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Solar Roof Top System on the Roofs of

KARNA LAKE TOURIST COMPLEX, KARNAL (50KWp)

GENERAL & TECHNICAL SPECIFICATIONS

FOR

SOLAR SYSTEM

IMPORTANT NOTE

"BIDDER IS REQUESTED TO VISIT ALL THE SITES IN PERSON AND THEN SUBMIT THEIR BEST OFFER. ANY TYPE OF DENIAL /OBJECTION WILL NOT BE ENTERTAINED AFTER FINALIZATION OF ORDER."

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GENERAL SPECIFICATIONS

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1. BRIEF ABOUT THE PROJECT:

1.1 SCOPE OF WORK & TECHNICAL SPECIFICATIONS

Scope of work: The scope of the work is supplying, installing, testing and commissioning of 50 KW roof top solar power plant (Grid connected) at KARNA LAKE TOURIST COMPLEX, KARNAL (50KWp). This includes insuring, transportation, loading and unloading of all materials/equipment for the above work required for the above work.

The buildings identified for the above work are as follows: -

Sl. No.	Site Name	Proposed Capacity (KWp)
1	Hotel	30
2	Restaurent	10
3	Shops	10
Total		50

The bidder shall ensure that proper water treatment on the rooftops of buildings is provided at the time of installation of structure for mounting PV solar panels on roof tops. Further, if there are any water leakages in future during the warranty period (i.e. 5 years) in any of the buildings where the roof top solar panels are installed, then the bidder shall dismantle the roof top solar panels for water proofing and reinstall the solar panel once the water proofing work is done satisfactorily. The bidder shall bear the cost towards both dismantling and reinstallation of the solar panels in these buildings in such case. Further, if the water leakage in the rooftop is due to the installation of solar panels, then the water proofing cost shall also be borne by the bidder only. The bidder has identified only such buildings where future expansion is not present.

Note: Module of 300 Wp or above (approx. 170 Nos) shall be supplied by BHEL. Remaining all BoS supply shall be in bidder scope. **Bidder to note that storage, safe keeping, transportation, loading, unloading (including lifting and shifting) and insurance after unloading till installation of BHEL supplied items at site shall be in bidder scope.**

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Part A: General Scope

1. Services Related to supplies made by BHEL (Sl.No. 1 of BoQ)

Upon award of work for a particular site - Vendor has to identify central area within the CUSTOMER/user premises for unloading and storing of BHEL supplied items. Subsequent arrangement for unloading, safekeeping, shifting to site for installation shall be part of services to be offered by the Bidder associated with BHEL supplied items.

1.1. Unloading, safe storage and movement of supplied items received at site:

a) Vendor shall organize all necessary resources such as labour, machinery and tools, cranes, hydra, forklifts, transportation trucks/ trolleys, lifting accessories etc. for unloading the BHEL supplied items from the transport vehicle reaching identified location at site and subsequent movement to storage yards/sheds.

b) Similar arrangements shall also be made by vendor for movement of the stored items from storage yards/sheds to the exact construction locations within the project site.

c) Vendor shall maintain proper registers/ files/ records of invoices, LRs, delivery challans, material receipt certificates etc. Also, proper records shall be maintained to keep track of material entry (for storage) and material issue (for construction).

d) All such documents shall be suitably preserved for further handing over to BHEL.

e) Safety of items shall be in vendor scope. Accordingly, vendor will make all requisite arrangements for safe storage and preservation of BHEL supplied material.

f) All the equipment shall be handled very carefully to prevent any damage or loss. No untested wire ropes / slings etc. shall be used for unloading / handling. The equipment shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the stores shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at site.

g) The material received shall be properly inspected for any damage caused during transit and the Goods Receipt Document of the Transporter shall be acknowledged after verifying the condition of goods received. Any damage shall be immediately reported to BHEL. In cases when such information is not given to BHEL in time – it will be presumed that material was received in good condition by contractor and damage may have taken place at a later stage. Such damage or loss shall be attributable to the contractor.

h) Contractor shall ensure that while lifting slings shall be put over the points indicated on the equipment or as indicated in the manufacturer's drawings. Slings / shackles of proper size shall be used for all lifting and rigging purposes. All care shall be taken to safe guard the equipment against any damage.

i) Contractor shall be responsible for examining all the plant and materials issued to him and notify the Engineer immediately of any damage, shortage, discrepancy etc. before they are moved out of the stores / storage area. The contractor shall be solely responsible for any

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shortages or damages in transit, handling, storage and erection of the equipment once received by him.

j) The contractor shall maintain an accurate and exhaustive record-detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the engineer at any time.

k) All the material in the custody of contractor and stored in the open or dusty locations must be covered with suitable weather proof covering material wherever applicable and shall be blocked up on raised level above ground.

l) The contractor shall hand over all parts / materials supplied by BHEL and remaining extra over the normal requirement with proper identification tags and measurements to BHEL before site closure. Such intimation will be given in writing to BHEL well in time.

m) It shall be the responsibility of the contractor to keep the work / storage areas in neat, tidy and working conditions. All surplus/unusable packing and other materials shall be removed and deposited at location(s) as identified within the project premises.

n) All suitable lifting arrangement and local transport arrangement within premises for material handling at stores/yard/siding of BHEL/Customer/Vendor are included in scope.

o) Minor items (supply/installation/modification) such as Gland, lugs, nut bolt etc required for finishing completed and satisfactory working plant shall be done by bidder.

1.2. Preservation of components

a) After taking delivery from BHEL / customer's stores, plant materials storage shall be subjected to the following protection besides other provisions indicated in these specifications elsewhere.

b) Items stored outdoors shall be stacked up at least six inches (6") off the ground. Items should not be stored in a low lying area where water logging is a possibility.

c) Electrical items shall be stored indoors or otherwise protected against getting wet/ damaged, using suitable measures and should be protected from direct rain.

1.3. "Security & safekeeping of BHEL supplied material.

For all system capacities and in all situations – it is the prime responsibility of the contractor to ensure security and safekeeping of the BHEL supplied material till handing over of complete system in working condition to customer. The contractor will make their own assessment based on prevailing condition at site and will make all arrangements for security and safekeeping of BHEL supplied material. The contractor shall also indemnify BHEL towards any loss incurred towards loss of damage to BHEL supplied material.

2. Installation of BHEL Supplied items (Sl. No. 2 of BoQ)

2.1. SPV Modules:

Vendor Shall do the erection of the SPV module as per approved layout design of BHEL. After placing the purchase order on vendor, BHEL will provide layout drawings that will describe the exact way in which the series/parallel strings are formed. Vendor shall implement the interconnection as per these drawings. Required number of nuts and bolts for the erection of Modules shall be supplied by vendors. These will be **made of SS 304 material - NUTS, BOLTS AND PLAIN WASHERS.**

Installation activity shall include Placing on base, bolting, clamping with Structure material, Ferrule Marking near String. Other fasteners like Clamp, brackets, M6 Screws shall also be supplied as required additionally.

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Series interconnection of SPV modules to form strings

Vendor shall interconnect the SPV modules as follows:

a) Each module is fitted integrally with a junction box having positive and negative polarity cables (4 sq-mm).

b) Positive cable of one module shall be connected to the negative cable of adjacent module. **The cables have MC4 type of connectors to be supplied by contractor**. One polarity cable has male type connector, while the other has female type connector.

c) This way, Min 17 Modules shall be connected in series. Each set of connections is called as a series string. Series formation may change as per approved layout and design.

Interconnection of SPV module strings to string inverters

a) Vendor shall connect each series string of 17-20 SPV modules to the DCDB/string inverter using 1Cx 4 cable, copper, XLPO, unarmored as per TUV 2pfg 1169/08.2007.

b) MC4 connectors shall have rating of 1000VDC (IEC), rated current of 30A, Type approved by TUV Rhineland for product safety. **MC4 connector shall be supplied by Contractor.**

c) Min. Two sets of tool kits (with box enclosure) shall be supplied. This shall include crimping plier MC4, open end spanner set MC4, stripping plier MC4, socket wrench insert to tighten, socket wrench insert to secure etc.

