RINL Ltd. ESSAR Steel Ltd. Steel Authority of India M/s Jindal Steel and Power Limited Beekay Steel Industries Limited ArcelorMittal
3	Reinforcement Steel	JSW steel Ltd Jindal Steel and Power Limited RINL Ltd. ESSAR Steel Ltd. Steel Authority of India Beekay Steel Industries Limited ArcelorMittal

The sub vendor list furnished is tentative/indicative. Any new vendor may also be included during the execution stage with approval from M/s NLC.

Enclosure 3 to Corrigendum 4 dated June 03, 2021 to Tender Specification BHEL PSSR SCT 1959

Contour Drawing (AutoCAD File)

(Enclosed as a separate file)

Enclosure 4 to Corrigendum 4 dated June 03, 2021 to Tender Specification BHEL PSSR SCT 1959

Extract of specification (02 pages) relevant to clarification provided at Sl. 18 in the Corrigendum

- In urinal area dadooing shall be provided with ceramic wall tiles up to 1500 mm height.
- All kitchen working tables shall be provided with granite finish and ceramic wall tiles up to 600 mm ht above kitchen working table.
- All corridors in residential buildings shall be provided with 900 mm ht skirting using ceramic wall tiles.

✓ **Painting :**

- All interior walls shall be provided with interior emulsion of two coats over a putty coat.
- All exterior walls shall be provided with two coats of exterior emulsion of anti-fungal & weatherproof quality. The emulsion paint for all external walls shall be of reputed brand suitable for masonry surfaces for high rainfall zone.
- All room ceiling shall be provided with interior emulsion (White colour)
- All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller. All paints shall be of approved make and quality.
- For steel members, Minimum 2 finishing coats of synthetic enamel paint shall be applied over a coat of Zinc based primer. For painting on steel work and ferrous metals, relevant BIS shall be followed.
- For painting on concrete, masonry and plastered surface IS: 2395 shall be followed.
- For windows safety grills, factory made with powder coated painting shall be provided.

✓ **Roofing :**

- In case of flat RCC roof - Ceramic weather proof roof tiles
- In case of sloped RCC roof - Terracotta red clay roof tiles/Mangalore pattern tiles

✓ **Water supply from power plant to township :**

- Contractor shall ascertain the total water requirement for integrated township considering 4 members per quarters/house and necessary provision for Non-residential buildings. Per capita water requirement shall be based on latest CPHEEO manual.
- Based on the detailed engineering, main pipeline of suitable diameter, thrust blocks, pipeline support structures, necessary pressure relief valves, Air valves, scour valves, fixtures, inspection chambers and

distribution pipeline network etc., shall be provided considering minor and major head losses.

- Cement Mortar lined Ductile Iron (CMDI) main water pipeline of suitable diameter shall be laid below ground level (Crust of pipe Minimum 1.20 m below ground level) from WTP in power plant to township including crossing Bhedan river via service duct in bridge, with suitable crossings across NH/SH/Other roads with required supporting structures (if any along the alignment) for a length of approximately 7 kms.
- Necessary route survey, required soil investigation shall be conducted along alignment of main water pipeline.
- Water pipeline shall be routed alongside dedicated approach road connecting power plant and township.
- Pipe testing to withstand the design pressure shall be carried out as per IS standards.
- Pumping systems with pump rooms at intermediate levels with standby pumps as per site requirement shall be provided.

✓ **Water supply within township :**

- Based on the detailed engineering, distribution pipelines of suitable diameter, thrust blocks, pipeline support structures, necessary, Air valves, scour valves, fixtures, valve chambers and distribution pipeline network etc., shall be provided considering minor and major head losses. Design calculations shall be made and executed for feeding the entire buildings in Township at a time.
- Main water pipeline after reaching township shall be pumped to RCC overhead tank (OHT) with minimum capacity of 3 lakh litres and minimum staging height of 24 m (based on design requirement) using booster pump of adequate capacity with standby arrangements
- OHT to be provided with pump room, lightning arrestor, GI ladder with proper approach with handrails from ground level for maintenance.
- For preliminary architectural drawing of Overhead tank, **Refer Annexure Drg no. C25**
- Also, provision to be given for adequate number of underground sump to meet the contingency situation. Minimum capacity of underground sump shall be 1 lakh litres.
- For preliminary architectural drawing of sump, Refer **Annexure Drg no. C24**

Enclosure 5 to Corrigendum 4 dated June 03, 2021 to Tender Specification BHEL PSSR SCT 1959

Detailed specification for solar roof top PV plant and other related details (34 pages)

			to approach road to township.	specifications.	township to power plant DELTED from scope of bidder. (ref corrigendum 3)	
63.	558 Section A - Infrastructure works/Chapter I Cl. 2 Page 12 of 280	Corrigendum 1	Plot Plan Drawing No. 18A03-DWG-M-002A Scope of work, Thermal Power Plant area 4 CISF – Barracks (G+2), Armoury and quarter guard, Canteen, security check post and toilet block	Township/ CISF Barracks is shown in the Plot Plan @ E810200/ N 2411450 Bidder understands that the particular area marked in the Plot Plan shall be utilized for construction of CISF Barracks (C+2), Armoury and Quarter guard, as per the scope of work of thermal power plant area mentioned in clause no. 2, Section A- Infrastructure, page 12 of 280. Canteen, security check post, toilet block and Integrated township are not envisaged in that area. Owner to please confirm Bidder's understanding.	Tentative Location indicated in North Eastern side of power plant (RHS of forest land) shall be used only for CISF Barracks (G+2), Armoury and quarter guard, Canteen, Security check post and toilet block. Exact location will be finalized during detailed engineering. Integrated Talabira township is not located in that area. For location of Integrated Talabira township refer key plan in Section A-Annexure Drg No. C1	Clarifications furnished
64.	564	TOWNSHIP Vol IB- Section B Chapter III Page 69	Layouts, design and drawings : ➢ Township layout with state of the art facilities and incorporating green building concept/features. For Indicative township	Bidder understands GRIHA, IGBC or similar Green building certification shall not be obtained. If 'Yes', please provide the rating.	Certification is not required. However, green building concepts shall be adopted in Integrated talabira township. In township area VIP Guest House, Type-I, Type-II, Type-III and Type-	As per requirement

			layout- Refer Annexure Drg no. C1		IV, Executive hostel shall be provided with roof top solar. For works covered in Section A, Thermal project office building shall be provided with rooftop solar as mentioned in technical specification.	
65.	565	TOWNSHIP Vol IB- Section B Chapter III Page 69	Architectural drawing including floor plans, elevations, cross sections with good aesthetic appearance and perspective view in colour for all buildings along with **3D Revit models** for all residential buildings, Auditorium, library, Guesthouse, VIP Guest house & community hall.	Bidder request to accept 3D models in other formats like Naviswork, Sketchup.	Acceptable	
66.	566	TOWNSHIP Vol IB- Section B	Tender drawings	Bidder requests Owner to provide autocad file of all Power plant and Township Tender drawings.	Bidder to refer Annexure drawing pdf files provided in tender document.	
67.	567	TOWNSHIP Vol IB- Section B Chapter III Page 72	Door /Windows	Bidder understands, that the detail specification of door, windows, partition and glazing shall be referred from specification Vol II-G1/ Section IV	Agreed.	

