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|  | <b>PURCHASE SPECIFICATION</b><br><b>GROUP : BDC</b> | BDC1617 -3001 |
|   |   | REV NO: 00    |

**BDC1617-3001**

**SPECIFICATIONS FOR SUPPLY OF BOS, ERECTION & COMMISSIONING FOR 30 Kw<sub>p</sub> ROOF  
TOP GRID CONNECTED SPV POWER PLANT**

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## 1.0 INTRODUCTION:

This specification defines the scope of the vendor in **Supply of Balance of System (BOS) except solar PV modules for a 30 kW<sub>p</sub> and Erection & Commissioning (E&C) of the Power Plant.**

Vendor should visit the site before quoting to fully understand the site conditions. Vendor is required to furnish clause-wise response for this specification furnished below.

## 2.0 VENDOR'S SCOPE :

| SI. No. | ITEM DESCRIPTION  | Qty      | SUPPLY | E&C | MAKE/ REMARKS   |
|---------|---|----------|--------|-----|---|
| 1.      | Galvanized MS Module Mounting Structures with precast PCC pedestals of 350x350x350 (in mm) with galvanized MS foundation bolts and SS Hardware  | 1 lot    | ✓      | ✓   | As per the indicative Structure drawing (Drg. No: <b>3-679-05-00683</b> ) attached. Actual configuration may vary based on the array layout. However vendor shall ensure the structure stability and shall submit the structure wind load calculations.     |
| 2.      | Grid Connected Solar String Inverter 30 kVA with mounting accessories, AC output 3Ø, 400V, 50 Hz  | 1 No.    | ✓      | ✓   | Refusol / Delta / Sungrow / Growatt / Fronius / Power one / Danfoss / SMA /ABB/ Schneider   |
| 3.      | 1.1kV grade heavy duty PVC insulated, Double sheathed, UV protected FRLS stranded copper cables as per IS 1554<br>(a). 1 core 4 sq. mm Unarmored red cable from series string to string inverter for +ve side | 200 Mtrs | ✓      | ✓   | Reputed makes viz., Polycab / Pagoda/ KEI / LAPP / Advance Cables / equivalent.<br>Test reports confirming to IS should be submitted<br>Length is indicative and can vary upto ±10%. Any variation beyond 10% shall be payable/recoverable @ Rs. 60/ meter. |
|         | (b). 1 core 4 sq. mm Unarmored black cable from series string to string inverter for -ve side   | 200 Mtrs | ✓      | ✓   |   |
| 4.      | 1.1kV grade heavy duty PVC insulated galvanized strip/wire armoured FRLS stranded Aluminium conductor cables as per IS 1554<br>4 C x 16 sq.mm cable (from PCU to LT panel)                                    | 100 Mtrs | ✓      | ✓   | Reputed makes viz., Polycab/KEI/LAPP/Advance Cables/equivalent.<br>Length is indicative and can vary upto ±10%. Any variation beyond 10% shall be payable/recoverable @ Rs. 60/ meter.  |
| 5.      | PVC Pipe 10 kgf/cm <sup>2</sup><br>1" pipe for 4 sq.mm series wiring & earthing strip/wire With   | 300 Mtrs | ✓      | ✓   | Length is indicative. Vendor to supply any excess length to complete the project if required.   |

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|     | necessary connectors C,T, flexible bends, clamps & fixtures for proper routing.   |   |   |   | <b>Make:</b><br>Supreme/Finolex/Flow guard/equivalent make   |
| 6.  | Weather proof Male / Female Snap-on(MC4 type) Connectors 4 sq.mm along with suitable crimping tool, lugs etc. for connection from PV module string to string inverter<br><br>Crimping tool for Snap on connectors | 45 nos of male<br>45 nos of female<br><br>1 No. | ✓ | ✓ | ( <b>Make:</b> Bizilink/Hensel / Tyco / Weidmueller / Multicontact / Elcom/ Elmex)<br>Excess connectors and crimping tools should be kept stored at site as a regular tools and spares after the completion of installation. |
| 7.  | Pipe earthing for Structures, String inverter and LA earthing as per IS3043.  | 3 Nos   | ✓ | ✓ | Make: JK / Ibex / equivalent   |
| 8.  | Miscellaneous items viz., 200 mm length Cable ties (UV protected), insulation tapes, ferrules, Lugs for termination along with contact compound tube, cable glands  | 1 set   | ✓ | ✓ | Quantities as required for project completion, vendor has to organize without any additional cost.   |
| 9.  | Lightning Arrestor (Globe type) for roof top system along with mounting arrangement and pedestal casting  | 1 set   | ✓ | ✓ | As per the attached drawing No. <b>3-679-05-00037</b>  |
| 10. | 8 SWG GI wire for Structures, LA ,PCU earthing with necessary clamp fixtures for proper routing   | 200 mtr   | ✓ | ✓ |  |
| 11. | MCCB, 3P+NL, 50 A for grid connection at the output of string inverter in the array area with outdoor mounting enclosure  | 1 No.,  | ✓ | ✓ | ABB/Schneider/L&T/equivalent reputed make  |
| 12  | Plant Name Board – 4 ft x 2 ft  | 1 No.,  | ✓ | ✓ | Plant Description should be approved by BHEL.  |

