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Technical Specification for

Supply of Balance of System items and Installation & Commissioning

For 2.5 MW Solar PV grid connected power plant at

BHEL-Jhansi, UTTAR PRADESH

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1.0 Introduction

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up a 2.5 MW Grid Connected SPV Power Plant for BHEL-Jhansi, Uttarpradesh.

The plant will have PV modules of mono-crystalline / poly-crystalline type mounted on module mounting structures. Electrically, the PV array will have 2 nearly equal segments, each generating DC power of ~1250kWp, which is then inverted to AC by grid-connected power conditioning units (PCU) of 1250kW rating. At the AC output level, every two PCUs are combined using a 3-winding dry type transformer of 2.7 MVA rating which will step up the voltage to 11kV.

The solar array will have 18 string monitoring combiner boxes (SMBs) that collect the solar PV generated DC power and provide inputs to the 2 PCUs housed in centralized control room. Control room building will also house HT switchgear panel, ACDB, SCADA, battery bank, FCBC, UPS and other associated panels along with store room and toilets.

There will be 1 No. dry type transformers (2700KVA, 11KV/ 350-350V) located in control room. A typical layout of control room is enclosed. The plant will have SCADA integration and PC based monitoring desk to gather DC, AC and other parameters from SMBs, PCUs, weather monitoring equipment, transformers, LT / HT breaker panels.

The output of solar power plant shall be connected to 11KV substation through 11KV underground cable which will be in the scope of BHEL.

This technical specification provides requirements of BHEL for supply, installation, commissioning of balance of system items and defect liability period of 6 months. BHEL scope of supply and work is mentioned under section 4.2.

Note:

Vendor shall visit the site to assess all the technical and operational requirements and familiarize with the site conditions before placing the bid.

2.0 Documents enclosed with this specification

1	Tentative Single line diagram of overall power plant
2	Tentative Site layout with locations of solar array, control room (Autocad drawing of site layout will be provided on request by vendor through e-mail)
3	Tentative Control Room Layout
4	Tentative drawing of String Monitoring box

3.0 Documents to be submitted along with offer

- 1. Clause-wise compliance shall be filled-up in the column provided in this specification, with signature and seal on every page.
- 2. Company brochure.
- 3. Project implementation time schedule.
- 4. Stage-wise manpower schedule.

Note: Wherever approved vendors are provided, in case if it is required to propose additional vendors, the same shall be done with prior approval by BHEL. For all the items wherever approved vendors are not provided, approval of makes shall be obtained from BHEL before placement of P.O on sub-vendors.



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4.0 Scope of Supply and work

4.1 Vendor scope of supply and work

The table below indicates the vendor's scope of supply, installation and defect liability period of 6 months as briefly outlined. Quantities mentioned below are indicative only. Vendor shall estimate exact requirement and quote accordingly.

S.No	Item description	Qty	Unit
1	Cable ties	1	Set
2	SMB mounting structure & hardware	18	Set
3	MC4 connectors	415	Set
4	HDPE DWC pipe 63 mm	1000	М
5	240 sqmm Cable lugs with bimetallic washers and hardware in SMB	36	Set
6	Cable trays inside CR	80	М
7	Cable tray support structure inside CR	1	ST
8	Cable glands 240 sqmm in PCU DC side	36	Nos
9	240 sqmm Cable lugs with bimetallic washers and hardware in PCU DC side	36	Set
10	1.1KV, 1CX300 sq.mm, Aluminium Conductor, XLPE insulated, Armored, PVC sheathed Cable from PCU to transformer	1000	М
11	300 sqmm Cable glands for PCU AC side transformer LT side	84	Nos
12	300 sqmm Cable lugs with bimetallic washers and hardware for PCU AC side transformer LT side	84	Set
13	HT cable - 11KV(UE), 3CX240 sq.mm	30	М
14	Reverse power relay	1	No
15	HT termination kits - indoor	2	ST
16	ACDB	1	No
17	UPS-5 KVA with battery with UPSDB	1	No
18	Weather Monitoring System	1	ST
19	DWC pipe for RS485 cable	1	ST
20	Auxiliary, data and control cables	1	ST
21	Lugs & hardware for data, auxiliary and control cables	1	ST
22	25X3 GI flat for earthing	1	ST
23	25X6 GI flat for earthing	1	ST
24	Earthing electrodes for MMS	1	ST
25	Hardware for array earthing	1	ST
26	SMB earthing electrodes	18	Nos
27	Copper cable -16 sqmm for earthing	1	ST
28	Copper cable -2.5 sqmm for earthing	1	ST
29	Copper flat- 50X4 for earthing	1	ST
30	Copper cable -25 sqmm for earthing	1	ST
31	Copper cable -70 sqmm for earthing	1	ST
32	Earthing electrodes for control room equipment	1	ST
33	ESE LA and earthing	1	ST
34	Yard lighting system	1	ST
35	Module cleaning system	1	ST



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36	Identification tags, markers etc.	1	ST
37	Hoarding board	1	ST
38	Display boards and sign boards	1	ST
39	Electrical insulation mat	1	ST
40	Checkered plate	1	ST
41	Air conditioner	1	ST
42	Tool kits and instruments	1	ST
43	Office furniture	1	ST
44	Fire alarm system	1	ST
45	safety related items	1	ST
46	Spares	1	ST
47	Installation & Commissioning as per respective clauses in specification	1	AU

4.2 BHEL scope of supply and work

For the sake of clarity to the vendor, the items that are within the scope of BHEL supply are listed below.

#	BHEL Scope of supply	Qty
1	Supply of Solar PV Modules	
2	Supply and Erection of Solar array structures with modules mounted on structures (MMS), with each having 20 Nos. of PV modules	~415 sets
3	Supply of Cable, 1Cx 6 sq-mm (for connection of PV modules to string monitoring boxes)	~ 35 km
4	Supply of Cable, 1.1KV, 2C x 240sq-mm (for connection from SMBs up to PCUs and PCUs to transformers)	~ 4 km
5	Supply of String monitoring boxes (24-in, 1-out)	18 Nos
6	Supply of Power conditioning units (PCUs) of 1250 kW rating along with duct	
7	Supply of Dry type transformer 2700kVA, 11KV/350V-350V (1 HV winding, 2 LV windings)	1 Nos
10	Supply of 11KV indoor HT panel	1 set
11	Supply of SCADA system with PC, accessories and software	1 set
12	Supply of RS-485 cable and Ethernet LAN cable for SCADA	1 set
	BHEL Scope of work	
13	Construction of control room including partitions for SCADA, store and toilets	1 No
14	Construction of boundary wall for the entire plant, pathways, approach road, drains within the solar plant	1 set

Note: For all civil related activities in the scope vendor, quality documents (Material test reports, Design mix report etc.) shall be submitted by vendor as per Annexure-C of BHEL tender.



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5.0 Detailed technical specification for supply, installation and commissioning

Vendor shall indicate clause-wise compliance (Yes/No) in the column provided below. In case of non-compliance or deviation, vendors shall record their comment.