Name of Work:	Single EPC package of NLC Talabira Thermal Power Project in two Sections for 3x800 MW NLC Talabira Thermal Power Project(hereinafter referred to as NTTPP) near Kumbhari & Tareikela villages in Jhasurguda District, Odisha

<table>
<tr>
<td></td>
<td></td>
<td>entrance of township</td>
<td>
electrification
k) Park and playground
l) Gardening & walkway inside Type I, II, III & IV Blocks area
m) Statue/logo/beautification near main entrance of township
4. DESIGN, ENGINEERING, MANUFACTURE, INSPECTION AT SUPPLIER'S WORKS, SUPPLY, FABRICATION, INSURANCE, TRANSPORT, STORAGE, ERECTION, TESTING, COMMISSIONING OF ROOF TOP SOLAR OF MINIMUM 900 KW (AC) AS PER SPECIFICATION DETAILED IN SECTION-B (INCLUDING CIVIL, ELECTRICAL AND ALL OTHER RELATED WORKS ETC, COMPLETE) FOR FOLLOWING BUILDINGS IN TOWNSHIP :
<table>
<tr><th>Sl Nos</th><th>Building name</th><th>Effective roof area (sq. m) - 80%</th><th>Estimated Generated power (KW) (Min)</th></tr>
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Name of Work:	Single EPC package of NLC Talabira Thermal Power Project in two Sections for 3x800 MW NLC Talabira Thermal Power Project(hereinafter referred to as NTTPP) near Kumbhari & Tareikela villages in Jhasurguda District, Odisha

				1	Type IV Quarters	3373	240
				2	Type III Quarters	3331	230
				3	Type II Quarters	1747	125
				4	Type I Quarters (NLCIL)	1236	80
				5	Type I Quarters (CISF)	618	40
				6	Executive hostel	2172	150
				7	VIP Guest house	528	35
		C. EXTERNAL ELECTRICAL WORKS:			**TOTAL**	**13005 m^2**	**900 KW**
		Design, engineering, manufacture, inspection, testing at manufacturer's work, packing, assembling, and forwarding to site, transportation, unloading, storage at site, erection, painting, civil and structural works, insurance, supervision, testing, obtaining		C. EXTERNAL ELECTRICAL WORKS: Design, engineering, manufacture, inspection, testing at manufacturer's work,			

VOLUME: II-F/2

SECTION-XV

ROOFTOP SOLAR POWER SYSTEM

CONTENTS

VOLUME: II-F/2

SECTION-XV

ROOFTOP SOLAR POWER SYSTEM

1.00.00 SCOPE

1.01.00 The scope of this specification shall cover design, detail engineering, manufacture, quality surveillance, testing at manufacturer's works, packing, forwarding, supply, erection, connecting with nearest 415V PMCC/MCC, testing, commissioning and performance testing of Grid Tied Roof Top Solar Photovoltaic System (GTRTSPVS) with associated components for installation at the roof of all RCC buildings inside the entire Power Station and owner's buildings (Admin. Building.etc).

1.02.00 Preliminary estimated generated power through GTRTSPVS is 1.5 MWp (AC). The available roof top area of the building for erection of Roof Top Solar panels are mentioned in Annexure-B. Module power of 310 Wp or higher wattage shall be considered to meet the required solar power to be produced. To achieve 1.5 MWp AC 15% additional DC Power Output from Solar Panels are to be considered.

Final Plant Capacity shall be as per detailed approved engineering design of each of the building's roof top.

1.03.00 These systems shall be complete with poly-crystalline PV modules array mounting structures, inverter, generation & net metering, junction boxes, AC, DC distribution boards, cables & its accessories, communication interface to SCADA, Data logger/PC based monitoring system with laser jet A4 printer, grounding, lightning protection and any other equipment necessary for safe and efficient operation of the GTRTSPVS. It should be noted that PV module supporting structures shall be mounted on RCC blocks and under no circumstances chipping of existing roof will be permitted. Bidder shall provide necessary cable and its accessories for terminating solar output to the nearest 415V PMCC/MCC (bidder's scope and also other's package scope) and also provide cable for communication of data to the solar roof top control and monitoring system which shall be located at any of the control room building. The location for accommodating SCADA (DATA Acquisition System / Roof Top Solar Monitoring with CPU, LCD monitor, UPS, Laser Jet printer), Power Conditioning Unit with remote Monitoring system shall be decided during detailed Engineering.

1.04.00 The Roof Top system will comprises of several Roof Top Units. Each Roof Top separately (or collectively for small BOP Buildings, to be decided during detail engineering) connect with nearest 415V PMCC/MCC, having separate Dry type Isolation transformer and multi-function tri-vector ABT complied energy meters. The inter connection with the nearest 415V PMCC/MCC for net metering and obtaining statutory approvals, as necessary, connectivity of each Roof Top Unit

and hook–up to Energy management system shall be included in the scope. Energy management system under the bidder's scope. The Energy Management system shall have separate module for Roof top solar Energy management system and provision of data transfer to remote with required hardware and accessories shall be under bidder's scope.

Roof top solar system in various places can be grouped to have suitably rated capacity isolation transformer. The capacity is minimum 75 KVA to 700KVA of approximately 10 groupings could be done as indicated in the table given in Annexure B. This grouping is only indicative and actual rating and number of groupings may vary according to the actual site condition which will be considered during detailed Engineering.

1.05.00 Regarding earthing & lightning protection of complete solar system, bidder shall connect the same to nearest earthing and lightning protection strips at roof.