Required number of MC-4 Connectors each set having a pair of male and female parts, to join both the cables along with ferrules shall be supplied by Vendor.

Bidder to check the module technical parameter along with Sr. No before final installation and fill the data in given format.

2.2. Installation of string inverters

Supply of string inverters is in vendor scope. Approximate weight of inverter 50-70 Kg.

a) Installation of string Inverter on Roof:

- On roof tops, the Inverter shall be mounted on MS stand that shall be attached by welding to the Roof top MMS.
- Minimum ground clearance shall be 500mm.
- In case of outdoor installation - Structure shall have canopy (as rain shade) made of GI sheet of minimum 2mm thick. Canopy shall be supplied and installed by Vendor.
- Earthing of inverter shall be done by 4sqmm CU wire **green colour.**

b) Installation of String Inverter on Wall:

- On wall, Inverter shall be mounted on mounting plate.
- Minimum wall clearance shall be 50mm.
- All structure items including hardware shall be in vendor scope of supply.
- Earthing of inverter shall be done by 4sqmm CU wire **green colour.**

2.3. Installation of AC combiner boxes (ACCB/ACDB)

Supply of AC Combiner boxes(ACCB/ACDB) is in vendor scope.

a) Installation of ACCB/ACDB on Roof:

- On roof tops, ACCB/ACDB shall be mounted on MS stand that shall be attached by welding to the Roof top MMS.
- Minimum ground clearance shall be 500mm.
- In case of outdoor installation - Structure shall have canopy (as rain shade) made of GI sheet of minimum 2mm thick. Canopy shall be supplied and installed by Vendor.
- All galvanizing shall be minimum 80 microns and as per IS: 4759, IS: 2629, IS: 2633

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- Vendor shall submit GA of the mounting structure along with stability calculations (STAAD.pro etc) for BHEL/CUSTOMER approval during detailed engineering.
- All structure/pedestal items including hardware shall be in vendor scope of supply.

b) Installation of ACCB/ACDB on Wall:

- On wall, Inverter shall be mounted on mounting plate.
- Minimum wall clearance shall be 50mm.
- All galvanizing shall be minimum 80 microns and as per IS: 4759, IS: 2629, IS: 2633
- All structure items including hardware shall be in vendor scope of supply.

2.4. Installation of DC distribution boxes (DCDB)

Supply of DC Distribution boxes(DCDB) is in vendor scope.

c) Installation of DCDB on Roof:

- On roof tops, DCDB shall be mounted on MS stand that shall be attached by welding to the Roof top MMS.
- Minimum ground clearance shall be 500mm.
- Structure shall have canopy (as rain shade) made of GI sheet of minimum 2mm thick.
- All galvanizing shall be minimum 80 microns and as per IS: 4759, IS: 2629, IS: 2633
- Vendor shall submit GA of the mounting structure along with stability calculations (STAAD.pro etc) for BHEL/CUSTOMER approval during detailed engineering.
- All structure/pedestal items including hardware shall be in vendor scope of supply.

d) Installation of DCDB on Wall:

- On wall, Inverter shall be mounted on mounting plate.
- Minimum wall clearance shall be 50mm.
- All galvanizing shall be minimum 80 microns and as per IS: 4759, IS: 2629, IS: 2633
- All structure items including hardware shall be in vendor scope of supply.

3. Installation of Structure for Module Mounting on rooftop/Tin Shed (Sl.No.3 of BoQ)

Vendor Shall do the erection of the Module Mounting as per approved layout design of BHEL. After placing the purchase order on vendor. Required number of nuts and bolts for the erection of Modules shall be supplied by vendors.

Wherever, welding is carried out, vendor shall arrange for proper grinding and cleaning of the weld surfaces, followed by application of Metal primer and Metallic aluminum paint. Pre-Galvanized parts shall be sprayed with Zinc spray after work.

Required number of nuts and bolts for the erection of MMS shall be supplied by vendors.

Note: NUTS, BOLTS AND PLAIN & SPRING WASHERS shall be made of SS 304.

4. Civil Pedestal (Sl.No.4 of BoQ)

Basic specification calls for Cement Concrete **1:2:4** (1 cement, 2 coarse sand & 4 graded stone aggregate 20mm nominal size). These will be mixed to get a compressive strength of 20 N/mm2 (M20 Concrete Grade).

Cement shall be good ISI Portland cement of reputed make. Cement bags shall bear ISI certification mark and date of manufacture. The sand shall be of river sand, clean & free from organic impurities. C.C. (1:2:4) concrete shall be mixed well in watertight platform in proportion as specified All ingredients in required proportion shall be mixed, first dry & than required quantity of water shall be added. Mixing shall be turned over twice or thrice, so that surface of the coarse aggregate coated

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with cement & concrete shall be used within half an hour of mixing. Any quantity remaining unused after an hour of mixing will not be allowed to use. The casted pedestals shall be cured minimum for ten days after completion of work. It shall keep well-watered & shall be protected from direct heat of sunlight by means of wet gunny bags.

Cement shall be procured by Vendor conforming to BIS: 8112 and / or BIS: 1489 Specification latest edition or higher Grade. The cement shall be procured directly from the reputed manufacturers/ stockiest as per approved list of BHEL/Customer. Relevant vouchers and test certificates will be produced as and when required. The cement shall be stored by the Vendor in such suitable covered and lockable stores, well protected from climate and atmospheric effects. The cement go-down shall be constructed by the Vendor as per the drawing in CPWD specifications at his own cost. The cement will remain under double lock, one from NBCC and other from Vendor. The cement in bags shall be stored in go-downs in easy countable position. Cement bags shall be used on first in first out basis. Cement stored for beyond 90 days will be required to be tested at Vendors cost, before use in works.

Concrete shall consist of cement, sand & graded stone in required proportion. Coarse aggregate for all concrete shall be graded crushed hard granite, trap or basalt stone and shall conform to the requirements. All materials shall be carefully & accurately measured in measuring box. Cement shall either be weighed or used in full bags. The required quantity of water shall be added by measuring in water cans. Concrete shall be mixed by mixer machine. Before any concrete is placed in position, all loose pieces of Timber, Stones, saw dust etc. shall be removed from the work. No concrete mixed 30 minutes' prior of placing in form shall be accepted. Proper water cement ratio shall be observed. Mechanical mixing method shall be adopted for mixing of concrete. The mechanical needle vibrator or other approved methods shall be adopted for compaction of the mix. The concrete consolidation shall be through & no honeycomb work (rough, pitted surface or voids in concrete) shall be allowed.

All the formwork shall be provided by the Vendor at his cost & shall be thoroughly wetted before the concrete is placed in position. Formwork shall be of approved quality. Where timber is used, the face in contact with concrete shall be plain & made smooth. All the joints in formwork shall be perfectly close to prevent the loss of cement slurry from concrete. After the form works are complete, the Vendor shall get it checked for strength, suitability & levels. For this advance intimation shall be given for inspection.

Sufficient number of framework/shuttering shall be maintained by the contractor at site to match the pace of the work required at site. Estimated number of shuttering is as specified below:

For capacity upto 100KW: 150 Nos.

J-Bolts –Supply & fixing:

The anchor bolts (J bolt) shall be sunk into the wet concrete by hand immediately after the concrete slab is poured. The anchor shall be standing straight and projecting, as the concrete hardens. 4 Nos. of J-bolt of straight length shall be used general of 200mm in addition to bent portion at unthreaded end as per standard and may change as per MMS design. These bolts are threaded at the top, for about two inches, and the rest of the bolt is smooth. Diameter of J bolt shall be 10mm and TWO nos. nuts each and suitable washers shall be supplied with each bolt. Arrangement shall be as per Drawing.

It is essential that a template or a plastic sleeve is used to hold the bolts in place until the concrete sets up enough to support the weight of the bolt. Using a template will help keep the bolts straight, plumb and the correct distance from each other.