**Note:** In material supply column, NA means, these items will be supplied by BHEL.

**1. The technical particulars, installation procedures and drawings of the bought out items like String inverter, Earthing kits, Snap-On-Connectors, MCCBs etc. shall be submitted for approval to BHEL before procuring.**

**2. Vendor has to procure materials as per listed make. Whenever equivalent make has to be procured prior approval has to be taken from BHEL submitting the make and technical particulars of the component.**

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**3. Test Certificates of raw material and dimensional test reports of structures confirming to IS should be submitted to BHEL for PSI.**

### **3.0 PV ARRAY PEDESTAL FOUNDATION**

Mobile precast PCC pedestals (1:2:4) of 0.35x0.35x0.35 (in m) should be supplied. The cement used for PCC pedestal casting should be Ordinary Portland Cement of reputed make. The sand used should be free from organic matter and clay content. The aggregate used should be 20 mm nominal size. Pedestal casting should strictly adhere to the drawing **3-679-05-00683**. No hand mixing for the concrete is allowed. Vendor has to ensure good finish of the pedestal without any honey combs otherwise BHEL has right get the entire pedestal reworked at no extra cost. Vendor has to ensure proper curing for at least 7 days after casting. All the necessary arrangements for proper casting, if casted at site will be in the scope of vendor.

### **4.0 MODULE MOUNTING STRUCTURE:**

The module mounting structure should be in line with the drawing enclosed. Array support structure shall be fabricated using corrosion resistant GI metal sections. Array support structure welded joints shall be adequately treated to resist corrosion and fasteners should be SS304.

The support structure shall be free from corrosion when installed. PV modules shall be secured to support structure using screw fasteners. Screw fasteners shall use existing mounting holes provided by module manufacturer. No additional holes shall be drilled on module frames. Module fasteners/clamps shall be adequately treated to resist corrosion. Adequate spacing shall be provided between any two modules secured on PV panel for improved wind resistance. Zinc rich spray paint shall be applied in scratches of the structures for preventing corrosion.

### **5.0 STRING INVERTER:**

String inverter should cater to the following requirements. The technical particulars of the inverter have to be submitted to BHEL for approval before procurement.

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| Sl.No         | Technical parameter            | Specification  |
|---------------|--------------------------------|--|
| 1             | Make                           | Make and Model No. shall be furnished by the vendor  |
| DC Parameters |                                |  |
| 2             | DC Input Voltage               | BHEL make SPV Module of 290Wp (L24270) shall be used in this system as per attached data sheet. 18 modules will be connected in series to form a string. |
| 3             | MPPT Feature                   | MPPT feature shall be available. Details of MPPT shall be furnished.   |
| 4             | MPPT range                     | MPPT range of voltages shall be furnished by the vendor.   |
| 5             | DC side connection arrangement | Details of No. of DC input connections and type of DC side connections shall be furnished by the vendor.   |
| 6             | DC disconnect switch           | Integrated Disconnect switch shall be provided on DC side  |
| AC Parameters |                                |  |
| 7             | AC Output Voltage              | 3 Phase 400 V AC, minimum 4 wire output  |
| 8             | No. of phases/wires            | RYBN or RYBN+PE  |
| 9             | Grid voltage range             | Output grid voltage range shall be furnished by the vendor. However, offered Inverter shall work within the range of $V_{nominal} \pm 15\%$              |