1.06.00 The scope of supply shall also include comprehensive insurance, storage & in-transit transportation.

1.07.00 Civil works for installation of complete system shall also be in scope of supplier. Bidder shall be careful in installing roof top solar panels at the building to avoid water leakage / seepage in the building roof. Bidder is responsible for any water leakage or seepage of the roof during the installation of solar panels in the buildings and the same shall be rectified by the bidder.

1.08.00 It is not the intent of this specification to specify completely herein all the details of design and construction of equipment. However, the equipment offered shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in commercial operation up to Bidder's guarantee in a manner acceptable to the purchaser, who will interpret the meaning of drawings, specification and shall have the power to reject any work or materials, which in his judgment are not in full accordance therewith. Owner's / Consultant's approval in all aspect shall be given due cognizance during the entire period of the contract.

1.09.00 It shall be responsibility of the Bidder to ensure that all the works as per scope of the specification are completed for safe and efficient working of the system.

1.10.00 It shall be responsibility of the Bidder to obtain all necessary clearances from the competent authorities, if so required.

2.00.00 CODES AND STANDARDS

2.01.00 All Equipment and accessories shall comply to requirement of standards published by Bureau of Indian Standards (BIS), international standard including IEEE for design and installation of grid connected PV system. The list of standards adopted shall be indicated in the bid.

2.02.00 The SPV Module must be provided with acceptable Test & Certified documents.

2.03.00 The quality of equipment supplied shall be generally controlled to meet the guidelines for engineering design included in the standards and codes listed in the relevant ISI and other standards, such as (these are in addition to those indicated in Section I of Vol. II-F1) :

- IEEE 928: Recommended Criteria for terrestrial PV power systems.
- IEEE 929: Recommended practice for utility interface of residential and intermediate PV systems.
- IEEE 519: Guide for harmonic control and reactive compensation of Static Power Controllers.
- National Electrical NFPA 70-1990 (USA) or equipment national standard
- National Electrical Safety Code ANSI C2 (USA) or equipment national standard.
- IEC: 61215 (2005) - Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
- IEC: 61730 - 1, - 2 Photovoltaic (PV) module safety qualification Part 2: Requirements for testing
- IEC: 60904-1(2006) Photovoltaic Devices - Part-I: Measurement of Photovoltaic Current-Voltage Characteristic
- IS 9000 Basic environmental testing procedure for Electronic and Electrical items

2.04.00 The PV power project developers will provide a copy of the valid type test certificate(s) / report(s) with the bid and routine type reports before the dispatch of the equipment.

3.00.00 SPECIFIC TECHNICAL REQUIREMENTS

3.01.00 Each solar PV system shall consist of following equipment:

a) The SPV modules
b) Power Conditioning Unit with Remote monitoring system / Inverters
c) SCADA (data logger) with CPU, LCD monitor, UPS, laser jet A4 printer
d) Mounting structures (Fixed Type)
e) IR / UV protected PVC Cable, control & Power cable

f) Junction box and distribution boxes

g) Earthing and Lightening protection

h) Surge protective device, Type-II

i) PVC pipes and accessories

j) Civil pedestals

k) Metering

3.02.00 **Solar Photovoltaic Modules** :

3.02.01 The PV modules used should be made in India.

3.02.02 The PV modules used must qualify to the latest edition of IEC PV module qualification test or equivalent BIS standards, Crystalline Silicon Solar Cell Modules IEC 61215/IS14286. In addition, the modules must conform to IEC 61730 Part-1 - requirements for construction & Part 2 - requirements for testing, for safety qualification or equivalent IS.

3.02.03 For the PV modules to be used in a highly corrosive atmosphere throughout their lifetime, they must qualify to IEC 61701.

3.02.04 The total solar PV array capacity should not be less than allocated capacity (kWp) and should comprise of solar crystalline modules of minimum 310 Wp and above wattage. Module capacity less than minimum 310 Wp shall not be accepted.

3.02.05 Protective devices against surges at the PV module shall be provided. Low voltage drop bypass diodes (Schottky) shall be provided.

3.02.06 Each solar PV module shall be warranted by the manufacturer for at least 90% of its rated power at the end of 10 years and 80% of its rated power at the end of 25 years from the date of system acceptance.

3.02.07 The efficiency of all photovoltaic modules measured at STC shall be minimum 15.20%

3.02.08 Fill factor of the module shall not be less than 0.70.

3.02.09 PV modules must be tested and approved by one of the IEC authorized test centers.

3.02.10 The module frame shall be made of corrosion resistant materials, preferably having anodized aluminum.

3.02.11 The rated output power of any supplied module shall have only positive tolerance.

3.02.12 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 % from the respective arithmetic means for all modules and/or for all module strings, as the case may be.

3.02.13 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, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP-65 rated.

3.02.14 The glass used to make the crystalline silicon modules shall be toughened low iron glass with minimum thickness of 3.2 mm for both 72 and 60 cell module. The glass used shall have transmittance of above 90%.

3.02.15 The back sheet used in the crystalline silicon based modules shall be of 3 layered structure. Outer layer of fluoropolymer, middle layer of Polyester (PET) based and Inner layer of encapsulant primer. The thickness of back sheet should be of minimum 300 microns with water vapour transmission rate less than 2 g/m2/day. The Back sheet shall have voltage tolerance of more than 1000 V.

3.02.16 The sealant used for edge sealing of PV modules shall have excellent moisture ingress protection with good electrical insulation (Break down voltage >15 kV/mm) and with good adhesion strength

3.02.17 The bidder shall provide the sample solar PV module electrical characteristics including current-voltage (I-V) performance curves and temperature coefficients of power, voltage and current. However, the tabulated document with all the relevant data like voltage, current, power output for all the modules also to be provided.

3.02.18 The PV modules shall be suitable for continuous outdoor use having highly corrosive atmosphere having relative humidity of 85% & temperature between 10^0C to 85^0C (module temperature) and Modules should have rugged design to withstand tough environmental conditions and high wind speeds suitable for site condition.

3.02.19 The PV module shall be made of high quality laminated in ultra violet stabilized polymer material such as Ethyl Vinyl Accelerate (EVA), Tedler, and toughened class. The size of single crystalline silicon PV cells shall be so chosen so as to maximize energy density and align with economies of scale.

3.02.20 PV module shall be provided with frame of anodized channels for size and simplicity in installation offered as a single module or series parallel combination of modules. The PV module shall be provided with screen-less frame with solar cable and connector.

3.02.21 The PV modules shall be equipped with bypass diode to minimize power drop caused by shade.

3.02.22 The PV modules shall be made of light weight cells, resistant to abrasion, hail impact, rain, water and environmental pollution. The PV modules shall be provided with anti-reflection coating and back surface field (BSF) structure to increase conversion efficiency.

