	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

**SOLAR ROOF TOP SYSTEM ON THE OFFICE BUILDING OF BHEL LODHI  
ROAD, NEW DELHI**

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."**



Signature and seal of Bidder


95

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

## Brief About Project and Scope

A

94

	<b>TECHNICAL SPECIFICATION</b>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

**Project-** Supply, Installation and Commissioning of Solar Rooftop project at Office building of BHEL Lodhi Road, New Delhi

**Capacity-** 15 KWp

**Site Location-** BHEL, Lodhi Road, CGO Complex, Pragati Vihar, New Delhi- 110003

**Items Supplied By BHEL-**

Sl. No.	Item	Qty.	Unit
01	PV Module	51	No.
02	ACDB	01	No.
03	DCDB	01	No.
04	String Inverter (20 KW)	01	No.

**Scope of Bidder:**

1. Dismantling of Existing 10KWp Solar system.
2. Modification of existing solar structure to the extent feasible and supply of required quantity of additional Module mounting structure, Civil work for completion of work of 15KWp RTS.

**Note: All old structure shall be re-painted with zinc spray paint and existing civil work shall be re-vamped so as to make it suitable for 25 service life.**

3. Supply of DC and AC cable for the installation and commissioning of 15 KWp as per BOQ.
4. All electrical work like cable supply and laying, junction boxes shall be new. No old items/supply shall be used from existing.
5. Installation and commissioning of BHEL supplied items.
6. Supply and installation of items as per BOQ for 15 KWp system.


**Note:**

- a. **Site survey is must before submitting the offer.**
- b. **If any Item/provision is not covered in the BoQ but required for 100% completion of installation and commissioning of 15 KWp the same shall be supplied by the bidder free of cost.**
- c. **Payable amount against work shall be calculated based on actual quantity executed for each line items.**



Signature and seal of Bidder


93

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

## Technical specification

A

Signature and seal of Bidder

	<b>TECHNICAL SPECIFICATION</b>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

**Part A : General Scope AS per BOQ**

**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 like PV modules, String inverters, ACDB, DCDB etc. 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.

**A. 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.

Signature and seal of Bidder

91

	<b>TECHNICAL SPECIFICATION</b>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

- 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 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.

**B. 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.

**C. "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.

*dc*

Signature and seal of Bidder

	<b>TECHNICAL SPECIFICATION</b>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

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

### A. SPV Modules:

Vendor Shall do the erection of the SPV module as per approved layout design of BHEL. After placing the 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.

#### Series interconnection of SPV modules to form strings

Vendor shall interconnect the SPV modules as follows:

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

- 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.
- 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.
- 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 shall be supplied by Vendor.

### B. Installation of string inverters


Supply of string inverters is in BHEL scope. Approximate weight of inverter 50 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.



Signature and seal of Bidder

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

- 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.

**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.

**C. Installation of AC combiner boxes(ACCB/ACDB)**

Supply of AC Combiner boxes(ACCB/ACDB) is in BHEL 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
- 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.

**D. Installation of DC distribution boxes(DCDB)**


Supply of DC Distribution boxes(DCDB) is in BHEL 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

*dc*

Signature and seal of Bidder

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

- 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. 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/mm<sup>2</sup> (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 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,





	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

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.)
- For capacity > 100 KW and upto 500KW : (400 Nos.)
- For capacity >500 KW and upto 1500KW : (500 Nos.)

**Bolts –Supply & fixing:**

The anchor bolts 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: Bolt & Nuts shall be made of Galvanized steel and 02 NUTS AND 02 PLAIN WASHERS shall be used.


**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 <sup>3</sup> /day work	No of samples
01-05	1
06-15	2
16-30	3
31-50	4

*AK*

Signature and seal of Bidder

	<b>TECHNICAL SPECIFICATION</b>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

51 and above additional

4 plus one sample for additional 50 cum or part thereof.

#### 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 4<sup>th</sup> floor and for Tin Sheds of height upto 5 Mtrs. – no additional charges shall be payable for lifting. For lifting above these levels – additional amount over the basic rates has been considered elsewhere in the BoQ.

#### 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.

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

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

Login details shall be provided by the Bidder to access the parameters as listed below.


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.

Signature and seal of Bidder



05

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00


- 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.

**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.**

*Ar*

Items required during Installation like control cable, nuts/bolts etc shall be arranged by Vendor.

Signature and seal of Bidder

	<b>TECHNICAL SPECIFICATION</b>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

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

All the AC and DC cables of required size as per approved SLD shall be supplied by BHEL. 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 mobilisation. 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 – 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

Signature and seal of Bidder





	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

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, Conduits 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.

**A. 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.

**B. 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.

**C. 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.

**D. 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.

*Ac*

Signature and seal of Bidder

	<p style="text-align: center;">TECHNICAL SPECIFICATION</p>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

- 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.

**E. 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.

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/ HDPE 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 HDPE 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 HDPE pipe. Communication cables and HDPE pipe shall be in vendor scope of supply. Vendor shall submit GTP/ make/ part number of the HDPE 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.