Note: J-bolt shall be made of Galvanized steel and Nuts and washer shall be made of SS304.

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SAMPLING, INSPECTION & TESTING

Sampling and testing of concrete shall be carried out by drawing random sample during various stages of inspection. Guiding standard shall be IS: 516. Cube Test on selected sample after 7 days curing & 28 days curing shall be conducted for compression strength. Sampling plan as below:

Concrete in m^3/day work	No of samples
01-05	1
06-15	2
16-30	3
31-50	4
51 and above additional	4 plus one sample for additional 50 cum or part thereof.

Cube test report (in above time intervals) shall be submitted to this office along with final documents.

Pull Out Test

Pull out test of casted pedestals on roof shall be arranged by the contractor free of cost. Necessary arrangement to show that the pedestal is able to withstand the toppling load due to its dead weight and application of Nitto Bond. BHEL will specify the testing criteria based on roof condition and local site conditions and based on its own design of civil pedestals. The selected locations where pull out test shall be conducted shall be based on decision taken by BHEL site engineer and based on any specific customer requirement.

Lifting

Cost of Lifting of pedestals or raw material of pedestals upto the roof level is included in the contractor's scope. For buildings of height upto 4th floor and for Tin Sheds of height upto 5 Mtrs. – no additional charges shall be payable for lifting.

Preparation of Roof

Marking on the roof for the placement of pedestal shall be done by the vendor as per the approved layout.

Pedestal shall be placed after placement of the NITTO BOND on the roof. For particular type of surfaces like waterproofed roof etc. – NITTO BOND may not be required. In such cases – vendor will give prior intimation in writing to BHEL that NITTO BOND is NOT being applied by them. Unless such intimation is given – the vendor will be presumed to have used NITTO BOND in all cases and this will be part of site inspection by BHEL team.

Marked surface to be prepared cleaning the roof by wire brush after that NITTO BOND shall be applied on prepared roof.

Supply of **NITOBOND** is in scope of Contractor.

5. Monitoring of System Performance (Sl.No.5 of BoQ)

Vendor has to provide and install data logger device as per the approved make. This is required to enable data exchange between inverter & cloud server to get information on logging screen.

Data Acquisition System shall be provided for each of the solar PV plant.

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.

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~~**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 shall be 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. vii. PV array energy production: Digital Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided
- Computerized DC String/Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box. Computerized AC energy monitoring shall be in addition to the digital AC energy meter. It shall be taken care of by the Inverter itself and shall be available over data logger.
- 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 made available in Login 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 access 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.
- Remote Monitoring and data acquisition through Remote Monitoring System software at the owner 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.
- The bidders shall be obligated to push real-time plant monitoring data on a specified interval (say 15 minute) through open protocol at receiver location (cloud server) in XML/JSON format, preferably. Suitable provision in this regard will be intimated to the bidders.

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Web based Remote Monitoring system must be compatible with data logger. The system shall be provided with required accessories and **required SIM card** for wireless communication inside the premises. The rental and other costs of the SIM cards, IP address, Server charge (storage, access charge and other charges if any), and Rental charge of data communication for remote monitoring system for a period of Five (05) years shall be in Vendor's scope.
Items required during Installation like control cable, hardware, lugs etc shall be arranged by Vendor.

6. Cable Laying (Sl.No.6 of BoQ)

Supply of AC & DC cable in scope of Vendor.

Cable laying is in scope of Vendor laying details as follows:
All accessories for cable laying, including clamps, hooks, ties, double compression cable glands, cable lugs, SS304 bolts/ nuts/ plain and spring washers, anchoring arrangement shall be in vendor scope of supply. Cutting the wall/surface and making good the same as required is also included in the scope of the contractor. The Cable lengths supplied to site will NOT be in cut to size condition. Contractor has to arrange for cutting of the cables and jointing by using suitable cable jointing kits. All arrangement, tools & tackles in this regard will be in Contractor's scope.

Generally, jointing of cables in the run between two ends is not allowed. Hence, utmost care has to be taken while cutting required length of cables. The joints, as required otherwise due to any particular reason - shall be made only after getting prior consent from BHEL.

Vendor will submit scheme for cable laying within 15 days of site mobilization. This scheme will include following details:

(A) Approximate length of various sizes of cables based on routing agreed with customer/user during joint assessment at site. (Cable sizes shall be based on BHEL's Electrical Single Line Diagram).
(B) Approximate requirement of laying through Conduits, Treys, Excavation etc.
(C) Contractor to purchase the quantity of conduits, treys etc. after getting written acceptance from BHEL.

Method of measurement of length of cable laying

For the laying of 4 sq mm. DC cable (1 positive + 1 negative connection between different Modules) for formation of string – no additional charges shall be payable. This is covered in Module installation rate.

After the point where cables from different routes are bundled together – these will be routed through cable treys. For routing of cable in Bundles upto 5 parallel lengths on Treys/conduits – no additional charges shall be payable on account of laying of cable. Rates of conduits/treys have been considered elsewhere.

For laying of DC cables in bundles of 6 parallel or more – rates as applicable for maximum sizes of different slots shall be applied. For example – if 6 cables of 4 sq mm are grouped together for routing upto DCDB/AJB/Inverter – the applicable rates for 6x4=24 sq mm (upto 35 sq mm) shall be followed.

The cables shall be routed in such a way that the length of cables used is minimum and at the same time any specific requirement by customer/user is also complied with. The cables shall be grouped together to the maximum extent possible, while laying on treys/conduits. In case, BHEL observes during inspection that cable length has been taken on a higher side due to no particular such requirement and

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other better alternatives for cable routing are available – then BHEL will be free to ask for re-routing of the cable by the contractor without any additional charge.

Length of Excavation, Treys, Condiuits shall be calculated in measured length basis. These will be counted as one length only, for all cases in which clubbing of cables shall be done.

6.1. Routing of 1Cx4 cable below the SPV modules

a) 1Cx4 cables connecting the SPV module strings to DCDB/inverters shall be suitably routed below the SPV modules and along the horizontal purlin member of MMS structure. Also, the cables shall be fastened to the purlin using UV resistant cable ties that shall be in vendor scope of supply.

b) Spacing between two adjacent cable ties shall be so chosen as to ensure that there is no loose hanging of cables.

c) Cable ties, nylon polyamide 6.6 UV stabilized black, UL94 flammability rating V2, operating temperature up to 85 deg C, shall be used to arrest any possibility of movement or sagging. Width of the cable ties shall be minimum 4.5 mm. Length shall be so chosen as to ensure that the bunched cables are held firmly to the MMS structure. During detailed engineering, BHEL/CUSTOMER approval shall be obtained for the selected brand and sizes of cable tie.

6.2. Routing of 1Cx4 cable in GI cable trays

Where 1Cx4 cables run between two adjacent rows of structure and also where the cables run on the roof-floor up to DCDB/string inverters, routing shall be on GI cable trays Wx Hx t = 100x50x 2 mm, perforated type, with GI cover of minimum 2mm thick, coupler plates, GI hardware as per relevant IS standard. Suitable flexible PVC conduit shall be used wherever required for covering cable at entry into GI cable tray.

6.3. Termination of 1Cx4 (DC side), 3.5/4C AC cables at string inverters & ACCB/ACDB boxes

a) 1Cx4 cables of positive and negative polarities originating from SPV module strings shall be terminated at the DC input side of string inverters using MC4 connectors that are in vendor scope of supply for both ends.

b) For AC side connection at string inverters and ACCB/ACDB boxes, cable as per SLD, 1.1kV, Copper, XLPE, armored as per IS: 7098 part-1, together with nickel plated brass double compression cable glands, cable lugs, SS304 bolts/ nuts/ plain and spring washers shall be in vendor scope of supply. Termination shall be carried out using appropriate tools and torque setting as per BHEL/CUSTOMER approval.