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#	BHEL specification	Vendor compliance (Yes / No) In case of non-compliance or deviation, vendors shall record their comments:
5.1	 Setting up of temporary site office (1) Vendor shall set up a temporary site office using one porta cabin of minimum 160 sq.ft along with chemical toilet, water tank and septic tanks for BHEL use within 10 days from the date of purchase order to enable speedy commencement of site activities. (2) Porta cabin shall be retained at the site until completion of 1 month after commissioning or till completion of vendor's works whichever is later. (3) Cabin shall be furnished with essential amenities such as one computer with internet connection, printer, two work tables, six chairs and necessary number of power points, lamps, air conditioner and fans. (4) Vendor shall arrange drinking water in site office for the site engineers of BHEL and the staff/employees of vendor. (5) Vendor shall make arrangement for pantry shed for preparation of beverages such as Tea/ Coffee etc. Vendor shall depute office boy-cum-cook for preparation of Tea/Coffee. All the utensils, facilities such as LPG/electric stove and service requirements shall be included in vendor's scope. Consumables such as milk, tea, coffee powder, snacks etc. shall be arranged by BHEL. 	
5.2	Electrical power and water for construction (1) BHEL shall organize necessary electrical power supply and water supply required for construction activities in vendor's scope and also for the porta cabin on chargeable basis. Vendor shall pay the charges to BHEL based on consumption. Necessary metering arrangement shall be made by vendor.	
5.3	 Construction of temporary yards for safe storage of BHEL as well as vendor supplied items except PV modules and MMS (1) Vendor shall, at suitable locations at the site, as decided based on discussions with BHEL site engineer, construct a temporary yard for safe storage of all BHEL as well as vendor supplied items except PV Modules and Module mounting structures. This includes storage of all items such as electrical panels (SMBs, PCUs, HT panels, Transformer, Distribution boards etc), cables, spares, tools, instruments etc. (2) Area of storage yard shall be min. 300 sq.m. However, exact size shall be decided mutually with BHEL based on site conditions. (3) A portion of storage yard area (min. 100 sq.m) shall be provided with suitable temporary roof and side covers (asbestos, FRP, steel sheet etc.,) for storage of critical electrical panels (PCUs, SMBs, HT panel, electrical DBs etc.) in order to ensure that there will not be any water spillage which may damage the 	



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equipment. This should be supported by steel poles that shall be grouted using
suitable concrete foundations. Height should be appropriately decided to
ensure safe operation of hydra for loading/unloading etc.,

- (4) Necessary raised / covered arrangements shall be provided to the individual panels / equipment to ensure that these items are not affected by water at the ground level during time of rain storm, flood etc.
- (5) Yards shall be fenced all around with a steel gate of width of 4m minimum. Height of fence and gate shall be 2.5m minimum above the ground level.
- (6) Suitable fencing shall be provided using steel poles at every 3m intervals and barbed wires between the poles.
- (7) Gate shall be suitably secured to the fencing poles and shall be provided with lock and key.
- (8) Sufficient watch and ward security personnel shall be provided for the storage yard and complete solar plant erection area on round-the-clock basis.

5.4 Receipt, unloading, safe storage and movement of BHEL and vendor supplied items except PV modules and MMS

- (1) 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 and vendor supplied items except PV Modules and MMS received at the site and subsequent movement to the storage yard. Similar arrangements shall also be made by vendor for movement of the items from storage yard to the point of construction for vendor's scope of works.
- (2) Vendor shall maintain proper documentation / compilation of all the records related to shipping (invoices, delivery challans etc.) and shall take verification and approval from BHEL site engineer for every consignment. The documents shall be suitably preserved for further handing over to BHEL.
- (3) Safeguarding the items from pilferage etc. is responsibility of vendor. For this purpose, vendor shall post adequate watch and ward for the yard on round-the-clock basis.
- (4) Registers shall be maintained for the yard to keep track of incoming / outgoing items.
- (5) BHEL will ensure insurance for all the items. Vendor shall provide necessary documentation and assistance to BHEL for making insurance claim in case of damage /theft of BHEL supplied items.

5.5 Interconnection of SPV modules to form strings.

Supply of SPV modules is in BHEL scope. Vendor shall interconnect the modules as follows:

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

- (a) Positive cable of one module shall be connected to the negative cable of adjacent module. The cables have MC4 type of connectors. One polarity cable has male type connector, while the other has female type connector.
- (b) This way, 20 modules shall be connected in series. Each set of connections is called as a series string.
- (c) After placing the purchase order on vendor, BHEL will provide layout drawings that will describe the exact way in which the series strings are formed and interconnected to the respective SMBs. Vendor shall implement the interconnection as per these drawings.
- (d) Interconnected cables shall be neatly routed and dressed using UV resistant nylon cable ties of appropriate dimension.
 - e) These cable ties shall be in vendor scope of supply. Recommended make: 3M,



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	Phoenix contact, Weidmuller, Hellermanntyton, Panduit. BHEL approval shall	
	be obtained by vendor for use of any other make. Specs: Nylon cable ties, polyamide 6.6 UV stabilized black, UL94 flammability	
	rating V2, meant for outdoor use. Operating temperature up to 85 deg C. Width	
	of cable tie shall be minimum 4.5 mm. BHEL approval shall be obtained for the	
	selected brand and length of cable tie.	
	(f) Cables shall not be loosely hanging.	
5.6	Installation of string monitoring boxes	
	(1) Supply of string monitoring boxes (SMB) is in BHEL scope. These are 24-in and 1-out type.	
	(2) Vendor shall install the SMBs on Module mounting structure in the solar array field as per final array layout.	
	(3) Supply of SMB mounting structures using GI channels/angles and necessary hardware required for installation of SMBs are in the scope of vendor.	
	(4) Drawings of SMB and the fixing arrangement will be provided to the vendor after placement of purchase order.	
	(5) SMB location will be identified by BHEL and will be provided in the wiring layout.	
	(6) SMBs shall be fixed on the structures using necessary hardware which shall be supplied by vendor.	
	(7) All tools necessary for mounting shall be in vendor scope.	
5.7	Interconnection of SPV string cables to 6 sq-mm cable	
	(1) Each SPV module string shall be connected to SMB using 1Cx 6 sq-mm cable	
	supplied by BHEL. Overall diameter ~ 6 mm. Diameter under the outer sheath	
	(i.e over the insulation) ~ 4.6 mm.	
	(2) SPV module is provided with positive and negative cables (4 sq-mm) having	
	male and female parts of MC4 type connectors.	
	(3) Vendor shall supply plug connectors of MC4 type, each set having a pair of male and female parts, to join the 6 sq-mm cable with SPV module string. Necessary	
	crimping and termination is in the scope of vendor.	
	(4) MC4 connectors shall have rating of 1000VDC (IEC), rated current of 25A (min.), Type approved by TUV Rheinland for product safety.	
	(5) Approved make: Multi-contact or other reputed equivalent subject to BHEL	
	approval during detailed engineering.	
	(6) Total quantity of MC4 connector sets required = 415 sets (each set having a male and a female part).	
	(7) Extra quantity shall also be procured considering possibilities of damages	
	during the installation. Vendor shall ensure that there shall not be any shortage	
	during execution time.	
	(8) Vendor should make available MC4 tool kits of quantity as required during execution for simultaneous working on the array.	
5.8	Routing of 1Cx 6 sq-mm cable:	
	(1) 6 sq-mm cables connecting the SPV module strings to SMBs shall be neatly	
	routed along the module mounting structures using cable ties.	
	(2) 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. Cable ties shall be of make: 3M, Phoenix contact,	
	Weidmuller, Hellermanntyton, Panduit. Width of the cable ties shall be a	
	minimum of 4.5 mm. BHEL approval shall be obtained for the selected brand	
	and length of cable tie.	
1	(3) Cables shall not be loosely hanging.	



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5.9 Underground laying of 6 sq-mm cables between the rows

- (1) Where 6 sq-mm cables run between two rows of structure, HDPE double walled corrugated (DWC) pipe shall be used to guide the cables underground from one row to the other in trenches.
- (2) HDPE DWC pipe of required length shall be within scope of vendor supply. Vendor to procure necessary quantity of HDPE pipes based on the actual requirement and ensure no shortfall in supply during the time of installation. Qty required~1000 M
- (3) Inner Diameter (ID) shall be selected to accommodate the number of 6 sq-mm cables to be guided. However, Inner diameter shall be limited to a minimum of 63mm. Make: Tirupati Plastomatics, Jaipur or reputed make, as approved by BHFI
- (4) Make, part number, sizes / dimensions, datasheet shall be submitted to BHEL for approval.
- (5) Details of cable trench:
 - (a) Trench depth = 600 mm minimum.
 - (b) Trench width = 200 mm minimum.
 - (c) Bottom layer shall be sand of IS: 383 with 100mm thick.
 - (d) HDPE conduit shall be laid over the sand layer.
 - (e) Another layer of sand of 100 mm thick.
 - (f) Then, a single layer of class-2 brick (burnt clay type) of 75 mm thickness shall be laid.
 - (g) Trench shall, then, be filled with refill soil and compacted.