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| 10                  | Grid frequency & its range                         | 50 Hz with $\pm 5\%$  |
| 11                  | Total Harmonic Distortion (THD)                    | < 3%  |
| 12                  | AC side connection                                 | AC side connection arrangement and output cable size details shall be furnished by the vendor.                        |
| 13                  | Remote & Local Monitoring                          | Remote and Local monitoring of Inverters shall be available. Vendor shall furnish the communication protocol details. |
| 14                  | Standby power consumption                          | Standby power consumption of Inverter shall be furnished by the vendor.   |
| 15                  | Maximum inverter efficiency and rated power factor | Vendor to mention   |
| 16                  | Maximum overload capacity                          | Vendor to mention   |
| Protection Features |  |   |
| 17                  | Anti-Islanding Protection                          | Shall be provided.  |
| 18                  | DC Reverse polarity protection                     | Shall be provided.  |
| 19                  | AC side short circuit protection                   | Shall be provided.  |
| 20                  | Governing Standards                                | Shall be provided.  |
| Mechanical Features |  |   |
| 21                  | Operating Temperature                              | -20 Deg. C to + 55 De. C  |
| 22                  | Dimensions   | Shall be provided by the vendor.  |

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| 23 | Weight                  | Shall be provided by the vendor.   |
| 24 | Cooling                 | Cooling arrangement (if any) details shall be furnished by the vendor.                       |
| 25 | Ingress protection (IP) | IP 65 or better (outdoor installation)   |
| 26 | Maximum altitude        | Vendor to mention up to what altitude above sea level inverters will work without de-rating. |

Vendor shall provide assistance/supervision at the site for installation & commissioning of the string inverters. Vendor shall depute their service engineer to site during I&C of the string inverters. If vendor engineers are not competent, vendor has to arrange engineers from Inverter supplier during commissioning of the plant.

## 6.0 EARTHING SYSTEM: GOVERNING

### STANDARD: IS 3043 – 1987

The earthing for array, lightning arrestor, plant equipment and LT power system shall be required as per provisions of IS: 3043. The requirement of earthing system for the Plant shall be as furnished in the above table.

Installation of earth stations:

The electrode has to be completely buried in to the earth pit. Vendor has to supply and fill all around the electrode earth enhancing mixture i.e., coal and salt. vendor has to organize the required machines & tools for earthing kit installation. There should be a test point provided for each earth pit for regular testing. Masonry enclosure (identified with labels) with cast iron cover plate shall be provided for each earth pit.

The structures, string inverter shall be inter-connected by means of GI wire/strip and finally connected through 25 x 3 mm thick GI flat to the respective earth pits from roof top. This GI strip is to be properly routed from terrace to corresponding earthing pit properly by clamping to wall at regular intervals. There will be a separate path for the lightning arrestor. Vendor has to make necessary arrangements to ensure proper routing and maintain the aesthetic look of the building.

**Earth resistance of the earth pits shall be tested in presence of the representative of BHEL as per applicable IS before commissioning and value to be less than 3Ω for structures and to be less than 1Ω for equipment body earthing for acceptance.**

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## 7.0 ERECTION & TESTING OF 30KWp SYSTEM:

**A)** Vendor has to arrange for receiving and unloading all the materials supplied by BHEL/BHEL vendors at the site. The storage, watch & ward responsibility of all the materials including BHEL supplies at site will be in vendor's scope until the commissioning of the plant. Any deficit occurring due to misplacement/mishandling will be borne by the vendor at no extra cost. The shifting of all the materials to the roof-top from storage location for erection will be in the scope of the vendor and he has to make necessary arrangements for the same.

**B)** Pre-cast finished pedestals with foundation Bolts shall be supplied as per the drawing **no 3-679-05-00683** enclosed. Aligning and positioning of each precast block to get uniform appearance of PV array is to be ensured. If required, filler material by way of filling concrete is required to be applied to get flat level of pedestals.

Note: Vendor has to do necessary pretreatment by chipping (nearly 10 mm) & grouting the PCC pedestal into the roof top floor. This should enhance the stability of the SPV structure on the roof top. The necessary water leak proof compound such as Dr. Fixit/equivalent approved by BHEL is to be used in the mortar, to arrest the water seepage, before fixing the pedestal on the roof. Necessary treatment to avoid water seepage will be in the scope of vendor. Alternative Concrete adhesive compound can be used to provide bonding between existing roof and PCC pedestal.

Vendor is required to assemble all the structures on the roof top as per the structure drawing and PV array layout drawings enclosed.

**C)** Each module will be fitted at four locations on to the structure by using SS 304 grade screws have. Earthing strip has to be run through separate M6X80 mm foundation bolts provided at precast cement pedestals. Interconnection of structures for earthing has to be done using 8 SWG GI wire up to the earthing kit.

Any activities requiring hole drilling, cutting of structures for completing the installation and mounting of PV modules on the structures is in the vendor's scope. Vendor has to make necessary arrangement for the drilling machine/gas cutting machine, if required.