6.4. Ferruling for 1Cx4 cable

a) For 1Cx4 DC solar array cable, vendor shall provide UV resistant ferrules printed with source/destination identification of cable connection. Printing details shall be submitted for BHEL/CUSTOMER approval during detailed engineering. Printing shall be of appropriate size to ensure readability.

b) Ferrules shall be provided on both the termination ends: module end, inverter end.

c) Supply of ferrule shall be in vendor scope. Make shall be reputed brand. Approval for make/ type/ color/ dimension etc shall be obtained from BHEL/CUSTOMER prior to procurement.

6.5. Underground cable trenches and laying of cables from buildings to building if required.

Routing of cables from buildings to buildings is not envisaged. However, if required due to specific conditions, such power, control, communication cables routed from one building to another building through underground cable trench (direct burying) as per IS: 1255.

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Typical trench details/dimensions are below only for tender purpose. During detailed engineering, cable trench layouts and cross section drawings as per IS: 1255 shall be submitted for BHEL/CUSTOMER approval.

i. Total trench depth = 750 mm minimum
ii. Trench width = As per number of cables/ DWC pipes
iii. Trench shall have layers one over the other as below (from bottom to top):
   a) Bottom layer shall be sand of IS: 383 with 75mm minimum thick.
   b) 3C power cables shall be laid over the sand layer.
   c) Another layer of sand of 75 mm minimum thick.
   d) Single layer of brick as protective cover
   e) Layer of sand of IS:383 with 75mm minimum thick
   f) All communication cables shall be laid within DWC pipe
   g) Layer of sand of IS:383 with 75mm minimum thick
   h) Single layer of brick as protective cover
   i) Trench shall, then, be filled with refill soil and compacted

Communication cables shall be routed through DWC pipe. Communication cables and DWC pipe shall be in vendor scope of supply. Vendor shall submit GTP/ make/ part number of the DWC pipe, accessories and tools for BHEL/CUSTOMER approval during detailed engineering. Bending radii for cables shall be as per IS: 1255.

At pathway/road/drain/trench crossings, cables shall be routed through GI pipe of appropriate size that shall be in vendor scope of supply and technical details / brand etc shall be submitted for BHEL/CUSTOMER approval. It shall be ensured that a maximum of 60% of inner space of GI pipe shall be occupied by cables.

Vendor shall take utmost care in laying the cables in order to prevent damages on outer sheath and inner insulation. In case cables found to be damaged/ cut after the laying in trenches, vendor shall remove the damaged portion and join the cut pieces using appropriate cable jointing kits that shall be in vendor scope of supply.

6.6. Laying and termination of RS485 cables

Vendor shall supply and install RS485 cable, copper, 2Px0.5, twisted pair, screened, armoured in daisy chain loops (a) from data loggers to string inverters and (b) from MFM meters of LT Panels to data loggers, (c) from weather monitoring system to data loggers. All cable accessories such as glands, lugs, ties, ferrules, tags, trays etc shall be in vendor scope of supply.

6.7. Identification marking of cables using cable tags

- Cable tags shall be provided at both ends of the cables: at SPV modules, string Inverters, data loggers, ACCB boxes, LTPDB panels and so on.
- Cable tag shall be of rectangular shape.
- Cable tag shall be of 2mm thick aluminum with number punched (embossed) on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280.
- Reference shall be made to "**Cable installation methodology**" of this specification. Vendor shall submit the technical details of cable tags, ID numbering scheme for BHEL/ CUSTOMER approval during detailed engineering.

6.8. Cable route markers

Cable route markers and joint markers for underground cables shall be provided along the route of the cables as per section "Cable installation methodology" of this specification.

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7. Supply and installation of Conduits (Sl.No.7 of BoQ)

Contractor shall supply along with all accessories for laying of cable through it and install **Double Wall Corrugated (DWC) HDPE pipe**, ISI mark IIS 1930 part 2 & latest IS 16205- part-24) pipes along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required. Conduits pipes shall be lay as per the approved drawing/make list/ Instruction provided by BHEL/Customer.

Method of measurement shall be as detailed against Sl. No. 6 above. The Scheme for laying of cable treys, conduits shall be submitted by contractor for approval of BHEL. After getting clearance from BHEL only – contractor shall make procurement of required quantity of cable treys, conduits etc.

8. Supply and installation of Cable trey (Sl.No.8 of BoQ)

Contractor shall supply along with all accessories for laying of cable through cable trey and install suitable size of Cable trey along with accessories in surface/recess including cutting the wall and making good the same in case of recessed trey as required. Cable Trey shall be lay as per the approved drawing/make list/ Instruction provided by BHEL/Customer. The Cable Trey shall be of GI material.

All couplers, fixing screws, 45/90 degree bends, intersections, dividers are included in scope.

For cable routing through exposed surfaces to rain – Cable Trey lid and Standoff brackets (for suitably raising the trey above surface for rain protection by minimum 50 mm) shall be used. Also, for important indoor locations Cable Trey lid shall be used for best aesthetic purpose.

Method of measurement shall be as detailed against Sl. No. 6 above. The Scheme for laying of cable treys, conduits shall be submitted by contractor for approval of BHEL. After getting clearance from BHEL only – contractor shall make procurement of required quantity, particular size of cable treys.

Vendor has to supply and installed **cable trey (with cover)** with accessories.

Cable Trey shall be lay as per the approved drawing/Instruction provided by BHEL/Customer.

9. Supply and installation of Earthing strip with all accessories (Sl.No.9 of BoQ)

Vendor has to supply and install Earthing strip of Galvanized steel material of following size:

a) 25x5 mm OR

The Scheme for laying of Earthing strips shall be submitted by contractor for approval of BHEL. After getting clearance from BHEL only – contractor shall make procurement of earthing strip material in required quantity, particular size.

10. Supply and installation of Lighting Arrestor with all accessories (Sl.No.10 of BoQ)

Vendor shall supply, install and commission Copper Globe Type lightning arrestors at the rooftops alongwith GI **25x5** down conductors as base and suitable mounting arrangement for LA on PCC block as part of this scope. The GA drawing of LA, number and location of installation and support arrangement shall be submitted to BHEL for approval before making procurement of this item. All items in vendor scope of supply and installation. LA shall be supplied as per Indian Standard.

The main aim in this protection shall be to reduce the over voltage to a tolerable value before it

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reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc. The entire space occupying the SPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors.

Necessary foundation / anchoring for holding the lightning conductor in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future. The lightning conductor shall be earthed through flats and connected to the earth mats as per applicable Indian Standards with earth pits (rates of earth pits, GI strips covered elsewhere in scope).

11. Supply of Earthing Material and Installation after making of Suitable Pit as per standard (Sl.No.11 of BoQ)

Solar array MMS structures, string inverters, data loggers, ACCB/ACDB boxes, LTPDB and lightning arrestors etc shall be provided with appropriate earthing for protection against faults as guided by **IEC 60364/IS:3043-1987.**

Earthing system shall be designed with consideration of the soil resistivity of the project site. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed. Vendor shall submit design calculations for earth grids/ system for roof-top equipment's and lightning arrestors for BHEL/CUSTOMER approval during detailed engineering.

Chemical earthing electrodes of 3m minimum long, 50 mm minimum diameter, perforated GI pipe, chemical compound filled, double walled shall be installed at the ground level outside the buildings. For each electrode, earth chamber shall be constructed using brick masonry.

Vendor to ensure that earthing resistance shall be minimum **05 Ohm**.

Electrodes shall be supplied as per approved make of BHEL/CUSTOMER or during detailed engineering.

GI flat earthing terminal points and sizes :

(a) 25x5 mm for MMS structures:
  (1) structure to structure,
  (2) interconnection of structures of all rows,
  (3) from top of buildings to the chemical electrodes at ground level.