5.10 Connecting the 6 sq-mm cables on input side of SMBs

- (1) 6 sq-mm cables of positive and negative polarities originating from SPV module strings shall be terminated at the input side of SMBs using MC4 connectors.
- (2) MC4 connectors are fitted on input side of SMBs. Matching MC4 connectors will be supplied by BHEL in loose.
- (3) Vendor scope includes removal of sleeve at the cable end, crimping with MC4 connectors. These MC4 connectors have to be terminated on to the MC4 connectors that are part of the SMBs supplied by BHEL.
- (4) All necessary tools such as pliers, strippers, crimping tool etc. shall be within vendor scope.

5.11 Connecting the DC power cables on output side of SMBs

- (1) Cables of size 2Cx 240 sq-mm (Aluminium, armoured, XLPE insulation, PVC sheathed) shall be terminated at the output side of SMBs. Supply of this cable is in BHEL scope.
- (2) Overall diameter of cable ~ 45mm.
- (3) Vendor scope includes removal of sleeve at the cable end, crimping with suitable cable lug of appropriate type/size and connecting the lugged end to the bus bar within the SMB. Cables shall enter the SMB through the cable glands that are supplied by BHEL along with SMBs.
- (4) Aluminum Cable lug and bimetallic washer (Cu and Al) shall be in vendor scope of supply. Vendor shall submit catalog and datasheet of lug before procurement. Make: Dowell's /3D / 3M or any other reputed equivalent as shall be approved by BHEL. Quantity required ~ **36 Nos**.
- (5) Hardware such as bolts, nuts, plain washers and spring washers shall be in vendor scope of supply. The size and type of these shall be in accordance with termination arrangement on the bus bar of SMB. Hardware should be SS304. Spring washers should be Zn coated.
- (6) All necessary tools such as pliers, strippers, crimping tool etc., required to complete the work shall be within vendor scope.



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5.12 Cable trenches for laying power cables from SMB to inverters:

- (1) 2Cx 240 sq-mm (Aluminium, armoured, XLPE insulation, PVC sheath) cables of positive and negative polarities are routed from SMB box to power conditioning units (PCUs) located at control room.
- (2) These cables shall be laid underground from the point near SMB to control room.
- (3) One cable (+, -) from each of the SMBs have to be routed to respective inverters.
- (4) Tentative Array layout with location of SMBs and control room is enclosed for vendor's reference and for estimation purpose. Exact solar array layout will be provided by BHEL after placing purchase order. Vendor shall prepare and furnish cable routing layout as per standards for approval by BHEL.
- (5) Vendor shall estimate the length of cable trench. Generally these power cables will be packed in 1000 m drums. Vendor has to carefully plan laying of farther cables first to ensure cut lengths can be used for shorter cables. Any shortage of cable occurring because of vendor's works will be in the scope of the vendor.
- (6) Vendor shall construct the underground trench as follows:
 - (a) Trench depth = 750 mm minimum.
 - (b) Trench width shall vary en route to control room, based on the number of cables. As the cables join from SMBs en route, bunching takes place and the width of trench shall increase. Max trench width expected = 2m.
 - (c) Sand as per IS: 383 of 100 mm layer thickness shall be laid at the bottom most level of trench.
 - (d) Over the sand layer, cables shall be laid one adjacent to the other. Cables shall not be laid one over the other. In other words, only one layer of cables shall be allowed.
 - (e) Over the layer of cables, one more layer of sand of 100mm shall be laid.
 - (f) Then, a single layer of class-2 brick (burnt clay type) of 75 mm thickness shall be laid.
 - (g) Trench shall then be filled up with refill soil.
 - (h) Subsequently, land over the cable trench shall be leveled and compacted suitably.

The cables shall be laid inside Class-B GI pipes/ RCC hume pipes of suitable size under road crossings, drains, sewerage lines, entry and exit points of the buildings or where there are chances of mechanical damage Only terminal cable joints shall be accepted. No cable joints to join two cable ends is acceptable. Supply of GI/RCC hume pipes is in the scope of vendor.

5.13 Installation (indoor) of PCUs with ducting, transformer, HT panels, SCADA panel, ACDB located inside control room together with cable trays in cable trench:

- (1) Vendor shall organize necessary resources such as labour, cranes, hydra, forklifts, transportation trucks / trolleys and other accessories for movements and positioning of the items as below within the control, inverter and security rooms:
 - a. PCU panels: 2 sets (each ~2500 Kg)
 - b. Dry type transformer: 1No (~2000 Kg)
 - c. HT switchgear panel: 1 No (~1500 Kg)
 - d. ACDB panel: 1 No
 - e. SCADA panel: 1 Nos (~500 Kg each)
 - f. Control desk with PCs and accessories: 1 set
- (2) All equipment shall be placed over the cable trenches in control room, in the exact sequence and locations as shown in BHEL drawings that will be provided to vendor at an appropriate time during the period of execution.
- (3) All equipment shall be suitably grouted using welding / bolting methods as



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appropriate. BHEL approval shall be obtained for the grouting arrangement. All necessary hardware for the same shall be within vendor scope of supply.

- (4) Vendor shall supply and install cable trays of required length and corner bends as required within control room for laying DC, AC & signal cables over the trays. Vendor shall supply cable trays as follows:
 - a. Ladder type GI cable trays
 - b. Hot dip galvanized
 - c. Depth = 40 mm min.
 - d. Width = 600 mm min.
- (5) Vendor shall fix the cable trays on the projecting steel sections in cable trench of control room. Supply and works related to the appropriate placement of these steel sections will be in the vendor's scope.
- (6) Adjacent cable trays shall be interconnected using suitable hardware items that shall be in vendor scope of supply.
- (7) Cables shall be laid over the cable trays and neatly dressed using appropriate cable ties etc.
- (8) Cables from AC side of PCU (7RX1Cx300 sq.mm per phase) shall be laid over ladder type cable trays up to LV side of 2700 KVA inverter transformer located in control room.
- (9) Vendor shall install exhaust ducting on top of PCUs (1 set for each PCU) to throw heat from inside PCU to outside control room. Supply of duct material shall be in the scope of BHEL.
- (10) All 11KV panel and transformer works shall be carried out by a licensed electrical contractor as per STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/ CEA regulations.

5.14 Power cable terminations on DC side of PCUs

- (1) On DC side, for each PCU, vendor shall carry out the required number of cable terminations for 9 positive and 9 negative inputs connections by unsleeving, crimping and connecting.
- (2) BHEL shall supply the cables (2CX240 sq.mm Aluminum, armored, XLPE insulation, PVC sheath).
- (3) All cable glands, cable lugs, bolts, nuts and washers required for termination on DC side of PCU shall be supplied by the vendor. Qty of lugs and glands required ~36 Nos.
- (4) All tools and accessories required to carry out the termination shall be within scope of vendor.

5.15 Power cable terminations on AC (LT) side for PCUs and transformers

- (1) On AC side, 3-phase 3-wire power cable interconnections shall be made between PCUs and transformer using 7 runs of 1Cx300mm² Aluminum, armored, XLPE insulated cable per phase. Supply of this cable is in BHEL's scope.
- (2) For AC cable terminations at PCU end and transformer end, vendor shall supply the required number of cable glands, cable lugs, bolts, nuts, plain washers, spring washers. Aluminum lugs with bimetallic washer (Al-Cu) shall be supplied. Bolts, nuts, plain washers shall be of SS304 type. Spring washers shall be zinc plated steel. Make of lug: Dowell's /3D / 3M or any other reputed equivalent as shall be approved by BHEL. Quantity of lugs and glands required ~84 Nos
- (3) BHEL will furnish the exact diameter of the cable at an appropriate time during the period of execution. Vendor shall make suitable size cut-outs using hole—saw cutters in the gland plates of the transformers for entry and exit of cables.
- (4) Vendor shall make the measurements between the equipment, cut the cables to the required lengths, fix them with glands, unsleeve them at the ends, crimp