3.02.23 The PV module shall use lead wire with weatherproof connector for output terminal.

3.02.24 Based on selected nominal output voltage, the number of modules to be supplied shall be worked out accordingly.

3.02.25 The terminal box on the module should have a provision for opening for replacing the cable, if required.

3.02.26 Plants installed in high dust geographies must have the solar modules tested with relevant dust standards (Applicable standard would be IEC 60068-2-68). Modules shall be designed for rugged design to withstand tough environmental conditions & maximum wind load 2400 Pa and snow load of 5400 Pa as per Safety standard IEC 61730.

3.02.27 Module deployed must use a RF identification tag. The following information must be mentioned in the RFID used on each module. This should be inside the laminated only. A strip containing the following details should be laminated inside the module as to be clearly visible from the front side.

- 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

3.02.28 Each string voltage, current and power shall be measured at data logger.

3.02.29 **Provenness Requirement** : The offered Solar PV module design series as per type certificate must have been in successful operation for at least one year as on date of issue of LOA. Each PV module used in any solar power project must use a RF Identification Tag (RFID) as per standard industry practices capable of withstanding harsh environmental conditions.

3.02.30 **Warranties** :

a. **Material Warranty** :

i. Material Warranty is defined as, the manufacturer should warrant the

Solar Module(s) to be free from the defects and/or failures specified below for a period not less than five (05) years from the date of sale to the original customer ("Customer")

ii. Defects and/or failures due to manufacturing

iii. Defects and/or failures due to quality of materials

iv. Non conformity to specifications due to faulty manufacturing and/or inspection processes. If the solar Module(s) fails to conform to this warranty, the manufacturer will repair or replace the solar module(s), at the Owners sole option

b. **Performance Warranty** :

i. The predicted electrical degradation of power generated not exceeding 20% of the minimum rated power over the 25 year period and not more than 10% after ten years period of the full rated original output.

3.03.00 **PCU or String Inverter** :

3.03.01 The DC power produced is fed to inverter for conversion into AC. In a Station interactive system AC power shall be fed to the station PMCC / MCC at three phase 415V AC bus. Power generated from the solar system during the daytime is utilized fully by powering the connected loads. In cases, where solar power is not sufficient due to more demand or cloud cover etc. the building loads shall be served by drawing power from the grid. The inverter should always give preference to the Solar Power and will use Grid power only when the Solar Power is insufficient to meet the load requirement. Inverter shall be of transformer-less design. The power conditioning unit/Inverters should comply with IEC-61727 or IEC-62116 or equivalent standard for grid connectivity. Required modification in CT control circuits and suitable cable termination in the purchaser breakers/ modules are also included in the scope.

3.03.02 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 and IEC 60068.

3.03.03 The output of the inverter must synchronize automatically its AC output to the exact AC voltage and frequency of the grid.

3.03.04 Inverter shall continuously monitor the condition of the grid and in the event of grid failure; the inverter automatically switches to off-grid supply within 20-50 milliseconds. The solar system is resynchronized with the grid within two minutes after the restoration of grid.

3.03.05 Grid voltage shall also be continuously monitored and in the event of voltage going below a preset value and above a preset value, the solar system shall be disconnected from the grid within the set time. Both over voltage and under

voltage relays shall have adjustable voltage (50% to 130%) and time settings (0 to 5 seconds).

3.03.06 Surge protective devices, type-II shall also be provided on DC and AC side of the inverter.

3.03.07 The inverter control unit shall be so designed so as to operate the PV system near its Maximum Power Point (MPP), the operating point where the combined values of the current and voltage of the solar modules result in a maximum power output. The string Inverter shall be suitable for parallel operation with current THD less than 3% at 50% load.

3.03.08 The inverter shall be a true sine way inverter for a grid interactive PV system. The degree of protection of the outdoor inverter panel shall be at least IP-65.

3.03.09 The PCU must have the feature to work in tandem with other similar PCU's and be able to be successively switched "ON" and "OFF" automatically based on solar radiation variations during the day. Inverters must operate in synergy and intelligently to optimize the generation at all times with minimum losses

3.03.10 Inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

3.03.11 The output of power factor of String 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.

3.03.12 Built-in 0.2s class TOD/ABT Compliance Bi-directional meter and data logger to monitor plant performance through external computer shall be provided.

3.03.13 Anti-islanding (Protection against Islanding of grid): The String shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.

3.03.14 Successful Bidders shall be responsible for galvanic isolation of solar roof top power plant at all locations with electrical grid on LT panel.

3.03.15 The PCU/inverters should be tested from NABL/BIS accredited testing-calibration laboratories or MNRE approved test center or international testing laboratories such as TUV, Intertek, UL etc.

3.03.16 Liquid crystal display shall at least be provided on the inverters front panel or on separate data logging/display device to display following:

- AC Output Voltage (V)
- AC Output Current (I)
- AC Power Output (kW)
- Power Factor (PF)

- DC Input Voltage (V)
- DC Input Current (I)
- Current time and date
- Time active
- Time disabled
- Time Idle
- Temperatures (°C)
- Converter status

3.03.17 Following shall also be displayed:

Protective function limits (viz. AC Over Voltage, AC Under Voltage, Over Frequency, Under Frequency, Ground Fault, PV Starting Voltage, PV Stopping Voltage, Over Voltage Delay, Under Voltage Delay, Over Frequency, Ground Fault Delay, PV Starting Delay, PV Stopping Delay).

3.03.18 Nuts & bolts and the inverter enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.

3.03.19 Dimension and weight of the inverter shall be indicated by the bidder in the offer.

3.03.20 All doors, covers, panels and cable exists shall be gasketed or otherwise designed to limit the entry of dust and moisture. All doors shall be equipped with locks.

3.03.21 **Operation Mode**:

Night or Sleep Mode: Where the Inverter is almost completely turned off, with just the timer and control system still in operation, losses shall be less than 2W per 5kW i.e. 0.04%.

Standby Mode: Where the control system continuously monitors the output of the solar generator until pre-set value is exceeded (typically 10W).

Operational of MPP Tracking Mode: The control system continuously adjusts the voltage of the generator to optimize the power available. The power conditioner shall automatically re-enter standby mode input power reduces below the standby mode threshold. Front panel shall provide display of status of the inverter.