(b) 25x5 mm/Equivalent cross section for string inverters, data loggers, ACCB box, lightning arrestors at roof-top

The Earth chamber shall have features as follows:

(a) Square sized with 300mm x 300mm minimum inner opening. Exact size shall be chosen to ensure ease of maintenance operation using spanners etc.
(b) Brick wall thickness all around = 115 mm minimum
(c) Depth of chamber = 500 mm minimum below FGL.
(d) Projection of chamber above FGL = 150mm minimum
(e) Top of electrode shall have minimum clearance of 100 mm below cover plate.
(f) Cover plate, cast iron of 5mm minimum thickness, square shaped to fit the opening of chamber, painted with red oxide and two coatings of black paint both sides.
(g) Cover plate shall have suitable lifting hooks and padlocking arrangement.
(h) Both the outer and inner walls of the brick wall shall be plastered and painted as per relevant clauses of "General civil works" of this specification.
(i) Supply and installation of all materials shall be in vendor scope.

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General points:

i. All items related to earthing viz electrodes, GI flats, hardware etc are in vendor scope of supply.
ii. GI bolts, nuts, plain washers shall be used. Spring washers shall be zinc/epoxy coated.
iii. Wherever applicable, welding for GI flats shall be carried out using electric arc welding. Both the flats shall be overlapped for the full width where they are in perpendicular direction in same plane. Where the connection is along same line, both flats shall be overlapped for a minimum of 50mm. L-bend with weld length of 50mm minimum shall be adopted wherever overlap length to be ensured.
iv. Resistance of welded joint shall not be more than that of GI flat.
v. Welds shall be treated with red oxide for rust protection and then coated with bitumen compound for corrosion protection.
vi. While laying earthing electrodes, adding/mixing of chemical compound and water around the electrode in the dug hole shall be as per instructions of OEM. Vendor shall ensure visit of OEM engineer to site at the time of installation for proper guidance/ supervision.
vii. Other applicable standards:
   - IS: 2629: Recommended practice for hot dip galvanizing of iron and steel - IS: 2633: Method for testing uniformity of coating on zinc coated articles
   - IS: 6745: Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
   - IS: 513: Cold rolled low carbon steel sheets and strips
   - IS: 3063: Fasteners single coil rectangular section spring washers

In compliance to Rule 11 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode.
All equipment earthing (inverter/DCDB/ACDB/ACCB/LT Panel etc) shall be earth by using a green colored 4Sqmm Cu wire (with ring type lugs) from equipment respective earthing terminal to earthing strip.

12. Supply and fixing of Name Plate (Sl.No.12 of BoQ)

The quantity mentioned in the BoQ shall be only to meet specific requirements of the Customer specification/Signage for Name plate. These will be generally of size 250x200 mm of steel material and of thickness 2 mm.

In addition to this, Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site. For all other places where it is required to fix danger plates as per Good Engineering practice and as per Latest Electricity Act stipulations – the same shall be complied with.

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Part B Special Scope

1. Installation of BHEL supplied items

a. Installation of ISOLATION TRANSFORMER (Sl.No.1 of BoQ)

To avoid surge injection to Charging station, shall be avoided by using an isolation transformer at the output of the inverter. isolation transformer shall be supplied by BHEL. Following works are in bidder scope

1. Preparation of foundation for transformer
2. Installation of transformer
3. Cable termination by using suitable cable lugs
4. Earthing of transformer
5. Barricading of transformer

b. Installation of Charger Distribution Box supply

Charger distribution Box (**Double door type**), shall be supplied by BHEL. Following works are in bidder scope

a) Preparation of foundation
b) Installation of CDB
c) Cable termination by using suitable cable lugs and metal glands
d) Earthing of CDB

2. Integration with existing DG (Special Scope/Part B – Sl.6)

The output power from SPV would be fed to the inverters which converts DC produced by SPV array to AC and feeds it into the main electricity grid after synchronization. In case of grid failure, or low or high voltage, solar PV system shall be out of synchronization and shall be disconnected from the grid. Once the DG set comes into service, PV system shall again be synchronized with DG supply and load requirement would be met to the extent of availability of power. 4 pole isolation of inverter output with respect to the grid/ DG power connection need to be provided

This type of integration should adhere to voltage level regulations as per local DISCOM and as per latest commercial circulars.

~~3. Maintenance of Solar RTS (Special Scope/Part B – Sl. 1)~~

~~Rates against this activity has been invited on per month or per visit basis based on various requirements of maintenance of Solar Rooftop system.~~
~~Decision regarding particular line item to be chosen will lie with BHEL.~~
~~**Monthly basis**~~

~~a) Inspection of fire extinguishers (weight, pressure indication, physical status etc) followed by refilling actions, if necessary, based on indications. Report to be submitted as per BHEL approved recording formats.~~
~~b) Earthing resistance measurements for solar array structures, various equipment and lightning arrestors: measured values shall be recorded in registers and reported to BHEL as per BHEL approved recording formats.~~

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c) Submission of values / status of plant parameters and events for the corresponding month, as below, as per BHEL approved formats:
   - Daily values of solar array at string inverters, ACCB, LTPDB panel levels
   - Daily values of weather parameters (solar energy, wind speed, ambient temperature)
   - Events (with date, time) of faults / tripping / breakdown of equipment
   - Events (with date, time) of grid outage
   - Events (with date, time) of equipment damages, accidents and thefts
   - Activities of module cleaning

d) (Monthly reports shall be submitted to BHEL for all the above data.

e) (Energy generation / meter reading report to be prepared and submitted to the concerned state/central department. Signatures from BHEL/CUSTOMER representatives shall be obtained wherever required.

Vendor shall deploy personnel as per following description

Technical / administrative / office personnel

- One experienced technical-cum-administrative in-charge having diploma in electrical/ electronic engineering and experience with overall responsibility for complete plant operations. The in-charge shall have competence to deftly handle technical and operational / crisis problems.

- Working level staff with ITI / diploma level qualifications in engineering with competence for operating electrical/ electronic/ mechanical equipment, taking measurements, data logging / maintaining registers, preparation of reports in computer.
- In addition to the above, separate set of persons shall be deployed for water cleaning of SPV modules on daily basis. Number of persons shall be decided considering maximum 7 days per cleaning cycle.

2. Vendor shall provide uniforms for staff.
3. Similarly, personnel shall be provided with raincoats, toolsets, earthing rods, safety gloves, safety harness, safety goggles, gumboots, helmets and all other personal protective equipment (PPE) that will be relevant to ensure human safety.
4. Names, qualification, work responsibility of personnel shall be listed on a display board at an appropriate location as suggested by the end customer.
5. Attendance registers shall be maintained for all the staff, workmen.
6. Vendor shall ensure statutory requirements such as ESI, PF, labour license, BOCW etc as applicable for their O&M personnel posted at site.

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7. ~~BHEL/CUSTOMER shall have right to disallow any O&M employee, if found unfit to perform. BHEL instructions issued in writing shall be binding on vendor who shall replace the person.~~
8. ~~O&M personnel at site shall conform to general regulations in force at site and to any special instructions from BHEL/CUSTOMER administration.~~
9. ~~O&M personnel at site shall be deemed to be aware of damages and risks incidental to conditions of rooftop place & works from time to time and BHEL/CUSTOMER shall not be responsible for any injury to personnel arising there from.~~

~~**10. Training personnel**~~

~~It is the absolute responsibility of vendor to ensure imparting of necessary training to their personnel to get them acquainted with the operations of various electrical and mechanical equipment of the power plant. For this purpose, vendor shall identify the personnel well in advance and involve them during installation and commissioning stages so that they become well versed with various functional aspects of the power plant.~~

~~Availability of personnel at power plant~~

- ~~Vendor shall ensure that operating staff are present in the power plant during 6:30 AM – 6:30 PM every day. (staggered shift to cover duty time)~~
- ~~Vendor shall ensure that certain minimum operating staff are present at the power plant even on festivals, public holidays and any other unique occasions so that the plant is run under competent supervision on all days.~~

~~Personnel shall, strictly, not use any part of the power plant for their personal /residential purposes. Their presence at the plant shall, strictly, be meant only for the purpose of operation and maintenance of plant.~~

4. Grid Integration & start of Net Metering of Solar PV System after getting all approvals, calibration through state department

(Special Scope/Part B – Sl. 2)

This line item pertains to liaison part with DISCOM. Activity will start from co-ordination with customer and submission of application form to DISCOM for installation of bidirectional meter. Subsequently (a) arranging issue of net meter (either from local DISCOM or through approved supplier) (b) Calibration of meter through recognized lab of local DISCOM (c) Arranging Testing of new meter (d) Getting replacement order from DISCOM office after inspection of Old/existing energy Meter (e) Getting estimates done for issue of Solar Meter (f) Arranging order from DISCOM for installation of Bidirectional Meter.