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	them with the lugs and terminate them at the respective bus bar provisions	
	within the panels. (5) All tools and accessories required to carry out the termination shall be within	
	scope of vendor.	
5.16	Installation of 2700kVA, 11KV /350-350V dry type transformer supplied by	
	BHEL	
	(1) Dry type transformer and its accessory parts as supplied by BHEL shall be	
	moved from storage yard and installed on cable trench in control room. All parts and hardware shall be assembled as per guidance at site provided by	
	BHEL / transformer vendor.	
	(2) Vendor shall provide all necessary support and assistance to the representative	
	of transformer manufacturer during installation and commissioning checks.	
5.17	Supply of reverse power relay	
	Wandanakallalaa suunka Marusussa massa malassin laasa sukiskiis manuinadka ka	
	Vendor shall also supply 1 No. reverse power relay in loose which is required to be installed in terminal substation. Make: ABB, or reputed make which shall be	
	approved STATE ELECTRICITY DEPARTMENT/BHEL.	
5.18	Laying of HT power cable	
	(1) Output from inverter transformer shall be connected to incoming feeder of	
	indoor HT Switchgear panel using HT Cable which shall be laid on cable trays in	
	control room cable trench. (2) Supply of HT cable shall be in the scope of vendor. Quantity required ~30m.	
	(3) Specification for HT cable: 11KV (UE), 3CX240 sq.mm, Aluminum Conductor,	
	XLPE insulated, Armored, PVC sheathed as per IS 7098 (Part-2).	
	(4) Vendor shall lay these cables layer wise providing adequate separation as per	
	the relevant IS standards. Vendor shall indicate the IS standards employed.	
	(5) Trench layout and trench drawings shall be submitted to BHEL for approval.	
5.19	(6) From outgoing of HT panel, HT cable shall be laid up to substation by BHEL. Power cable terminations on AC HT side (11KV)	
3.17	(1) Vendor shall carry out HT power cable terminations on HV side of 2700 kVA	
	transformers (1 set), on incoming and outgoing side of HT panel (2 set). HT	
	termination kits and all necessary hardware shall be within vendor scope of	
	supply. HT termination kits shall be indoor type suitable for 11KV, 3CX240	
	cable. Make: Raychem, 3M or reputed equivalent as shall be approved by BHEL.	
	(2) Quantity of termination kits required shall be 3 sets of indoor type for 11KV 3Cx240 sq-mm cable. Quantity indicated above is the exact requirement.	
	Vendor shall ensure procurement of additional quantity of termination kits, if	
	required at no additional cost to BHEL to tide over any contingencies during	
	installation.	
	(3) All tools and accessories required to carry out the termination shall be within	
	the scope of vendor.	
	(4) Since no cable glands are provided for these cases, vendor shall apply suitable	
	grade of bitumen, RTV or any other sealant as shall be approved by BHEL, for sealing the gap around the cable at the cable entry of transformers and HT	
	panels.	
	(5) Vendor shall provide support mechanism using clamps and GI pipes for HT	
	cables wherever required so that the connecting terminals are not damaged due	
	to mechanical load of cable.	
5.20	Supply and installation of ACDB Panel	
	One number ACDB shall be supplied and installed by the vendor in the control room	
	for internal loads of solar plant. Vendor shall submit the single line diagram, GA	
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drawing showing the details of feeders for HT panels, transformers, internal lighting, module cleaning pumps, Air conditioner, periphery lighting and other loads in the plant. Vendor shall ensure equal loading in all the three phases. The number of feeders and their capacity shall be decided during detailed Engineering stage.

CONSTRUCTION FEATURES: The ACDB panel shall be made of CRCA sheet steel of 2mm thick and shall be fully dust and vermin proof, providing a degree of protection of IP-20. Panel shall be provided with hinged doors with handle and locking facility for switch on interlock of doors. Doors shall be gasketted all round with Neoprene gaskets. The DB shall have two earthing terminals on either side for earthing.

The required cable glands for the cables shall also be supplied with DBs. The incoming MCCB of rating 100A shall be hand operated, air break, quick make and quick break type with short circuit breaking capacity of not less than 50kA.

The Outgoing MCBs shall conform to IS-8828 (latest edition) and shall have a minimum interrupting rating of 10 kA. The ACDB shall be provided with of 3-phase, 4 wire, 0.5 class Multi-Function Meter (MFM) for measuring auxiliary power consumption. The MFMs shall have a RS-485 Modbus communication port to communicate with the central PC system (SCADA).

5.21 Supply and installation of UPS

Vendor shall supply and install 1No. 5KVA UPS with UPSDB in the control room for auxiliary supply to PCUs, SCADA panels, PCs and emergency lighting. Vendor shall supply battery for UPS with a backup of 2 hours. Vendor shall submit the sizing calculations for battery considering design margin, temperature correction factors and safety margins for approval.

5.22 Supply, installation of weather monitoring station

Vendor shall supply and install Weather monitoring Station (WMS) on top of control room. Exact location shall be decided by BHEL during execution. WMS shall consist of Pyranometer (1 No.), Anemometer (1 No.), Module temperature sensor (1No.) and Ambient temperature sensor (1 No.).

All the sensors of WMS shall be provided with output of 4-20mA signal. Converters if any required for conversion of sensor output to 4-20mA shall be in the scope of vendor.

All necessary communication/ signal cables required for termination of WMS sensors in SCADA panel shall be in the scope of vendor. Supply and installation of Galvanized Mounting structure for WMS along with pedestal is in the scope of vendor.

Approved makes: Kipp & Zonen/ Campbell Instruments / Aeron Systems / Dynalab / Metone / Hukeflex or any other reputed make as shall be approved by BHEL. BHEL approval shall be obtained for make and GTP prior to procurement.

Detailed technical specifications of the equipment are given below.

PYRANOMETER:

I. Spectral Response- 300 to 2800 nano meters.



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2. Sensitivity- 8 to 20 µV/W/m2

3. Operating temperature range: 0 deg to +70 deg.

4. Resolution: Min +1W/m2

5. Output: Analog form 4-20 mA

6. Standard: ISO 9060 -second class or equivalent.

7. Maximum operational irradiance: 2000W/m2

8. Response Time (95%): <30s

9. IP rating: IP65 (minimum)

Pyranometer shall be supplied with necessary cables. Sample calibration certificate with calibration traceability to World Radiation Reference (WRR) World Radiation Centre (WRC)/ IMD shall be furnished along with the offer.

ANEMOMETER:

Anemometer shall be 3-cup tubular stainless steel type. Velocity range shall be up to 45 m/s and accuracy limit of 0.5 m/s up to 10 m/sec.

AMBIENT TEMPERATURE SENSOR:

PT100 sensors mounted inside a radiation shield, communication cable of adequate length, temperature range: -40 to +60 degC with accuracy of +/-0.2 degC.

MODULE TEMPERATURE SENSOR:

Module temperature sensor shall be fixed to one of PV modules using heat conducting tape and output shall be connected to nearest SMB. Temperature range: 0 to +80 degC with accuracy of +/-0.2 degC.

5.23 Power cable terminations at ACDB panel

- (1) Auxiliary power of approx. 30KW shall be provided by BHEL up to control room using LT power cable of suitable size. Supply and laying of this cable shall be in BHEL scope.
- (2) Vendor shall carry out termination on input and output side of ACDB. Cable glands, cable lugs, bolts, nuts, plain washers and spring washers shall be within vendor scope of supply.

5.24 Support and assistance for SCADA integration for the power plant

- (1) SCADA of power plant comprises of data station panel and PC based control desk with software to collect, store, process and report the data parameters of power plant as follows:
 - (a) String monitoring boxes in solar array field: string current, voltage, box temperature, module temperature, status of SPD and load break switch in SMRs
 - (b) Weather monitoring equipment: solar irradiation, ambient temperature, wind velocity.
 - (c) Power conditioning units: DC input /AC output parameters of inverters, grid data, fault status and events logged, etc.
 - (d) HT panels: status of breakers, status of protection relays of transformers, Multi Function meters.
 - (e) Transformers: winding temperature
 - (f) Energy export to the grid from ABT meters etc.
- (2) Vendor shall carry out following activities:
 - (a) Formation of underground cable trenches and cable laying and termination for data communication cables from SMBs to SMBs (daisy chain) and from end SMB of each loop to SCADA, from transformers, VCB panels to SCADA.