**F. 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.

*Ac*

Signature and seal of Bidder

81

 Rudrapur	TECHNICAL SPECIFICATION GROUP : REG(Renewable Energy Group)	Doc. No.	REG1920-20190247
		Part 03	TS
		Rev no	00

**G. 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.

**H. 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.

**6. 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 medium class PVC conduit 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.

HDPE pipe of PE63 grade, pressure rating PN6, appropriate nominal diameter and as per IS: 4984 (1995) shall be used. It shall be ensured that a max of 60% of inner space shall be occupied by the cables.

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.

**7. Supply and installation of Cable tray ( Sl.No.8 of BoQ)**


Contractor shall supply along with all accessories for laying of cable through cable tray and install suitable size of Cable tray along with accessories in surface/recess including cutting the wall and making good the same in case of recessed tray as required. Cable Tray shall be lay as per the approved drawing/make list/ Instruction provided by BHEL/Customer. The Cable Tray 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 Tray lid and Standoff brackets (for suitably raising the tray above surface for rain protection by minimum 50 mm) shall be used. Also,

Signature and seal of Bidder

Az

	<p style="text-align: center;">TECHNICAL SPECIFICATION</p>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

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 accessories.

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

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

Vendor has to supply and install earthing strip (of Galvanised steel material) of following size:

- a) 25x6 mm

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.

**9. 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.


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

**GI flat earthing terminal points and sizes :**

- (a) 25x6 mm for MMS structures:
  - (1) structure to structure,

Signature and seal of Bidder



	<b>TECHNICAL SPECIFICATION</b>	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

- (2) interconnection of structures of all rows,  
(3) from top of buildings to the chemical electrodes at ground level.
- (b) 25x6 mm/Equivalent cross section for string inverters, data loggers, ACCB box, lightning arrestors at roof-top

**The Earth chamber shall have features as follows:**

- Square sized with 300mm x 300mm minimum inner opening. Exact size shall be chosen to ensure ease of maintenance operation using spanners etc.
- Brick wall thickness all around = 115 mm minimum
- Depth of chamber = 500 mm minimum below FGL.
- Projection of chamber above FGL = 150mm minimum
- Top of electrode shall have minimum clearance of 100 mm below cover plate.
- 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.
- Cover plate shall have suitable lifting hooks and padlocking arrangement.
- 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.
- Supply and installation of all materials shall be in vendor scope.


**General points:**

- All items related to earthing viz electrodes, GI flats, hardware etc in vendor scope of supply.
- GI bolts, nuts, plain washers shall be used. Spring washers shall be zinc/epoxy coated.
- 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.
- Resistance of welded joint shall not be more than that of GI flat.
- Welds shall be treated with red oxide for rust protection and then coated with bitumen compound for corrosion protection.
- 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.
- 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

Signature and seal of Bidder

78

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

continuity conductors to an efficient earth electrode.

### 10. Testing ( Sl.No.12 of BoQ)

Testing includes all the following activities. 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.

##### 10.B.1. Basic checks

##### 10.B.1.1. 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

##### 10.B.1.2. Electrical continuity checks

##### 10.B.1.3. Megger (1kV) checks for all 1.1kV grade cables

##### 10.B.1.4. AC/DC supply checks at TBs of all electrical panels/ DBs.

#### 10.B.2. Pre-commissioning electrical tests:


##### 10.B.2.1. String inverters

- DC side open circuit voltage



Signature and seal of Bidder

३३

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

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

**10.B.2.2. Earth resistance measurements for all chambers of vendor scope**

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

**11. Termination of Solar power output for evacuation on existing distribution board of customer ( Sl.No.13 of BoQ)**

**A. Laying and termination of cables from ACCB box to existing LTPDB box of customer.**

- a) Exact measurement of Cables as per SLD, 1.1kV, Copper/Alluminium , XLPE, armoured as per IS: 7098 part-1 shall be submitted by Contractor to BHEL . These will be supplied by BHEL but installation and laying between ACCB to LTPDB is in vendor scope. Required cable shall be cut out from longer lengths as supplied by BHEL. Necessary cutting arrangement/crimping arrangement and Cable jointing arrangement and all associated supplies will be in the scope of the Contractor.
- b) 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 specification.


**B. Laying and termination of cables from BHEL's LTPDB to Customer LT point evacuation.**

- a) Exact measurement of Cables as per SLD, 1.1kV, Copper/Alluminium , XLPE, armoured as per IS: 7098 part-1 shall be submitted by Contractor to BHEL . These will be supplied by BHEL but installation and laying between ACCB to LTPDB is in vendor scope. Required cable shall be cut out from longer lengths as supplied by BHEL. Necessary cutting arrangement/crimping arrangement and Cable jointing arrangement and all associated supplies will be in the scope of the Contractor.
- b) Nickel plated brass double compression cable glands, cable lugs, SS304 bolts/ nuts/ plain and spring washers for above cable terminations shall be in vendor scope of supply. Termination shall be carried out using appropriate tools and torque setting as per BHEL/CUSTOMER approval.
- c) Wherever spares breakers are available at Customer LT evacuation panel, termination shall be carried. However, few sites where spare breakers not available, LT busbar extension is required from customer LT panel to solar LTPDB and cable shall be terminated.