**D)** 108 Nos of 290Wp SPV modules have to be assembled using structure materials.

**E)** Before mounting the PV modules on to the structures, each PV module have to



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be tested during peak sunshine period. Short circuit current ( $I_{sc}$ ) & Open circuit voltage ( $V_{oc}$ ) of the module has to be checked & recorded using multimeter and Clamp meter. Ensure the modules are electrically OK.

**F)** Approx., 18 numbers of PV modules of each 290 Wp are to be connected in series using quick connects with cables supplied along with PV modules. +ve & -ve terminals of each string has to be routed to string inverter + ve & - ve inputs through the PVC pipes. Vendor shall supply the MC4 type male / female connectors and the suitable crimping tool required for making interconnection. From the end terminals of each string, 4 sq. mm cable shall be drawn to string inverter. On either side and throughout the routing of the cables through pipes marking has to be done.

Special crimping tools required for crimping to be arranged by Vendor as per this specification, have to be used to crimp 4 sq.mm cables to quick connects for connecting output of series strings to inverter inputs. This crimping tool has to be kept at site permanently even after completion of project.

**G)** Each string Open circuit Voltage & Short Circuit Current (with a testing jig having appropriate load) to be checked and recorded as directed by the BHEL site engineer at site.

**H)** Mounting of string inverter on galvanized MS support structure at site is in the scope of vendor. Vendor has to mount the inverter at an appropriate place where a shade cover or canopy cover is available above string inverter. If canopy cover is not available, vendor to provide necessary canopy to cover the string inverter.

**I)** Cable laying and termination at all areas shall be carried out in such a way that there shall be no stress on the cables / lugs at the entry / exit points.

**J)** 1 run of 4CX16 mm<sup>2</sup> armoured cable from the 3Ø AC output of inverter have to be terminated on to a 50 A MCCB. The mounting of the MCCB is in the vendor scope. The output of MCCB has to be routed through PVC pipe, to the customer LT panel in the ground floor of the building. Marking of the cables has to be done on either ends and throughout the routing of the cable through PVC pipes for easy tracing of the cable. Appropriate cable lugs and crimping tools for terminations have to be arranged by vendor.

**K)** Pipes on the terrace have to be routed on cement brick work to ensure no water logging later on as shown in the attached Annexure-1. The necessary clamp fixtures required for routing pipes on the walls have to be procured and used by the vendor to ensure aesthetic look.

**L)** All the terminations required for SPV plant viz., at the inverter and LT panel etc., will be in the scope of the vendor. The necessary lugs and hardware required for

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the termination have to be arranged by the vendor. Vendor has to ensure that terminations have been made without any tension.

Note: Vendor have to carefully measure twice the exact length of cables required for the connection before cutting the cable from cable drum. Any short fall in length of cable arising out of vendor works should be borne by the vendor.

For 4 mm<sup>2</sup> termination appropriate marking with red and black insulation tapes have to be done by the vendor. The necessary tapes have to be arranged by the vendor.

The DC cables from the array have to be terminated on the inverter with proper labeling.

**M)** The installation of the Lightning arrestors and earthing pits will be in the scope of vendor. The necessary arrangements of digging and running the earthing strip from terrace to the bottom will be in the scope of vendor. Vendor has to neatly clamp the strip at regular intervals with necessary drum insulators/clamps and should ensure aesthetic look of the building.

**N)** Vendor is required to assist BHEL and associate with the other vendor's technical team during pre-commissioning checks and in commissioning of the power plant.

**O)** Vendor has to do coping for all the pedestals at the structure legs and at the pedestal base on all the four sides with cement plaster of 1:6. After coping vendor has to arrange for painting all the pedestals with weather resistant cement paint of suitable colour decided by BHEL engineer at site.

Note:

1. Vendor can visit site and ascertain what type of equipment/machines needed at site for execution.
2. **Supply shall be made directly to the site.**
3. **Vendor has to organize for unloading of all the materials including BHEL supplied materials at site and should arrange for safe storage. BHEL will inform in advance, the date of dispatch of BHEL materials viz., PV modules.**
4. The shifting of all the materials viz., BHEL supplied material and vendor supplied materials from stores/storage location to the site (building rooftop) also lies in the scope of vendor.
5. The roof is accessible through open concrete stepped staircase, but in case the materials has to be shifted avoiding staircase, pulley or other lift arrangements to shift it to rooftop has to be done by vendor.
6. All tools and tackles, like power drilling machine, cutting machine, digging tools, complete set of crimping tools etc, required for installation, wiring, crimping, assembly, digging of cable trenches, if required, earth pits & megger for checking insulation resistance of cable prior to commissioning

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etc., have to be organized by the contractor.