Cost of CT &PT, Bidirectional Meter, Solar Meter, Government receipts for calibration etc. shall be borne by Bidder. In case, such items are to be arranged through the contractor – the cost of supply & installation has been covered elsewhere. Minor accessories required during installation of bidirectional meter shall be in the scope of the contractor. The contractor has to co-ordinate with the agency for installation of net meter at site and the contractor will provide required manpower assistance during installation of the Net Meter.

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Bidder to note that Net meter practices varies from DISCOM to DISCOM. Bidder to ensure particular DISCOM guideline state/Area. All equipment like CTs, PTs, Meter Box, Meter(Net/RE) Cable including procurement, DISCOM testing and installation shall be done by Bidder Only.

5. Supply of Bidirectional Meter and Installation (Special Scope/Part B – Sl. 3)

A Bi-directional electronic energy meter shall be supplied, installed and commissioned by the vendor at appropriate place at MRS (main receiving station) of CUSTOMER. The vendor shall take NOC/approval for the connectivity, technical feasibility and synchronization of the Solar plant with distribution network and submit to CUSTOMER through BHEL before commissioning of the plant. The Bi directional meter shall be of 0.5 S class/as required of type and make as approved by DISCOM and shall be installed for measurement of Import and export of energy.

The utility meter (Net-meter) has to be bi-directional meter to register both import grid electricity amount as well as export solar electricity amount.
The utility meter (Net-meter) has to be bi-directional meter to register both import grid electricity amount as well as export solar electricity amount. Bidirectional energy meter with CTs and PT, if required, having the feature of recording both the import and export of energy, besides other parameters shall be as per CEA metering regulations or State Grid code as applicable and of the make & specifications as approved by the DISCOM. This shall be installed at the point where interconnection is made between Consumer system and DISCOM system.

6. Supply and Installation of Solar Meter (Special Scope/Part B – Sl. 4)

Solar Meter (or Solar Energy Meter) is used to record the output of String Inverters. This is required to be installed as per requirement of DISCOM.
The Solar Meter shall be supplied, installed and commissioned by the Contract at appropriate place of CUSTOMER. The vendor shall take NOC/approval for the connectivity, technical feasibility and synchronization of the Solar plant with distribution network and submit to CUSTOMER through BHEL before commissioning of the plant. While required cable shall be supplied by BHEL – all other minor accessories shall be in Contractor's scope.

7. Integration with existing DG (Special Scope/Part B – Sl.6)

The output power from SPV would be fed to the inverters which converts DC produced by SPV array to AC and feeds it into the main electricity grid after synchronization. In case of grid failure, or low or high voltage, solar PV system shall be out of synchronization and shall be disconnected from the grid. Once the DG set comes into service, PV system shall again be synchronized with DG supply and load requirement would be met to the extent of availability of power. 4 pole isolation of inverter output with respect to the grid/ DG power connection need to be provided
This type of integration should adhere to voltage level regulations as per local DISCOM and as per latest commercial circulars.

8. FIRE EXTINGUISHERS: (Special Scope/Part B – Sl. 6)

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

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

Vendor shall provide fire extinguishers as follows for fighting fire electrical wiring, live machinery fires and flammable liquid/ gas as per recommendation by relevant fire safety authority and as per relevant standards IS: 2171 and IS: 10658 marked. Make shall be Safex/ Ceasefire/ Vintex/ Unicare fire safety or any other reputed equivalent subject to BHEL/CUSTOMER approval.

- DCP type (ABC) 9Kg designed/tested IS 15683/ IS: 13849 with safety release valve, NRV and CE approved valve. Dry powder IS 14609 with standard accessories.
- CO2 type Hand 9 Kg with wheel. Designed/tested IS 2878 complete with hose, screw valve, CO2 gas IS 1522, cylinder IS 7285, valve IS 3224. Tested at 250 Kgf/cm2.

Quantity shall be as per vendor scope of supply (deliverables) in this specification.

Note:

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

b) Sand buckets in the control room

c) 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.

~~**ii. Arrangement of Inspection by statutory authority like CEA, DISCOM/MNRE/ agency other than customer (example PMC) - as applicable as part of contract requirement (Special Scope/Part B – Sl. 7)**~~

~~a) Liaison responsibility for getting the above approvals rests with contractor.~~

~~b) Following are the areas of approval, as applicable, for the SPV-side portions including solar array and up to 1.1kV side connection point.~~

- ~~Schemes/ layouts/ calculations such as solar array layout, lighting arrestor layout, module cleaning system, cable trench layout, fire alarm system etc.~~
- ~~GTP/ datasheets/ GA drawings/ Bill of materials, MQP etc of supply items.~~
- ~~Factory test reports of supply items including BHEL-supplied items.~~
- ~~Interaction with supervising/ inspection agency such as MRT departments, Transco, CEIG, CEA etc, as applicable, for applying to them/ inviting them for supervision/ inspection at site.~~
- ~~Interaction/ coordination with customer (CUSTOMER) in the above process as and when required.~~
- ~~All necessary testing kits/ instruments shall be arranged as per the requirements of inspection agency. Basic instruments such as digital multimeter, 5kV digital megger with PI feature, earth resistance meter, clamp meters etc shall be organized at site at the time of inspection.~~
- ~~Competent electrical technician shall also be made available at the site.~~
- ~~Subsequent to site inspection by the concerned agency, vendor shall support the upstream 1.1kV evacuation line/ Vendor in following-up with them to obtain their clearance for line charging/ grid synchronization.~~

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- ~~Vendor shall implement all the observations of CEIG related to SPV-side portion including solar array and up to 1.1kV connection point to metering panel at plant end.~~

~~liaison activities with state / central departments / DISCOM/ CEIG etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant. (Clearances shall include obtaining prior approvals for all applicable drawings/ documents etc from concerned state / central departments / DISCOM/ CEIG etc.)~~

Part C: scope not cover in part A & B

1. String Inverter (Part B – Sl. 1)

As SPV 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)" or Central/String Inverter. In addition, the PCU/Central/String Inverter shall also house multiple MPPT (Maximum Power Point Tracker) (Minimum two), 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.

Sl. No	Technical parameter	Specification
1.	Type	Grid Connected String Inverter (transformer less).
2.	Make	As per approved make list enclosed.
3.0	**Standards**	
3.1	Efficiency Measurement	IEC 61683/ Equivalent BIS Std.
3.2	Environmental testing	IEC 60068-2 (1,2,14,30) / Equivalent BIS Std.
3.3	EMC	IEC 61000/Equivalent BIS Std.
3.4	Islanding Prevention Measurement	Bidder to specify
3.5	MPPT	Bidder to specify
3.6	Type Test certificate issuing authority (for Sl. No. 3.1,3.2,3.3,3.4 and 3.5)	NABL/ IEC Accredited Testing Laboratories or MNRE approved test centers.
4.0	**Input DC**	
4.1	Voltage range	Min 200-1000 V
4.2	MPP voltage range	Min 200-1000 V
4.3	Power Control	MPPT (Multiple)
5.0	**Output AC**	