*AC*

Signature and seal of Bidder

70

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

**12. Supply and fixing of Name Plate (Sl.No.14 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.

**13. Additional Safety Arrangement for compliance of HSE/OHSAS requirement (Sl.No.15 of BoQ)**


This line item shall be applicable when working on RCC roofs above 4<sup>th</sup> floor (G+4 and above buildings) or on Tin Sheds above 5 Mtr. Height is required. All necessary items required for compliance of safety norms as per SCC Chapter VII of this Tender document (Part 3) will be arranged and deployed by the contractor at the erection site. The scope includes items such as Insulating mats, working platform for Tin shed/Tilted slopes, Barricading on roof, safety nets, special PPEs, and all other items as required as per Chapter VII (Part 3).

It is also underlined here that for RCC roofs/Tin Sheds below the heights as mentioned above – all safety compliances as noted under SCC Chapter VII has to be mandatorily complied with. However, cost on this account is already built up within major heads of the BoQ.

*AE*

Signature and seal of Bidder

75

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

**Part B Special Scope**

**1. Supply & Installation of Steel Member for Superstructure etc. (Special Scope/Part B – SI.2)**

This is a special requirement arising in case installation of Solar PV system is not feasible without making of Superstructure at site. In such case – prior approval shall be taken by contractor from BHEL before initiating any activity in this regard.

Apart from supply and installation of the Superstructure - Scope would also include, activities like making of drawing, getting the same reviewed and vetted by chartered structure engineer and submitting the same for approval to BHEL. In this regard BHEL will make all attempts to optimize the support structure weight. The same shall be considered by contractor and accordingly, different combinations will be tried by the contractor in the design submitted for approval. In all cases – complete responsibility for suitability, strength and safety as per technical specification of the project will lie wholly with the contractor. All support structure material shall be Steel Sections as per standard and of reputed make.

- a) Hot dip galvanized MS structures may be used for mounting the modules/ panels/arrays. Galvanization thickness should not be less than **80 micron** and structure must comply **IS875**.
- b) 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 (Delhi-wind speed of **150 km/ hour**). Bidder has to ensure that the design has been certified by a recognized Lab/ Institution/Chartered Structure Engineer in this regard and submit wind loading calculation sheet to BHEL(**STAAD Report**). Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed.
- c) 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.
- d) Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts.
- e) The fasteners used should be made up of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels


**Note:**

- a. For Existing Mounting Structure Zinc painting to be carry out by the Bidder.
- b. Required Number of end clamps, Mid clamps suitable for existing



Signature and seal of Bidder

74

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

- and new structure shall be in bidders scope.
- c. All hardware used for Module mounting shall be SS-304. No old fasteners shall be retained.

2. Lighting arrestor -special type (NFC series-European standard)  
(Special Scope/Part B – Sl. 19)

This item is to be supplied against specific requirements arising out as part of the contract specification. Detailed specification, make shall be as per BHEL approved. The Technical Data Sheet , Quality Plan and make shall be got approved by contractor from BHEL.


3. Additional Charges applicable for lifting of material on roof above floor IV or tin shed above 5 Mtrs (Lifting of Material like PCC, Modules, Structure considered)  
(Special Scope/Part B – Sl. 22)

For high rise buildings and difficult heights of Tin shed roof – additional lifting charges shall be allowed. Additional charges have been considered by estimating that 02 Mandays per Roof per addl. 4 floors is considered for lifting all material typical for system capacity upto 50KW. Quantity shall be finalized in the work order based on actual number of such roofs.



Signature and seal of Bidder

73

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

**Part C Item Not Covered in Part A & B**

**1. Cables: Supply**

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

Sl. No	Item	Description
1.0	<b>DC Cable</b>	From PV module to inverter
1.1	Type	1.1kV grade heavy duty PVC insulated, Double sheathed, UV protected XLPO/XLPE stranded copper cables as per IS: 7098 (Part I & II) – 1976 or IS 1554 or IS9537/IEC60227/IS694
1.2	Size	1 core 4 sq. mm Unarmored
2.0	<b>AC Cable</b>	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 and stated in BOQ

**2. Dismantling Work**

Presently a 10 KWp Solar system is installed at site the dismantling of the system is in scope of Bidder.


Work involve as follows:

1. Dismantling of Solar Module approx. 55 Nos.
2. Dismantling of String inverter, ACDB, DCDB and wiring etc..
3. Modification in existing Module mounting structure.



Signature and seal of Bidder

११

	TECHNICAL SPECIFICATION	Doc. No.	REG1920-20190247
		Part 03	TS
Rudrapur	GROUP : REG(Renewable Energy Group)	Rev no	00

**LIST OF ENCLOSURES:**

**Following enclosure makes the part Tender documents**

- 4.1. SPV Module drawing
- 4.2. SPV Module Data Sheet

A

Signature and seal of Bidder