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		,
	(b) Data cable laying from PCUs, transformer, VCBs, ACDB panels to SCADA.	
	(c) Data cable terminations at PCUs, ACDB panels, transformers and VCB	
	panels.	
5.25	Cable trenches for laying data communication cables (RS485) from SMBs to	
	SMBs and control room.	
	(1) Data communication (RS 485) cables shall be laid between SMBs to form daisy	
	chain loop (Not more than 10 SMBs in one loop) and from the end SMB of each	
	loop, RS485 cable shall be laid to the SCADA panel in the control room.	
	Communication Cables shall be laid in HDPE DWC pipes of minimum ID 25mm.	
	(2) Supply of this RS 485 communication cable shall be in BHEL scope. Supply of	
	DWC pipes shall be in vendor's scope.	
	(3) These data cables shall be laid underground using separate cable trench. In	
	other words, these cables shall not be laid along with power cables. A minimum	
	distance of 500mm shall be maintained between the data cable trench and	
	power cable trench to avoid EMI interference.	
	(4) Underground laying shall be ensured even within the daisy-chain looping	
	between adjacent SMBs.	
	(5) Cable trench shall be as per details below:	
	(a) Trench depth = 600mm minimum	
	(b) Trench width shall be 200mm minimum	
	(c) Bottom layer shall be sand as per IS: 383 with 100mm layer thickness.	
	(d) Data cable shall be laid over the sand.	
	(e) Another layer of sand, 100 mm thick, shall be laid.	
	(f) A single layer of brick, class-2, 75mm thick, shall be laid over the sand.	
	(g) Trench, then, shall be filled up with refill soil and compacted.	
5.26	Data & Control cable laying and terminations in control room	
	Vendor shall carry out following data cable laying and terminations at 2700 kVA	
	transformers, VCB panels, ACDB panels and PCUs.	
	(1) Terminations at marshalling box of 2700kVA transformers (WTI).	
	(2) Terminations at VCB panel for SCADA. RS485 cable for MFM and numerical	
	relay to SCADA shall be supplied by BHEL.	
	(3) Terminations at PCUs of 1250kW for RS485 MODBUS communication over	
	TCP/IP cable connections using LAN cables. Supply of LAN cable is in BHEL	
	scope. (4) Terminations at ACDB panel.	
	(5) All the cables required for the above terminations except for PCUs shall be	
	within vendor scope of supply. Cable specification as follows:	
	Cable, 1.1kV grade, copper conductor, stranded, PVC_type-A insulation, twisted	
	pair, overall shielded with aluminium backed mylar sheet, inner sheath of	
	extruded PVC type ST1, Galvanized steel strip / round wire armoured as per IS,	
	outer sheath of extruded FRLS PVC type ST1, conforming to IS:1554 / part-1	
	with latest amendments up to date.	
	(6) Vendor shall submit the cable schedule for data, control and communication	
	cables. Control cables shall be 2.5 sq-mm minimum, copper conductor, PVC,	
	armoured. Communication cables shall be 0.5 sq-mm minimum, copper	
	conductor, PVC, armoured.	
	(7) Make of cables: Polycab, Advanced cables, Lapp, KEI or any other reputed	
	equivalent as shall be approved by BHEL.	
	(11) Cable lugs and all hardware required for making the above terminations	
	shall be in vendor scope of supply.	
	Note: Along with the above activities, DC/AC power supply cable laying and	
	terminations shall be also be carried out for transformers and VCB panels using	



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2Cx2.5 sq-mm copper, armoured, PVC cables which is in vendor scope of supply. Cable shall be laid from FCBC (for DC) and ACDB panel (for AC). 5.27 Earthing of solar array structures (1) Vendor shall interconnect solar array structures using welding of min. 25x3 mm GI strips. (2) Every row of such interconnected structures shall be terminated in a earthing electrode of 3000 mm long, hot dip galvanized and metal coated for rust proof, OD of minimum 50 mm shall be supplied by vendor. (3) Vendor to ensure that every earthed structure is provided with two alternate paths to earth. Accordingly, vendor shall provide suitable number of earth pits and ensure that the earth resistance of all earthed structures is less than 1 ohm. (4) Earth pit shall be drilled and earthing electrode shall be placed in the pit, filled with back filling chemical compound all around the electrode as per manufacturer's datasheet/installation instructions. (5) Earth chambers of brick masonry shall be constructed. All items of earth chambers, including lid, shall be in vendor scope of supply.

- (6) Earth chambers shall be interconnected in the solar array field, using min. 25x6 mm GI strip that shall be laid underground.
- (7) Terminations at the electrode end shall be made using bolting method. Welding shall not be applied at electrode end. For this purpose, a separate link with multiple mounting holes shall be used at the electrode end. This way, GI strips (25x3 mm) running from structure leg and the GI strips (25x6mm) from adjacent electrodes shall be terminated at this link, which shall, in turn, be connected to the electrode. Joining of 25x6 mm GI strips at intermediate positions, wherever applicable, shall be made using either welding or bolting method. Either way, the overlapping of the two strips shall be for a minimum length of 150mm. Welding shall be for the entire overlapping length. In case of bolting, minimum three bolt joints shall be used per overlap length. For each earth pit, necessary Test Point shall have to be provided.
- (8) All GI strips, earthing electrodes and all hardware (nuts, bolts, washers of SS304) shall be in vendor scope of supply.
- (9) Vendor shall provide calculations for earthing, layout drawings showing earth chamber locations during detailed engineering.
- For SMB earthing, independent earth electrodes of min. 2000 mm length shall be provided separately for each SMB. SMB earthing shall not be interconnected with module mounting structure earthing. Quantity required ~18 Nos.
- Power SPD inside SMB shall be earthed using min. 16 sg.mm copper cable and communication SPD shall be earthed using min. 2.5 sq.mm copper cable as per SMB recommendations which will be finalized during drawing approval.

Earthing lines for control room panels - PCUs, transformer, HT panel, ACDB, 5.28 SCADA panels, etc.

- (1) 50x4 copper strips shall be laid in the cable trenches of control room. Copper strips of required length shall be in vendor scope of supply.
- (2) Strips shall be covered by heat-shrinkable sleeves. Sleeves and Heater gun for heat-shrinking the sleeves over copper strips shall be organized by vendor.
- (3) Copper strips shall be anchored to the cable trench wall using insulation bush supports that will be in the scope of vendor.
- (4) Expansion bolts of appropriate size (Minimum M8) shall be used to fix the insulation bush supports.
- (5) Vendor shall provide the earthing line layout drawing along with calculations. Minimum two Nos. earthing pit shall be considered for each of control room



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- panels such as PCUs, transformer, HT panels, ACDB, SCADA panel etc. All the earth chambers shall be interconnected using 50X4 copper earth strip.
- (6) Copper strips shall be connected to the earthing terminals of all the control room panels except PCUs using min. 25 sq-mm copper, unarmoured, PVC cables that shall be supplied by the vendor. Cable lugs and hardware (bolts, nuts, washers etc shall be of SS304) required for connecting the 25 sq-mm cable to the earth terminals of panels and also to the copper strip end shall be in vendor scope of supply.
- (7) These chambers shall be located near the control room. Exact locations will be intimated by BHEL site engineer.
- (8) Connection between earth chamber and copper earthing strip shall be made using cable, 1Cx 25sq-mm, copper, unarmoured, 1100V, PVC cables as per IS:1554 (part-1) that shall be in vendor scope of supply.
- (9) For PCU earthing, min. 70 sq.mm copper cable shall be used as per PCU manufacturer recommendations. Quantity ~ 10 m.
- (10)Routing of 1Cx25 sq-mm cables to electrode earth chambers shall be using 1-inch CPVC pipes, joints, bends and elbows that shall be in vendor scope of supply. Routing shall be underground outside the inverter and control room, at a depth of ~450mm below the ground level. Required length of CPVC pipe shall be supplied. Number of CPVC joints and elbows shall be as applicable.
- (11)Expansion bolts, cable lugs and all hardware required for this activity shall be within vendor scope of supply.