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5.1	Output voltage and phase	415V, 3Phase, 50Hz (In case single phase inverters are offered, suitable arrangement for balancing the phases must be made.)
5.2	Reactive power	0.9 lagging to 0.9 leading
5.3	Total Harmonic Distortion (THD)	< 3 % at rated power
5.4	Power factor at rated current	0.98-1.00
5.5	Grid frequency tolerance range	± 3% Hz
5.6	Grid voltage tolerance	±10%
5.7	No-load losses	Less than 1% of rated power
5.8	Self-power consumption	Standby power consumption of Inverter shall not exceed 1 Watt
6.0	**Efficiency**	>93% (in case of 10kw or above with in-built galvanic isolation) >97% (in case of 10kw or above without in-built galvanic isolation) >90% (in case of less than 10kw)
7.0	**Protection**	
7.1	DC Side	Disconnection device Reverse polarity protection Reverse polarity protection. Over voltage protection. Surge protection
7.2	AC Side	Short circuit protection Over voltage/current limitation Anti-Islanding protection AC surge protection
7.3	Protection over and under Grid frequency protection.	Bidder to specify
7.4	Ground fault / Grid Monitoring	Bidder to specify
7.5	Over Temperature protection	Bidder to specify
8.0	**Display**	
8.1	Display type	LCD/LED
8.2	Display parameter	Bidder to specify
9.0	**Communication**	
9.1	Communication port	Bidder to specify
10.0	**General**	

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10.1	Operating Temperature	-20 Deg. C to + 50 De. C
10.2	Humidity	95% non-condensing.
10.3	Dimensions	Shall be provided by the Bidder.
10.4	Weight	Shall be provided by the Bidder.
10.5	Cooling	Cooling arrangement (if any) details shall be furnished by the Bidder.
10.6	Ingress protection (IP)	IP 65 or better (Out Door Installation)
10.7	Maximum altitude	Bidder to mention up to what altitude above sea level inverters will work without de-rating.
10.8	Noise level	<68 dB
10.9	Switching Devices	IGBT/MOSFET
10.10	Control	Microprocessor/DSP

Other important Technical Requirements:

a) The String Inverter 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.

b) The String Inverter must have minimum of DC input capacity. The PCU shall be capable of controlling power factor dynamically.

c) String inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

d) 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.

e) Built-in meter and data logger shall be provided to monitor plant performance through external computer.

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

g) The String 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.

h) String 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.

i) 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 or better and as per IEC 529 specifications.

j) The PCU or Central/String 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. Test report shall be submitted before supply.

2. ACDB (Part B – Sl. 2)

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a. AC Distribution Panel Board (DPB) shall control the AC power from PCU/ inverter, and should have necessary surge protection devices, MCB/MCCBs & AC circuit breaker with phase indication of R,Y,B. Interconnection from ACDB to mains at LT Bus bar while in grid tied mode.
b. All switches and the circuit breakers, connectors should conform to IEC 60947, part I, II and III/ IS60947 part I, II and III.
c. The changeover switches, cabling work should be undertaken by the bidder as part of the project.
d. All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air -insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz
e. The panels shall be designed for minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.
f. All panels will have protection of IP65 or better.
g. It Shall have AC disconnect switch and proper earthing arrangements
h. Should conform to Indian Electricity Act and rules (till last amendment).
i. All the 415 AC or 230 volts 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	+/- 3 Hz

BOM FOR ACDB 10KWp

S.No	ITEM DESCRIPTION	DIMENSIONS	MAKE	QTY
1	Enclosure	Metal Box-Outdoor Double door	Reputed	1
2	R,Y,B Indication Lamp with Control MCB		Reputed	3
3	MCCB Input1	4P,25A,10kA	L&T/Schneider/ABB	1
4	SPD-Type II	Three Phase	Phoenix/CITEL	1
5	Earth Terminal Block	16 Sqmm	Elmex/ Connectwell/Reputed	1
6	Dinrail		Phoenix/Hex/ Reputed	1
7	Cable Gland Input (4x10Sqmm)	Metal Double Compression	Jigo/Reputed	1
8	Cable Gland Output (4x25Sqmm)	Metal Double Compression	Jigo/Reputed	1
9	Earth Gland		Reputed	1
10	Indicating Stickers		Reputed	1
11	Screws, Cable, Lugs, etc..		Hex/ Reputed	1

BOM FOR ACDB 30KWp

S.No	ITEM DESCRIPTION	DIMENSIONS	MAKE	QTY
1	Enclosure	Metal Box-Outdoor Double door	Reputed	1

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2	R,Y,B Indication Lamp with Control MCB		Reputed	3
3	MCCB Input1	4P,63A,10kA	L&T/Schneider/ABB	1
4	SPD-Type II	Three Phase	Phoenix/CITEL	1
5	Earth Terminal Block	16 Sqmm	Elmex/ Connectwell/Reputed	1
6	Dinrail		Phoenix/Hex/ Reputed	1
7	Cable Gland Input (4x25Sqmm)	Metal Double Compression	Jigo/Reputed	1
8	Cable Gland Output (4x50Sqmm)	Metal Double Compression	Jigo/Reputed	1
9	Earth Gland		Reputed	1
10	Indicating Stickers		Reputed	1
11	Screws, Cable, Lugs, etc..		Hex/ Reputed	1

3. DCDB (Part B – Sl. 3)

DCDB is to be provided in the PV yard for connecting cables from solar string to string inverter. DCDB shall be dustproof, vermin and weatherproof and shall be made of GRP/FRP/Powder coated Aluminium/cast aluminium alloy. The material used for boxes shall be made with UV resistant material to avoid degradation during module life and the sealing shall comply IP65 degree of protection.

DCDB shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. All wires/cables must be terminated through cable lugs.

Terminals shall be connected to copper bus bar arrangement of proper sizes. Suitable markings shall be provided on Bus bar for easy identification and cable ferrules shall be fitted at the cable termination points for identification.

The junction box shall have hinged door with EPDM rubber gasket to prevent water entry and shall have provision for earthing.

DCDB must comprise of following:

- Arrangement for group array isolation.
- Test point for subgroup fault location.
- Shall have suitable capacity MCBs/MCCB,DC breaker, surge (Type II SPD, MOV), fuse protection device and suitable reverse blocking diode or bypass diodes to prevent hot spots in case of cell mismatch or shading.
- It Shall have DC disconnect switch and proper earthing arrangements.
- All fuses shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP65 enclosure with transparent covers.
- All internal wiring shall be carried out with 1100V grade stranded Cu wires.
- 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.

The design and components of DCDB must be approved by BHEL prior to Manufcaturing/ordering.

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4. ACCB (Part B – Sl. 4)

a. All switches and the circuit breakers, connectors should conform to IEC 60947, part I, II and III/ IS60947 part I, II and III.
b. The changeover switches, cabling work should be undertaken by the bidder as part of the project.
c. All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air -insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz
d. The panels shall be designed for minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.
e. All panels will have protection of IP65 or better.
f. It Shall have AC disconnect switch and proper earthing arrangements
g. Should conform to Indian Electricity Act and rules (till last amendment).
h. All the 415 AC or 230 volts 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	+/- 3 Hz

BOM FOR ACCB (2 IN 1 OUT 10+10KWp)-20KWp

S.No	ITEM DESCRIPTION	DIMENSIONS	MAKE	QTY
1	LT Panel Enclosure	Metal Box-	Reputed	1
2	R,Y,B Indication Lamp with Control MCB		Reputed	3
3	MCCB – Input1 10 KWp	4P,25A, 10kA	L&T/Schneider/ABB	1
4	MCCB – Input2 10 KWp	4P,25A, 10kA	L&T/Schneider/ABB	1
5	MCCB - Output 1 20 KWp	4P,36A, 10kA	L&T/Schneider/ABB	1
6	Bus Bar -Copper	36A	Reputed	4
7	Earth Terminal Block	16 Sqmm	Elmex/ Connectwell/Reputed	1
8	Dinrail		Phoenix/Hex/ Reputed	1
9	Cable Gland Input (suitable for 4x16Sqm)	Metal Double Compression	Jigo/Reputed	2
10	Cable Gland Output (suitable for 4x50Sqm)	Metal Double Compression	Jigo/Reputed	1
11	Earth Gland		Reputed	1
12	Indicating Stickers		Reputed	1
13	Screws, Cable, Lugs, etc..		Hex/ Reputed	1