3.03.22 **Synchronizing Equipment**:

Solar PV systems shall be provided with synchronizing equipment having input for comparison i.e. grid supply vs. solar output so as to connect the SPV systems in synchronism with grid. In case of grid failure, solar PV system shall

be disconnected from the grid and out of synchronization for a period grid supply is not restored.

3.04.00 **Protections and Control:**

3.04.01 PV system software and control system shall be equipped with islanding protection as described above. In addition to disconnection from the grid (islanding protection i.e. on no supply), under and over voltage conditions, PV systems shall be provided with adequate rating fuses, fuses on inverter input side (DC) as well as output side (AC) side for overload and short circuit protection and disconnecting switches to isolate the DC and AC system for maintenances are needed. Fuses of adequate rating shall also be provided in each solar array module to protect them against short circuit.

3.04.02 A manual disconnect switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personal to carry out any maintenance. This switch shall be locked by the utility personal.

3.05.00 **Metering Scheme:**

3.05.01 Metering is required to measure the Solar Gross Generation on continuous basis and register cumulative energy based on 15min interval basis, daily, monthly and yearly energy generation.

3.05.02 The average voltage and power factor based on 15min interval must also be recorded.

3.05.03 Meter must also display on demand, instantaneous, AC system voltages and currents, frequency, reactive power with sign, total harmonics current and voltage distortion etc.

3.05.04 Meters shall comply with the requirements of CEA Regulations on “Installation and Operation of Meters “.

3.05.05 Technical particulars of energy meters are indicated in clause 3.03.12.

3.05.06 An integrating pyranometer (class II or better) to be provided, with the sensor mounted in the horizontal and inclined plane at a shadow free suitable location near solar arrays. Readout shall be integrated with data logging.

3.06.00 **Power Quality Requirements:**

3.06.01 DC Injection into the grid: The injection of DC power into the grid shall be avoided by using an isolation transformer at the output of the inverter separately (or collectively for small BOP Buildings, to be decided during detail engineering) before connecting with nearest 415V PMCC/MCC. It is proposed to limit DC injection within 1% of the rated current of the inverter as per IEC 61727.

3.06.02 Harmonics on AC side

- Harmonic distortion is caused principally by non-linear load such as rectifiers and arc furnaces and can affect the operation of a supply system and can cause overloading of equipment such as capacitors, or even resonance with the system leading to overstressing (excessive voltage & current). Other effects are interference with telephone circuits and broadcasting, metering errors, overheating of rotating machines due to increased iron losses (eddy current effects), overheating of delta connected winding of transformer due to excessive third harmonics or excessive exciting current.

- The limits for harmonics shall be as stipulated in the CEA Regulations on grid connectivity which are as follows:
  - Total Voltage Harmonic Distortion= 3%
  - Individual Voltage Harmonics Distortion=2%
  - Total Current Harmonic Distortion=5%

3.06.03 Voltage Unbalance -The Voltage Unbalance in the grid shall not exceed 3.0%

3.06.04 Voltage Fluctuations:

- The permissible limit of voltage fluctuation for step changes which may occur repetitively is 1.5%.

- For occasional fluctuations other than step changes the maximum permissible limits is 3%.

3.07.00 **Communication Interface:**

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

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

3.07.02 The following parameters shall also be measured and displayed continuously:

- Solar system temperature
- Ambient temperature
- Solar irradiation / isolation
- DC current and Voltages
- DC injection into the grid (one time measurement at the time of installation)

- Efficiency of the inverter
- Solar system efficiency
- Display of I-V curve of the solar system
- Current, voltage and power in each string
- Any other parameter considered necessary by supplier of the solar PV system based on prudent practice.

3.07.03 Data logger with PC based monitoring system must record these parameters for study of effect of various environmental & grid parameters on energy generated by the solar system and various analysis would be required to be provided through bar charts, curves, tables etc.

3.07.04 The communication interface shall be an integral part of inverter and shall be suitable to be connected to local computer.

3.07.05 Solar Irradiance: An integrating Pyranometer (Class II or better) shall be provided, with the sensor mounted on a horizontal and inclined plane at a shadow free suitable location near solar arrays. No. of Pyronometer (minimum two (2) nos.) and its location shall be decided by the bidder subject to acceptance of owner during detail engineering.

3.07.06 Temperature: Temperature probes for recording the PV Cell temperature shall be provided.

The above data has to be integrated into the plant network for monitoring through main HMI or any computer. Any hardware required for the same shall be included in the scope.

3.08.00 **Mounting Structures / Array structure:**

3.08.01 Hot dip galvanized MS mounting structures may be used for mounting the SPV modules / panels / arrays on the Roof Top. Each structure should have tilting angle of inclination as per the site location in accordance with the latitude of the place of installation 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 steel shall be as per latest IS 2062: 1992 and galvanization of the mounting structure shall be in compliance of latest IS 4759.

3.08.02 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 (At Talabira– Max wind speed of 180 kM/ hour). It may be ensured that the design has been certified by a recognized Lab / Institution in this regard and submit wind loading calculation sheet to REIL. Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed. Mounting structures shall be designed to withstand the extreme weather conditions in the area. The risk coefficient factor (K1) shall be taken as 1.0. The terrain factor (k2) and topography factor (k3) shall be as per

IS 875. All fasteners including Nut & bolts shall be of Stainless steel - SS 304. Other hardware will have to be adequately protected against all climatic condition.

3.08.03 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.

3.08.04 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.

3.08.05 The total load of the structure (when installed with PV modules) on the terrace should be less than 60 kg/m.

3.08.06 The minimum clearance of the structure between the lower edge of the module and the roof level should be 300 mm for roof top solar power plant .For multiple module mounting structures located in a single row, the alignment of all modules shall be within an error limit of maximum 10mm

3.09.00 **Power and Control Cables:**

3.09.01 Power Cables of adequate rating shall be required for interconnection of:

- Modules / panels within array
- Within different Junction Boxes/Distribution box
- Inverter & 415V Main LT SWGR through distribution board

3.09.02 All AC power cable shall be 1.1kV grade, heavy duty, stranded copper / aluminum conductor, extruded cross-linked polyethylene (XLPE) / extruded PVC type A insulated, extruded flame retardant low smoke low halogen (FRLSH) PVC compound inner-sheathed conforming to type ST2 of IS: 5831 for multicore cables, galvanized steel wire / strip armoured, flame retardant low smoke low halogen (FRLSH) extruded PVC type ST-2 outer-sheathed. The cables shall, in general conform to IS-1554 & other relevant standards.