5.29 | Lightning arrestors (ESE) type

- (1) Vendor shall supply and install Early streamer emission lightning arrestors as per standards: UNE 21186 and NF C-17 102, Make: Ingesco/ABB/equivalent as shall be approved by BHEL, with minimum protection radius of 100 m. with counters and earthing systems.
- (2) Quantity: As required to cover the entire area of the plant and control room building as per manufacturer recommendations.
- (3) Lightning arrestors shall be mounted on top of a mast of height 5m minimum above ground level using GI pipe of 100 mm minimum average diameter; Each mast shall be secured by three steel stay wires that are suitably grouted. Masts shall have appropriate steel base plate for mounting on an RCC concrete foundation pedestal of 450x450 mm size, 1m depth below ground level, 300mm minimum above ground level, PCC 1:4:8 as the bottom layer (~100 mm thick), steel rods of diameter 8mm minimum, concrete M25 with four J bolts (M16) of 750mm long, with nuts and washers.
- (4) Minimum two earthing chambers per lightning arrestor set using earthing electrodes shall be constructed as per manufacturer's recommendations.
- (5) All mechanical and electrical connections, cables, junction boxes, hardware etc shall be within vendor scope.
- (6) Vendor shall submit general arrangement and detailed drawings with bill of materials / quantities of the overall lightning arrestor arrangement including foundation pedestal details to BHEL for approval.

5.30 Yard lights for approach roads and compound wall (periphery lighting):

- (1) Vendor shall supply and install required number of lights for approach road and compound wall to maintain minimum LUX requirement of 20 LUX.
- (2) Light fitting, Bajaj/Havells/Equivalent make LED type shall be supplied and fitted on the GI bend pipes/poles/angles available in compound wall using necessary hardware.
- (3) Adequate spacing between the poles shall be provided to ensure the minimum



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lux requirement.

- (4) Underground armoured, PVC insulated, copper/ Aluminum cables of suitable size and required length shall be laid for power supply. Supply of these cables is in the scope of the vendor. Vendor shall submit cable sizing calculation for approval.
- (5) Junction box shall be at a height of 1m above ground level. MCB of suitable rating along with junction box shall be provided for each pole.
- (6) The Junction box shall be made of stainless steel or FRP (IP65), Dust & vermin Proof and shall have suitable brass or copper made connector terminal, MCB (1A, single pole) of Schneider or reputed make, glands for incoming and outgoing cables.
- (7) The junction box, cable lugs, steel bracket for mounting the box on the lighting pole and all hardware items shall be in vendor scope.
- (8) Provision for timer based ON/OFF control shall be made for yard lighting in ACDB
- (9) Glands shall be located at the bottom side of Junction box.
- (10) Necessary underground cabling work is in the scope of the vendor.
- (11) Vendor shall submit the lighting layout, lighting illumination calculations, cable trench layout, shadow calculation, foundation pedestal details, detailed BOM for BHEL approval.
- (12) Vendor shall ensure that equal loading is distributed in all the three phases.
- (13) Supply of necessary hardware such as nuts, bolts, washers (SS304) is in the scope of vendor.
- (14) Vendor to ensure the lighting arrangement does not cast shadows on the PV modules.
- (15) All necessary tools and tackles shall be in the scope of vendor.

5.31 Cable trench formation and laying of cables for yard lights

Vendor shall construct the underground trench of required length for laying the cables for yard lights

- (1) Trench depth = 600 mm minimum
- (2) Trench width = 200 mm minimum
- (3) Sand as per IS: 383 of 100 mm layer thickness shall be laid at the bottom most level of trench.
- (4) Over the sand layer, cables shall be laid one adjacent to the other. Cables shall not be laid one over the other. In other words, only one layer of cables shall be allowed.
- (5) Over the layer of cables, one more layer of sand of 100mm shall be laid.
- (6) Then, a single layer of class-2 brick of 75 mm thickness shall be laid.
- (7) Trench shall then be filled up with refill soil.

5.32 Cable terminations and supply of cables and CPVC pipes for yard lights

- (1) Cable termination:
 - (a) Termination of cables, including unsleeving, crimping, connecting to the junction box and lamp shall be within scope of vendor.
 - (b) Similarly, cables shall be terminated at the ACDB panel within the control room.
- (2) Vendor shall supply following cables of required length:
 - (a) 4-core, Cu/Al, armoured, PVC cable from JB of one pole to JB of adjacent pole (size of cable shall be finalized based on cable sizing calculation to be submitted by vendor)
 - (b) 2Cx 1.5 sq-mm Cu/Al, unarmoured, PVC cable from JB to light fitting
- (3) Vendor shall supply following 1-inch CPVC pipes of required length:



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5.33 Water supply for O&M, electrical cabling and plumbing works

- (1) BHEL will provide water outlet point near to plant boundary. Vendor shall lay pipe line from the outlet location to water storage tank to be located on the control room building.
- (2) Pressure pump of required capacity (3 phase) with all necessary electrical cabling up to the ACDB located in control room shall be provided from pumping water storage tanks. Vendor shall submit the calculations for deciding pump rating and cable size.
- (3) Casing as required shall be provided for the pump.
- (4) Pump and the electrical cables shall be in vendor scope of supply. Cable (Armoured, PVC) of suitable size depending on pump rating and of required length shall be laid underground at a depth of ~600 mm, with sand layers below and above the cable (100 mm each). A brick layer, class-2, 75mm thick shall be laid over the sand layer. Trench shall, then, be closed with refill soil and neatly compacted.
- (5) Pump make: CGL, Suguna, Kirloskar, or other make for which BHEL approval shall be taken.

Vendor shall supply and install 1 No. PVC water storage tanks of 5000 liters capacity each on control room.

5.34 SPV module cleaning system

- (1) Vendor shall lay 2-inch CPVC pipelines from overhead tanks to the solar array field with all necessary CPVC nipples, T-joints, reducers, bends, couplers etc. This forms the main header pipeline. Suitable valves such as brass valves of 2inch etc shall be provided for this main header line. For the branching out lines that spread into various rows of the solar array to provide water delivery points for module cleaning, 1-inch CPVC pipelines shall be used. Supply of CPVC pipe shall be in vendor's scope.
- (2) Centrifugal 3-phase booster pump of required capacity shall be supplied and installed at control room to draw the water from storage tanks to solar array field for solar PV module cleaning. Vendor shall furnish design/pressure calculations for selection of pump size.
- (3) Starter and DP switch shall be supplied and installed in control room for operating the pump.
- (4) Supply of electrical cables (with lugs, hardware) and wiring the pump up to the ACDB panel / starter in the control room shall be in vendor scope. Cable of required dimension, Cu, armoured, PVC cable shall be supplied and used.
- (5) CPVC pipelines shall be laid underground (at a depth of ~ 500 mm below ground level).
- (6) There shall be adequate nos of delivery points for module cleaning. At these delivery points, 1-inch riser lines shall be provided to tap the water from underground line to the delivery point ~300 mm above ground level. Ball valve forged steel type, 1-inch, with suitable nipple for connecting the hose pipe, shall be provided at each delivery point.
- (7) After installation and testing of water lines, excavated trenches shall be closed with refill soil. Further, the soil, all along the water lines, shall be suitably leveled and compacted.
- (8) Hosepipes (ribbed, flexible) of 50m long shall be provided for connecting the hose to the nearest ball valve/nipple. The other end shall be provided with nozzle/appropriate gun to direct the pressurized water on the module for cleaning.6 such sets shall be provided.
- (9) Vendor shall ensure adequate pressure of water is available for module cleaning.
- (10) Vendor shall submit detailed scheme with BOM etc. for module cleaning