BOM FOR ACCB (2 IN 1 OUT 20+30KWp)-50KWp

S.No	ITEM DESCRIPTION	DIMENSIONS	MAKE	QTY
1	LT Panel Enclosure	Metal Box-	Reputed	1
2	R,Y,B Indication Lamp with Control MCB		Reputed	3
3	MCCB - Input3 20 KWp	4P,36A, 10kA	L&T/Schneider/ABB	1

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4	MCCB - Input4 30 KWp	4P,63A, 25kA	L&T/Schneider/ABB	1
5	MCCB - Output 200 KWp	4P,125A, 25kA	L&T/Schneider/ABB	1
6	Bus Bar -Copper	150A	Reputed	4
7	Earth Terminal Block	16 Sqmm	Elmex/ Connectwell/Reputed	1
8	Dinrail		Phoenix/Hex/ Reputed	1
9	Cable Gland Input (suitable for 4x50Sqmm)	Metal Double Compression	Jigo/Reputed	3
10	Cable Gland Output (suitable for 4x120Sqmm)	Metal Double Compression	Jigo/Reputed	1
11	Earth Gland		Reputed	1
12	Indicating Stickers		Reputed	1
13	Screws, Cable, Lugs, etc..		Hex/ Reputed	1

5. Support Structure: : (Part C – Sl. 4)

Hot dip galvanizes 80 Micron module mounting structure shall be supplied by the bidder. Bidder to submit the charted Engineer approved STAAD calculations and Drawing for approval.

6. AC & DC Cables: (Part C – Sl. 5,6&7)

a. The Specification of wiring material of PV Power plant shall include but not limited to the following:

Sl. No	Item	Description
1.0	**DC Cable**	From PV module to inverter
1.1	Type	1.1kV grade heavy duty PVC insulated, Double sheathed, UV protected XLPO stranded copper cables as per IS: 7098 (Part I & II) – 1976 or IS 1554 or IS9537/IEC60227/IS694 or Solar DC Cable as per BS EN 50618
1.2	Size	1 core 4 sq. mm Unarmored
1.3	Laying	The cable must be laid through PVC conduit /GI pipe/ cable tray on roof and indoor. In case of using metallic pipe as conduit proper grounding of the conduit must be done.
2.0	**AC Cable**	From inverter to ACDB and ACDB to distribution panel/LT panel
2.1	Type	1.1kV grade heavy duty PVC insulated galvanized strip/wire armored XLPE stranded Cu conductor cables as per IS: 7098 (Part I & II) – 1976 or IS 1554 or IS9537/IEC60227/IS694.
2.2	Size	As per site requirement
2.3	Laying	The cable must be laid through PVC conduit /GI pipe/ cable tray on roof and indoor. In case of using metallic pipe as conduit proper grounding of the conduit must be done.

b. **Procedure of cable laying**:

i. Cable terminations shall be made with suitable cable lugs & sockets etc, crimped properly and cables shall be provided with dry type compression glands wherever they enter junction boxes/ panels/ enclosures at the entry & exit point of the cubicles. The panels bottoms should be properly sealed to prevent entry of snakes/lizard etc. inside the panel.

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All cables shall be adequately supported. Outside of the terminals / panels / enclosures, shall be protected by conduits. Cables and wire connections shall be soldered, crimp-on type or thimble or bottle type.

ii. Only terminal cable joints shall be accepted. Cable joint to join two cable ends shall not be accepted

iii. All cable/wires/control cable shall be marked with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

iv. All fasteners will be made of Stainless steel or Aluminum or UV Protected PVC.

v. All DC wire upto DCDB & Inverter shall be covered in CPVC (suitable size) heavy duty (SDR 11) as per IS 15778:2007 & ASTMD 2846.

vi. All AC cable shall be routed in covered perforated metal cable tray.

vii. All AC/DC cable shall be properly tied by plastic ties.

viii. DC wires shall be routed through proper marking/naming by farrules.

ix. Earthing by greens wires only, if required.

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General Note:

Following work also in scope of bidders: -

1. Testing

The payments against particular testing items as listed in the BoQ shall be admissible only after completion of all the Pre-commissioning inspections/checks/tests as per description given below:
Vendor shall organize all necessary tools/ measuring instruments required to operate the various electrical equipment at the time of commissioning: Digital megger 5KV with PI feature, Earth resistance tester, Phase sequence meter, Clamp meters etc, discharge rods, etc.

A. Pre-commissioning inspections / checks / tests on DC side

Vendor shall carry out following minimum pre-commissioning checks:

a. Verification of firmness of SPV module interconnections (MC4)
b. Verification of firmness of DC cable terminations at string inverters using torque wrench (for the specified torque values)
c. Verification of firmness of RS485 cable terminations
d. Verification of firmness of all earthing connections
e. Cable megger/ continuity check for all DC power cables
f. Measurement of open circuit voltage of individual strings
g. Measurement of earth resistance at individual earth pits of solar array: (a) as disconnected from earth mat grid and also, (b) as connected to earth mat grid
h. Submission of test reports to BHEL for acceptance.

B. Pre-commissioning inspections/checks/tests on AC side.

Basic checks

Tightness checks:

- Terminations of AC power cables at string inverters, data loggers, ACCB box, LTPDB panels.
- Terminations of Control/ Instrumentation/ Data/ Communication cables wherever applicable.
- Terminations of earthing at all electrical equipments/ panels. 4) Terminations of earth chambers of vendor scope

Electrical continuity checks
Megger (1kV) checks for all 1.1kV grade cables
AC/DC supply checks at TBs of all electrical panels/ DBs.

C. Pre-commissioning electrical tests:

String inverters

- DC side open circuit voltage
- Vendor to provide technician support to service engineer of string inverters for all other pre-commissioning tests as per OEM checklist

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D. Earth resistance measurements for all chambers of vendor scope

- With electrode connected to grid
- Without connecting electrode to grid

2. Tool & Tackle and Spares

After completion of installation & commissioning of the power plant, necessary tools & tackles are to be provided free of cost by the bidder for maintenance purpose. List of tools and tackles to be supplied by the bidder for approval of specifications and make from [NAME OF THE ORGANISATION]/ owner.

A list of requisite spares in case of PCU/inverter comprising of a set of control logic cards, IGBT driver cards etc. Junction Boxes. 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.

3. Safety Measure

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.

4. 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 one each at battery –cum- control room, solar array area and main entry from administrative block. Text of the signage may be finalized in consultation with [NAME OF THE ORGANISATION]/ owner.

5. All drawings and SLDs shall be submitted to BHEL-CFP for approval.

6. CONNECTIVITY:

The maximum capacity for interconnection with the grid at a specific voltage level shall be as specified in the Distribution Code/Supply Code of the State and amended from time to time.

Following criteria have been suggested for selection of voltage level in the distribution system for ready reference of the solar suppliers. Plant Capacity Connecting voltage Up to 10 kW 240V-single phase or 415V-three phase at the option of the consumer Above 10kW and up to 100 kW 415V – three phase Above 100kW At HT/EHT level (11kV/33kV/66kV) as per DISCOM rules

a) The maximum permissible capacity for rooftop shall be 1 MW for a single net metering point.
b) Utilities may have voltage levels other than above, DISCOMS may be consulted before finalization of the voltage level and specification be made accordingly.
c) For large PV system (Above 100 kW) for commercial installation having large load, the solar power can be generated at low voltage levels and stepped up to 11 kV level through the step up transformer. The transformers and associated switchgear would require to be provided by the SPV bidders.
d) The bidirectional electronic energy meter (0.5 S class) shall be installed for the measurement of import/Export of energy.
e) The bidder must take approval/NOC from the Concerned DISCOM for the connectivity, technical feasibility, and synchronization of SPV plant with distribution network and submit the same to BHEL before commissioning of SPV plant.

Note:

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Step up transformer is not required existing transformer can be used for connectivity. Connection to Transformer if required shall be done by Bidder.

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LIST OF ENCLOSURES:

Following enclosure makes the part of REG1920-20190700

a) SPV Module drawing

b) SPV Module Data Sheet

c) Layout and SLD of Buildings

d) SCC

e) GCC

f) Site pictures

g) FQP

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