## **8.0 O&M Manual and TEST CERTIFICATES**

- a) 03 copy of O&M Manual shall be submitted within 10 days of E&C.
- b) Routine test certificates/Test Reports for structures (along with galvanization), string inverters & Earthing kits to be furnished by the VENDOR. BHEL, if required will inspect the materials at vendor place.
- c) Equipment shall not be dispatched until BHEL issues a "Dispatch clearance" to vendor.
- c) Warranty certificates shall be submitted for all bought-out items.

## **9.0 Delivery Schedule**

Work shall be completed within 30 days from the date of issue of PO.

## **10.0 GENERAL TERMS AND CONDITIONS:**

- 1) Vendor's responsibility, right and liabilities under this project will commence from the date of acceptance of the purchase order.
- 2) The installation activity will have to be carried out in such a manner that will not cause any inconvenience to the other agencies working in the site. Any permits from the customer, if required, are to be arranged by the vendor for his personnel.
- 3) After completion of the I&C, the entire site/area will be cleaned of debris etc. by the vendor prior to handing over of the site to BHEL.
- 4) All the materials brought to site has to have proper paper work like DC, Invoice etc. duly verified & signed by BHEL/BHEL's customer to be submitted to BHEL for payment.
- 5) Any damage to the buildings/structures/area made by vendor's work men or by vendor's agent will be made good by vendor at vendor's cost.
- 6) Vendor shall take work permit before commencement of all types of non-routine works as per the statutory procedures followed at the work place.
- 7) Vendor shall explain the job, associated hazards and precautions to his workmen.
- 8) Vendor shall ensure one person who should have the skill, knowledge and experience of performing the allotted task and shall be able to guide his team.
- 9) Vendor shall ensure safe procedure is followed during execution of the job.
- 10) Vendor shall ensure that his workmen wear appropriate safety Personal Protective Equipment.
- 11) Vendor shall ensure adequate supervision of the activity by his supervisor.
- 12) Vendor has to adhere to necessary legal/safety requirements and BHEL shall be kept indemnified against any untoward events taking place during the course of work.

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- 13) No child labour should be employed for executing the project.
- 14) In case project is not completed as per BHEL scope due to reasons arising out of materials from BHEL end/vendor's end, contractor has to complete the job at later stage without any extra charges. No over run charges shall be paid in case of extension of project schedules.
- 15) Any miscellaneous materials that have not been mentioned specifically in the specification/tender which are required for I&C of the plant, shall be deemed to be included in the specification and shall be supplied by the vendor without any extra charges. Any scope of activities which are not specifically mentioned in this specification but required for the completion of the I&C of the SPV plant for safe, trouble free, normal operation shall be provided at no extra cost by the vendor, unless explicitly excluded in the specification. Any charges for the electricity/water used for the construction work at site will be in the scope of vendor.
- 16) Scaffolding: Vendor have to employ scaffolding, belts/safety accessories for safety of personnel working on high rise building during erection, routing of earthing strips, use lifeline ropes while walking on height, and cabling through PVC pipes from roof top of the terrace to control room. Safety shall be ensured for workmen during Erection, testing & Commissioning against electrical hazards.
- 17) The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other statutory regulations.
- 18) **Statutory obligation:** Vendor is required to meet all the statutory obligations/ legal requirement with regard to workmen deployed by vendor for the project such as ESI, PF, Minimum wage act, Work man compensation act/Accident/medical insurance, Income Tax act, Employees Insurance act etc.
- 19) The installation should strictly conform to this specification. All the works shall be executed strictly as per the direction of BHEL engineer at site.

#### **11.0 WARRANTY:**

The warranty period for the string inverter should be 5 years and all other supplied items and work-man ship shall be for 2 year from the date of commissioning. Any defective parts/ activities shall be replaced/ rectified during warranty period on free of cost basis by the Vendor within 5 days from the complaint from BHEL. This warranty duration applies to all bought-out items by the vendor also. Warranty certificate shall be supplied for all supplied items.

#### **12.0 LIST OF ENCLOSURES:**

- 12.1 Typical Module Mounting structure- 3-679-05-00683
- 12.2 SPV Module drawing- 3-679-02-00352
- 12.3 SPV Module Data Sheet – CD- 4-4001-128
- 12.4 Schematic of Lightning Arrestor – 3-679-05-000