3.09.03 All DC power cables related to solar system located outdoor shall be 1.8kV DC grade, XLPO EBXL insulated (1200C continuous 2800C short circuit) tinned annealed single core copper conductor, flexible type as per TUV or UL specification. DC CABLE shall be TUV-2pfg 1169/09.2007 certified.

3.09.04 Power cables size for 415V systems shall be chosen taking into account the full load current & voltage drop. The allowable voltage drop at terminal of the connected equipment shall be max. 2.5% at full load. The derating factors viz. group duration of temp. duration shall also be considered while choosing the conductor size.

3.09.05 Control cable shall be 1.1kV grades, heavy duty, stranded copper conductor, extruded PVC type A insulated, extruded flame retardant low smoke low halogen (FRLSH) PVC compound inner-sheathed conforming to type ST1 of IS: 5831 for multicore cables, galvanized steel wire / strip armoured, flame retardant low smoke low halogen (FRLSH) extruded PVC type ST-1 outer sheathed. The cables shall, in general conform to IS- 1554 & other relevant standards.

3.09.06 The permissible voltage drop from the SPV Generator to the inverter shall not be more than 2% of peak power voltage of the SPV power source (generating system). In the light of this fact the cross-sectional area of the cable chosen is such that the voltage drop introduced by it shall be within 2% of the system voltage at peak power.

3.09.07 The DC cables from the SPV module array shall run through a UV-stabilized PVC conduit pipe of adequate diameter with a mini. all thickness of 1.5 mm.

3.09.08 Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4 compatible) and couplers.

3.09.09 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 to the size of the phase wires.

3.09.10 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

3.09.11 All connections should be properly terminated, soldered and / or sealed from outdoor and indoor elements. Relevant codes and operating manuals must be followed.

3.10.00 **Protection**

The system should be provided with all necessary protections like Earthing, Lightning, Grid Islanding, etc. as follows:

3.10.01 **Earthing and Lightning Protection**:

a) Earthing is essential for the protection of the equipment & manpower. Two main grounds used in the power equipment are :

- System earth
- Equipment earth

b) System earth is earth which is used to ground one leg of the circuit. For example in AC circuits the Neutral is earthed while in DC supply +ve is earthed.

c) In case of equipment earth all the non-current carrying metal parts are bonded together and connected to earth to prevent shock to the man power & also the protection of the equipment in case of any accidental contact.

d) To prevent the damage due to lightning the one terminal of the lightning protection arrangement is also earthed. The provision for lightning & surge protection of the SPV power source is required to be made. The entire space occupying the SPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors.

e) In case the SPV array cannot be installed close to the equipment to be powered & a separate earth has been provided for SPV System, it shall be ensured that all the earths are bonded together to prevent the development of potential difference between ant two earths.

f) Earth resistance shall not be more than 1 ohm. It shall be ensured that all the earths are bonded together to make them at the same potential.

g) The earthing conductor shall be rated for the maximum short circuit current & shall be 1.56 times the short circuit current. The area of cross-section shall not be less than 1.6 sq. mm. in any case.

h) The array structure of the PV modules shall be grounded properly using adequate numbers of earthing pits. All metal casing / shielding of the plant shall be thoroughly grounded to ensure safety of the power plant.

i) The protection against induced high-voltages shall be provided by the use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth. Internal surge protection shall consist of three MOV type surge-arrestors connected from +ve and –ve terminals to earth (via Y arrangement).

3.10.02 **Grid Islanding**:

a) 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. Inverter must comply IEC 61727 &/ VDE 026.

b) 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.

3.11.01 Junctions Boxes

a) The junction boxes are to be provided in the PV array for termination of connecting cables. The JBs shall be made of UV resistant material to avoid degradation during module life e.g. GRP / FRP / Powder Coated Aluminium / Cast Aluminium Alloy with full dust, water & vermin proof arrangement complying to IP65 degree of protection. All wires/cables must be terminated through cable lugs / MC4 compatible connectors. The JBs shall be such that input & output termination can be made through suitable cable glands.

b) Copper bus bars/terminal blocks housed in the junction box with suitable termination threads Conforming to IP65 standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry. Single / double compression cable glands. Provision of earthings. It should be placed at 5 feet height or above for ease of accessibility.

c) All fuses shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

d) Each Junction Box shall have High quality Suitable capacity Metal Oxide Varistors (MOVs) / SPDs, suitable Reverse Blocking Diodes. The Junction Boxes shall have suitable arrangement monitoring and disconnection for each of the groups. In order to provide protection to all cables and modules, string fuses shall be provided in both positive and negative legs of the string cabling. String fuses shall be of PV category and dedicated to solar applications and conform to IEC 60269-6 or UL-2579 standards.

e) The junction box used in the modules shall have protective bypass diodes to prevent hot spots in case of cell mismatch or shading.

f) Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.

g) All internal wiring shall be carried out with 1100V grade stranded copper wires.

3.11.02 DC Distribution Board

DC Distribution Panel Boards (DPB) to receive the DC output from the array field shall have sheet from enclosure of dust & vermin proof conform to IP 65 protection. The bus bars are made of copper of desired size. Suitable capacity MCBs/MCCB shall be provided for controlling the DC power output to the PCU along with necessary surge arrestors.

3.11.03 AC Distribution Board

a) AC Distribution Panel Boards (DPB) shall control the AC power from PCU/ inverter and should have necessary surge arrestors. Interconnection from ACDB to mains at LT Bus bar while in grid tied mode as per State / DISCOM authorities' requirement. Bus bar should be of Copper only.

b) All the Panel's shall be metal clad, totally enclosed, rigid, floor / wall mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz

c) All indoor panels will have protection of IP 42 or better. All outdoor panels will have protection of IP65 or better.

3.12.00 **String Monitoring Unit (SMU)**

Each series junction box (SJB) shall house string monitoring unit which shall give operational status of each string by current, voltage & power through shunt based sensors. SMU shall have RS485 port for communication with data logger. Foot print of PV strings showing the location of each SMU shall be displayed as screen shot on the monitor so that faulty SMU and string can be easily identified.

3.13.00 **PCU / Array Size Ratio**

3.13.01 Number of inverters shall be worked out by contractor, based on DC installed capacity and limit on overloading capacity (i.e. overload losses ≤ 0.2%). Project capacity shall be consider as lower of module or Inverter capacity in kWp.

3.13.02 The combined wattage of all inverters should not be less than rated capacity of power plant. Contractor may use higher capacity inverters.

3.13.03 Maximum power point tracker shall be integrated in the PCU/inverter to maximize energy drawn from the array. The MPPT unit shall confirm to IEC 62093 for design qualification.