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	avetam from storage tents to solar arms of all-l	Г	1
F 25	system from storage tank to solar array field.	amliachta ta	
5.35			
	the individual cases and as approved by BHEL, shall be provided:		
	(1) String monitoring junction boyos. Identification marking burner of	f pointing on	
	(1) String monitoring junction boxes: Identification marking by way of nearby module structure.	painting on	
	(2) All equipment such as PCUs, transformers, VCB panels, CT, PT, GOS a		
	metering panels shall be provided with suitable identification markings using		
	painting, with inscriptions as approved by BHEL.		
	(3) Cable sizes with arrow marks using painting.		
	(3) Cable sizes with alrow marks using painting. (4) Identification markings for all the earth chambers (using pai	nting) with	
	inscriptions as approved by BHEL.	iitiiig) witii	
	(5) Cable tags using aluminium plate of 1-2 mm thickness with suitable	inscriptions	
	as approved by BHEL for all the power cables of the electrical parts		
	PCUs, LT panels, Batteries, FCBC chargers, ACDB panel etc.	ileis sucii as	
5.36	Cable markers		
3.30	(1) Steel cable markers with suitable labels (DC cable, LT cable, Data	cable CDVC	
	water pipeline etc) and arrow marks (pointing to the cable destinat		
	supplied and installed along the cable trenches at appropriate le		
	following cases:		
	a) For DC cable from string monitoring boxes to respective inverte	rs	
	b) For data communication cables from string monitoring boxe		
	room		
	c) For cables of yard lights of solar array field, compound wa	II/chain-link	
	fencing		
	d) For electrical cables of pump connections		
	e) For CPVC water pipelines		
	(2) Cable markers shall be suitably grouted with concrete foundation depth of		
	minimum 300 mm below the ground level. Cross section of founda	tion shall be	
	minimum 200mm diameter.		
	(3) Cable markers shall have a minimum height of 300 mm above the gr	ound level.	
	(4) Cable markers shall be suitably painted.		
5.37	Hoarding board for the solar power plant.		
	(1) 1 No. hoarding for the plant shall be made of 1500x1800x 3mm thi	ck MS plate.	
	Approximate dimension of board 1500x1800 mm.	0-1:	
	(2) Board shall be given a red oxide coat and painted background.		
	background and letters shall be as approved by BHEL site in-charge.		
	(3) Board shall be fixed on a frame constructed using ISA 50x50x8 angle supports shall also be provided. The frame shall be supported by		
	legs of ISA 75x75x8 that is grouted with concrete foundation.	two vertical	
	(4) Depth of foundation shall be 600 mm below ground level, with 1	00mm thick	
	PCC layer 1:4:8 of 400x400mm, M25 concrete of 300x300mm,		
	pedestal of 200mm height above ground level.	Touridation	
	(5) Bottom level of board shall be at a height of 1.8 m above the ground	level.	
	(6) Vendor shall submit the drawing of hoarding arrangement to		
	approval.	DITEL TOT	
5.38	Display boards and sign boards		
-/	1 Board displaying instruction chart for restoration of person	1 No	
	from Electric Shock		
	Board displaying instruction chart for artificial respiration	1 No	
	3 Board displaying dos and don'ts.	1 No	
	4 Board displaying fire extinguishers details and operations	1 No	
	5 "No smoking" board	5 No	
L	1 . 10 officially board	J J	



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		Decad shoulder list of OOM stoff with many modification and	4 NI-
	6	Board showing list of O&M staff with name, qualification and	1 No
		work responsibility	
	7	Board showing list of contact details of BHEL, O&M team, O&M	1 No
		security, police station, fire service, hospital, medical store etc	
		with names, address, mobile numbers etc	
	8	Danger boards with details such as value of voltage etc for	Oty as
		string monitoring boxes, PCUs, LT panels, Transformers, HT	required
		panels etc.	
	9	Identification boards, of suitable sizes, within control room such	Oty as
		as scada room, store room, battery room, security room, gents /	required
		ladies toilets, pantry etc shall be supplied by vendor. BHEL will	
		provide the list.	
	(0) [Tanana khilali ayun haanad yyikh I.C. maalia yiinyid akialian (aananyikanimad	a
		omm thick sun board with LG make vinyl sticker (computerized ing) shall be used for SI Nos 4, 5, 8 and 9.	cutting and
		For others, flex banner with design & printing shall be used.	
		lired number of danger notice plates shall be provided whereve	or necessary
		able size of each Danger Notice plates shall be provided as p	
		irement, made of mild steel sheet and at least 2mm thick, a	
		neled white on both sides, and with inscription in signal red colo	
		as required. The inscriptions shall be in Tamil and English language	
5.39		trical insulation mat	0.
0.07		endor shall supply required number of electrical insulating mats a	s follows:
	(.,	(a) Make: Vardhman House Private Ltd or reputed equivalen	
		approved by BHEL.	
		(b) Colour: Black.	
		(c) Max use voltage = 1.1 KV/ 11KV depending on location	
	(d) Marking of IS standard shall be there on the mat		
	(2) Test certificate shall be provided by vendor		
		/endor shall lay the mats in front of electrical panels (PCUs, HT p	oanels, FCBC,
		ACDB panels) in control room.	
5.40	Che	kered plate for closing the cable trenches (a) behind the par	nels such as
	PCU	s, VCB panels, ACDB panels etc. in control room and also (b)	other open
	area	s of cable trench	
	(1) \	endor shall supply and install Checkered plate. Plate shall hav	e a suitable
		nandle (welded to the plate) to facilitate ease of lifting and moveme	nts.
		Plate thickness = 6mm min.	
		Vidth = 1000 mm max, total length as required	
		These width and length dimensions are indicative. Actual dimens	ions shall be
		pased on site conditions.	
		Plate shall be red oxide coated followed by black painting.	
F 44		BHEL approval shall be obtained for overall arrangement of checker	red plate.
5.41		onditioner	om o olitus. (mailia
		for shall supply and install 1 No. Split air conditioners of 1.5T c	
	BEE 3 star rating) with stabilizers in SCADA room. Make: LG, Videocon, Bluestar,		
		rej or reputed equivalent that shall be approved by BHEL. Cor	ISTURCTION OF
5.42		DA room and partitioning is in the scope of BHEL. kits and instruments	
J.42		kits and instruments for shall supply the following tool kits and instruments:	
		leasuring instruments	
	A. 1V	icasai ing msti aments	
	1	Digital Earth Resistance Cambridge 1 N	os
	1 1 1	Tester Instruments/equivalent	
	$\sqcup \sqcup \sqcup$. sette.	



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	Digital multimeter	Reputed make	2 Nos
3	AC-DC Clamp Meter	Lutron/equivalent	2 Nos
5	Digital thermometer	Reputed Make	1 Nos
6	Megger – 5KV	Shanti Electric Instruments,	1 Nos
		Nippen/equivalent	
7	Electrical Tester	Reputed Make	4 Nos

Note: Make / model number etc. shall be approved by BHEL prior to procurement.

B. Tool kits

1	Double ended flat spanners of sizes 6mm to 32mm	1 Set
2	Double ended ring spanners of sizes 6mm to 32mm	1 Set
3	Double ended tubular box spanners of sizes 6mm to 32mm	1 Set
4	Screwdriver Set	2 Set
5	Crimping tool with Dye range 50-400sq-mm cable, mechanical	1 Set
	gear power, hand operated	
6	Crimping tool up to 6 sq-mm cable	2 set
7	Drilling machine AC, hand operated, with bit size up to 20 mm	1 set
8	Measuring Tape, 5m	4 Nos
9	Measuring Tape, 50 m	2 Nos
10	Allen Key set	2 Set
11	Adjustable spanner 2-inch size	2 No
12	Hammer	4 Nos
13	Rough file kit	2 Set
14	Platform balance, 50Kg range, 100g accuracy	1 No
15	Cutting Pliers	4 Nos
16	Nose Pliers	4 Nos
17	Vacuum cleaner, of industrial type, for control room sweeping	1 No.
	/ cleaning.	
18	Blowers for cleaning the panels	1 No.
19	MC4 tool kits consisting of crimping plier, open end spanner	2 Sets
	set, stripping plier, socket wrenches	

Note: Prior to procurement, vendor shall obtain approval from BHEL for the make and specification of the items.

5.43 Office furniture

Vendor shall supply and install the following:

1	Executive table, wooden type with draws and side racks	1 No
2	Chairs, swivel type, with arm rest	6 Nos
4	PC table	1 No
5	Storage almirah	1 No
6	Filing cabinets	1 No

Make: Godrej or reputed equivalent as shall be approved by BHEL. BHEL approval shall be obtained, for the type of office furniture, for which catalog with model numbers, sizes / dimensions etc shall be submitted to BHEL.