3.14.00 **Weather Monitoring System**

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

3.14.01 <u>Pyranometer / Solar cell based irradiation sensor:</u>

i) Contractor shall provide suitable number (minimum 2 nos.) of pyranometers / Solar cell based irradiation sensor for measuring the incidental solar radiation at horizontal and inclined plane of array according to the size of plant

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

3.14.02 Thermometer:

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

3.14.03 Anemometer:

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

Details	Values
Velocity range with accuracy limit	± 0.11m/s upto10.1 m/s ±1.1% of true when more than10.1 m/s
Wind direction range with accuracy limit	0 to 360^{o} with accuracy ± 4^{o}

3.15.00 **Civil Works**

All associated civil works, including Design, Procurement & Supply and Erection of the rooftop solar power plant, in all respect for:

a) Embedment of structures suitable for mounting PV modules

b) Laying of earthing equipment / structures and connecting to the main ground mat as per the statutory requirements.

c) Necessary civil works for cable routing.

d) Necessary provision of water drainage at the roof top level.

3.16.00 **Cleaning / Washing Arrangement for SPV Panels**

An appropriate SPV panel washing / cleaning system complete GI pipes, hose pipes, wipers / mops, valves etc. shall be provided for regular cleaning / washing of the rooftop SPV modules. Minimum two sets of microfiber based cleaning tool are to be provided for each rooftop location. The system shall be specifically designed to take care of the harsh environment of thermal power plants. Source of water supply and drainage for this system shall be arranged by the bidder.

3.17.00 Not used.

3.18.00 **Danger Boards and Signages**

Danger boards should be provided as and where necessary as per IE Act. /IE rules as amended up to date. Signage shall be provided one each at solar array area, main entry to the connected PMCC/MCC room and other suitable areas to be decided during detail engineering in consultation with Owner. Text of the signage may be finalized in consultation with owner.

3.19.00 **Fire Extinguishers**

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

a. Portable fire extinguishers in the control room for fire caused by electrical short circuits

b. Sand buckets in the control room

The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing PCUs as well as on the Roof or site where the PV arrays have been installed.

3.20.00 **Data Acquisition System Monitoring**

3.20.01 Data Acquisition System shall be provided at one location of the scope of BOP building which will be decided during detail Engineering in consultation with owner and which in turn will be connected to plant main DDCMIS.

3.20.02 Data Logging Provision for 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.

3.20.03 Solar Irradiance: An integrating Pyranometer / Solar cell based irradiation sensor (along with calibration certificate) provided, with the sensor mounted in the horizontal and inclined plane at a shadow free suitable location near solar arrays. Readout integrated with data logging system.

3.20.04 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.

3.20.05 The following parameters are accessible via the operating interface display in real time separately for solar power plant:

a. AC voltage
b. AC Output current.
c. Output Power

d. Power factor.
e. DC Input Voltage.
f. DC Input Current.
g. Time Active.
h. Time disabled.
i. Time Idle.
j. Power produced
k. Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage.

3.20.06 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.

3.20.07 PV array energy production: Digital Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided. Energy meter along with CT/PT should be of 0.2s accuracy class.

3.20.08 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. SCADA System to be installed at Company's office only.

3.20.09 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.

3.20.10 Computerized AC energy monitoring shall be in addition to the digital AC energy meter.

3.20.11 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.

3.20.12 All instantaneous data shall be shown on the computer screen.

3.20.13 Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.

3.20.14 Provision for instantaneous Internet monitoring and download of historical data shall be also incorporated.

3.20.15 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.

3.20.16 Ambient / Solar PV module back surface temperature shall be also monitored on continuous basis.

3.20.17 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.

3.20.18 Remote Monitoring and data acquisition through Remote Monitoring System software at the owner 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.

3.20.19 The bidders shall be obligated to push real-time plant monitoring data on a specified intervals (say 15 minute) through open protocol at receiver location (cloud server). Suitable provision in this regard will be intimated to the bidders.

4.00.00 ACCEPTANCE OF SYSTEMS AND PERFORMANCE EVALUATION

The installer must verify that the system has been installed according to the manufacturer's procedures. A checkout procedure should be developed to ensure an efficient and complete installation.

5.00.00 SYSTEM DOCUMENTATION

It is essential that the owner have complete documentation on the system. System documentation should include an owner's manual and copies of relevant drawings for whatever system maintenance might be required in the future.

6.00.00 INSTALLATION

Installation shall be done by the licensed engineer who has adequate experience with installation of the PV system.

7.00.00 MAINTENANCE REQUIREMENT

7.01.00 Easy access shall be provided for all components in the SPV plant and grid connecting equipment. Maintenance platform shall be provided for easy inspection of all the equipment.

7.02.00 If special tools are required for installation and maintenance, the bidder shall indicate the same and to be supplied free of cost.

7.03.00 The Bidder shall furnish operating and maintenance instruction manual to enable the purchaser to carry out maintenance of equipment effectively and safely.

7.04.00 Washing / cleaning of SPV panels would be carried out as per the prudent practice of the supplier.

7.05.00 Bidder to note that the power plant atmosphere is laden with coal dust and ash and hence adequate maintenance access to all equipment shall be provided.

8.00.00 TEST AND TEST REPORTS

8.01.00 Type test certificates for all the tests specified for the factory built Solar PV modules, and the component parts shall be submitted by the Bidder along with the bid.

8.02.00 The Supplier shall carryout all routine tests as specified in relevant standards on all major components in presence of the purchasers representative at works before dispatch and furnish copies of test reports for purchaser`s approval, If required, stage inspection will be carried out by the purchaser.

8.03.00 Supplier shall carryout all routine and functional tests as specified in the relevant standards on the assembled SPV Plant with all accessories of the equipment in the presence of the Purchaser's representative before dispatch and furnish copies of the test reports for approval before dispatch.

8.04.00 Equipment shall not be dispatched unless the test certificates are duly approved by the purchaser.

8.05.00 Two sets of copies of the compiled and approved test certificates shall be submitted to the Purchaser.

9.00.00 DRAWINGS TO BE FURNISHED BY BIDDER AFTER AWARD OF CONTRACT

The Contractor shall furnish the following drawings after award / intent of contract and obtain approval:

a) Output Capacity calculation of each roof top solar plant with necessary supporting drawings/document

b) General arrangement and dimensioned layout and Schematic Block Diagram for the solar plant

c) Data sheets, Schematic Drawing and General arrangement drawings of SV panel, Inverter, Data logger, Junction Boxes, AC and DC Distribution Boards, meters, String Monitoring unit etc.

d) Structural drawing along with foundation details for the structure

e) Itemized bill of material for complete SV plant covering all the components and associated accessories

f) Overall layout showing SV Plant

g) Interconnection block diagram showing inverters, data logger, CPU, monitor, printer etc.

10.00.00 LAYOUT REQUIREMENTS

The overall dimensions of the SPV Plant shall suit the space provided for the layout requirements so that maximum number of solar PV modules shall be installed. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels.

11.00.00 INSTRUCTION AND O&M MANUALS

11.01.00 Two copies of Instruction and Operation and Maintenance Manual in English and the local language should be provided with the system.

11.02.00 The manual shall be furnished at the time of dispatch of the equipment and shall include the following aspects:

- Precautions during unpacking
- Instructions for handling at site.
- Erection drawings with written assembly instructions that would enable the Purchaser to carry out erection with his own personnel if opted by him.
- Detailed instructions and procedures for the installation operation and maintenance
- Pre-commissioning tests
- About solar PV system – its components and expected performance
- Clear instructions about mounting of PV module(s)
- About electronics
- DO's and DONT's
- Principle of Operation of various equipment
- Safety and reliability aspects
- Metering scheme
- About power conditioning units software and controls
- Clear instructions on regular maintenance and troubleshooting of solar power plant.
- Name and address of the person or service center to be contacted in case of failure or complaint.
- Outline dimension drawings showing relevant cross sectional views, earthing details and constructional features.

- Rated voltages, current and all other technical information which may be necessary for correct operation of the SPV plant.
- Catalogue numbers of all the components which are liable to be replaced during life of the SPV plant and all the component parts.
- Trouble shooting and diagnostic procedure

11.03.00 Customer training:

Bidder shall provide necessary training at factory / site for mutually agreed duration and number of persons to enable the purchaser to maintain the system.

ANNEXURE – A

RATINGS & REQUIREMENTS

A	**Site Data**	
	Site Ambient Temperature	4.3°C to 44.6°C
	Design Ambient Temperature	50°C
	Humidity	82% (Max.) non-condensing
B	**SPV Power Plant**	
i.	Output, kWp	As per roof area of the building, to be decided by the bidder and supporting drawings / documents shall be submitted for Client / Consultant's approval. However, Minimum total power to be generated through GTRTSPVS will be 1.5 MWp (AC) and no negative tolerance from quoted power rating on solar module shall be allowed.
ii.	No. of modules	To be decided by bidder supported by Calculation.
iii.	No. of series modules in one array	To be decided by bidder based on availability of Roof Area of a particular Building
iv.	No. of arrays in parallel combination	To be decided by bidder based on availability of Roof Area of a particular Building
v.	PV cell type	Crystalline Silicon Terrestrial (Mono / Poly)
vi.	Power rating of one module	Minimum 310Wp without any negative tolerance
vii.	Rated current of module	To be decided by bidder as per Manufacturer's standard
viii.	Rated voltage of module	To be decided by bidder as per Manufacturer's standard
ix.	Short circuit current of module	To be decided by bidder as per project requirement
x.	Open circuit voltage of module	To be decided by bidder as per project requirement
C	**Mounting Arrangement of SPVs**	
i.	Mounting	Fixed Type
ii.	Tilt angle (slope) of PV module	11.6°

D	**Inverter / Power Conditioning Unit (PCU)**	
i.	Number of unit	To be decided by bidder based on array design of a particular Building based on its Roof Area
ii.	Rated capacity	As per requirement
iii.	Continuous Output Power Rating	Min. 90% of solar array capacity should be provided to convert DC power produced by SPV modules to AC power
iv.	Input DC voltage range	To be decided by bidder based on array design of a particular Building based on its Roof Area
v.	Output Voltage	415V AC, 3 Phase.
vi.	Accuracy of output voltage	±1%
vii.	Frequency	50Hz
viii.	Accuracy of Frequency Control	±0.5%
ix.	Grid Voltage Tolerance	+/- 10%
x.	Grid Frequency Control Range	+/- 3Hz
xi.	Minimum Efficiency:	>93% (In case of 10 kW or above with in-built galvanic isolation) >97% (In case of 10 KW or above without in-built galvanic isolation) > 90% (In case of less than 10 kW)
xii.	Inverter no load losses	<1% of rated power and max. loss in sleep mode shall be <0.04%
xiii.	Power Factor (PF) Control	0.95 lagging to 0.95 leading
xiv.	Total Harmonic Distortion (THD)	< 3%
xv.	PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.	
xvi.	Built-in meter and data logger to monitor plant performance through external computer shall be provided.	
E	**Grid Connection Details**	
i.	Electrical parameters for interconnection	415V, 3Ph, 50Hz

GROUPING FOR ISOLATION TRANSFORMER ANNEXURE-B

SL. No.	BUILDING NAME	AVAILABLE AREA (M^2)	EFFECTIVE AREA (80%) (M^2)	ESTIMATED (KWp) GENERATED POWER	MIN. SIZE (KVA) OF ISOLATION TRAFO	GROUPING INFORMATION
1	TURBINE BUILDING	14500	11600	829	850	INDIVIDUAL Station Service PMCC
2	RAW WATER PUMP HOUSE& NEARBY	500	400	29	30	INDIVIDUAL –Raw Water PMCC
3	CLARIFIED WATER PUMP HOUSE	270	216	15	160	COMBINED – DM Plant PMCC
4	CHEMICAL HOUSE / LABORATORY	200	160	11		
5	EFFLUENT TREATMENT PLANT RO SYSTEM	1125	900	64		
6	DE-MINERALISATION PLANT	1000	800	57		
7	CIRCULATING WATER PUMP HOUSE	3500	2800	200	250	INDIVIDUAL – CW Service PMCC
8	AHP COMPRESSOR HOUSE	1600	1280	91	125	INDIVIDUAL –AHP Compress
9	CANTEEN	900	720	51	175	COMBINED – Misc. SWGR
10	FIRE STATION	900	720	51		
11	TIME OFFICE AND SECURITY COMPLEX	100	80	6		
12	MISC. BUILDING	770	616	44		
13	ADMINISTRATIVE BUILDING	1100	880	63	75	INDIVIDUAL
	TOTAL	**26465**	**21172**	**1511**	**1665**	

Note: Above Solar PV system capacity in each building and grouping are indicative only, the same will be decided during detailed engineering.