5.44 Fire alarm system for control room:

(1) Fire alarm system with smoke detectors, hooters, manual call points, an electronic control panels and interconnection wiring shall be supplied and



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- installed. Make: Zicom/ Notifier /Ravel or any other reputed equivalent as shall be approved by BHEL.
- (2) Control panels in sheet steel enclosure, power coated finish, shall be a microprocessor based system with central processing unit, input / output modules, power supply with battery and battery charger, control electronics and display mechanisms. The panel shall be a 4 zone system with audio-visual provisions (LED indications and beeps) for zone-wise annunciation. Individual detector-wise traceability / addressability is not required. It shall have provisions for acknowledgement of alarm and manual resetting. Batteries used shall be lead acid maintenance free type provided with connecting leads.
- (3) Smoke detectors shall be of conventional / optical / photoelectric type. It shall not be of ionization type that employs radioactive materials.
- (4) Electrical hooters shall sound the alarm upon detection of smoke by the detectors.
- (5) Manual call point shall be with high-gloss finish, alarm LED provision, breakable glass unit, hammer and chain.
- (6) All the system components shall be installed and commissioned using suitable wiring using copper cable, min. 2C x 1.5 sq-mm, armoured, fire retardant low smoke PVC, of required length, as approved by BHEL. Cable shall be laid in PVC conduit and fixed to the ceiling of control room.
- (7) Sufficient quantity of sensors, alarms, hooter, manual call points etc. shall be supplied and installed as per the necessary statutory requirements. Vendor should ensure the design of fire protection system in line with the regulations of the Fire Safety department of the state.
- (8) Vendor shall submit fire alarm layout/scheme along with the detailed BOM to BHEL for approval.
- (9) Fire alarm control panels shall have provision for RS-485 Modbus output so that status can be monitored in plant SCADA system.

5.45 Other safety related items

(1) Safety gadgets:

1	Gas Mask	2 Nos
2	First Aid Box with essential medicines and bandage cotton,	2 set
	antibiotic cream, Dettol, etc.	
3	Hand Gloves 1KV for Maintenance of SMB	2 sets
4	Safety Helmet	5 Nos
5	Rain Coat	2 Nos

(2) Fire extinguishers and sand buckets, as per the regulations of the Fire safety department of the state, shall be supplied and commissioned at the power plant. BHEL approval shall be obtained for locations at which they shall be kept. Quantities mentioned below are minimum. Vendor to comply the requirements of statutory bodies.

1	Dry powder fire	Capacity: 9 Kg	3 Nos
	extinguisher	IS: 2171, IS:10658	
	(stored pressure	CM/L-7759096	
	type)	Suitability for Class A, B & C fire, related	
		to solid combustibles, flammable liquid	
		and gases.	
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	2	Carbon di-oxide	Capacity: 9 Kg	3 Nos	
		(CO2) type fire	IS: 2878		
		extinguisher with	Suitability for Class B&C fires		
		trolley	Involving flammable liquids & gases,		
			electronic equipment.		
	2	Sand buckets	GI fire buckets (as per IS: 2546) with	2 sets	
			suitable steel stand and cover		
			arrangement. All items shall be painted		
			with red oxide and BHEL approved red		
			paint.		
			BHEL approval shall be obtained for the overall arrangement.		
			Each set of stand shall carry four sand		
			buckets. A suitable cover shall be		
			designed and provided to protect the		
			buckets from rain.		
5.46	-	be supplied along w			
	,	4 Connectors – 130 Pai			
5.47		oor type HT termination	on Kit - 1 set ns / checks / tests and coordination w	ith state	
3.47		.	approvals and clearances for commi		
			l post-commissioning operation of the p		
			ving minimum pre-commissioning checks:		
			of terminations in all electrical equipme	nt: SMBs,	
			nsformer, SCADA stations, weather m		
		quipment and PV array	S .		
	(2) Verification of earthing for all these electrical equipment.				
	(3) Measurement and verification of parameters at string monitoring boxes at				
			g current, voltage, combined SMB outpu	current,	
		nodule temperature, SM		DCUs. DC	
			cation of parameters on DC input side of dor shall support the PCU engineer on the		
		•	leasurements (megger tests) for all the		
		quipment of control roo	. 55	Ciccii icai	
			CUs: Vendor shall support the PCU engine	er during	
		ne pre-commissioning t		5	
			nsformer marshalling box:		
	A	vailability of AC/DC p	ower supply, (b) Responses of the relay	s at VCB	
	pa	anels and correspondi	ng indications at annunciation panel by s	imulating	
	th	ne alarm / trip of WTI a	t marshalling box.		
	(0) E	unctional checks for VC	R nanols		
			DC power supplies (b) VCB on/ off, (c) spring	
			ndications, (e) functioning of electromag		
		5 5	responses at VCB panels to operations fro		
		3	ndows, alarm accept/reset operations /SC		
	(k		lock operations related to incomer and		
		VCBs.			
		-	ers at SCADA station: (a) DC/AC parame		
		•	3 panels, Metering panels, (b) status of		
			mer protection relays, (c) weather m	onitoring	
	l b	arameters.			



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- (10) Functional checks on SCADA software: mimic diagrams, trend graphs, remote accessibility etc.
- (11) Earth resistance measurements at the electrode chambers for solar array, control room panels and switch yard equipment.
- (C) Pre-commissioning tests on transformers, vacuum circuit breaker, relays, etc:
 - (1) Usually performed tests are indicated as below. However, exact type of tests required to be conducted at site prior to commissioning shall be in line with STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/CEIG/SECI etc., requirements.
 - (a) Transformers: IR tests, ratio tests, excitation current measurement, magnetic balance test on HV, short circuit test, excitation test LV side, vector group test.
 - (b) 11KV vacuum circuit breaker panels: IR tests and continuity tests for panels, IR values for CTs/PTs, excitation test on CTs, primary injection tests for CTs, ratio test for PTs
 - (c) Relays in VCB panels: open/close, tripping, primary injection tests.
 - (d) Lightning arrestors: IR tests
 - (2) Appropriate testing agency shall be arranged for the tests.
 - (3) Vendor shall coordinate / liaison with concerned STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/MRT departments to fix up test schedules and witness by their representatives.
 - (4) Vendor shall prepare and submit the reports to STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/MRT/CEIG/SECI and obtain their approval through necessary liaison activities.
- (D) Vendor shall coordinate and liaison with STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/CEIG etc., prepare and submit the applications with necessary enclosures on behalf of BHEL and obtain their approval:
 - (a) Approval for BHEL drawings
 - (b) Approval for synchronization of plant with grid.
 - (c) CEIG inspection of power plant
 - (d) Provisional CEIG clearance to proceed with commissioning
- (E) Vendor shall take approval of BHEL for appointing Electrical consultant for the entire SPV plant and switch yard to comply with CEIG norms and getting approvals.
- (F) Vendor shall implement corrective steps on the observations of CEIG, follow-up with them and obtain final clearance for licensed operation of the plant on a continuous basis.

Note: Scope of coordinating with state departments such as STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS, CEIG to get the clearances / approvals for licensed / statutory operation of the power plant on a continuous basis includes all transactions required for successful liaison and clearances. Application fees and renewal fees (say, in the form of DD) to be enclosed with application / renewal documents and all other expenses in the above process shall be in the scope of vendor.

6.0 Tests at manufacturer / sub-vendor works and witnessing by BHEL

- 6.1 BHEL shall witness routine / acceptance tests performed at manufacturer works for following items. Vendor shall accordingly provide inspection call to BHEL, with submission of quality assurance plan to BHEL in advance.
 - 1) All cables under vendor scope (LT, data, control and communication cables)
 - 2) Earthing electrodes & earth strip
 - 3) Lightning arrestor (ESE)
 - 4) Fire alarm system



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5) ACDB

6) UPS with battery

Note: In case the item is bought out from dealers, test certificates, as per relevant IS / IEC standards, as issued by manufacturer shall be submitted to BHEL. However, prior approval shall be obtained from BHEL for procurement of the item from dealers.

7.0 General conditions applicable during installation and commissioning phase

7.1	All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement of materials shall be organized by the vendor.	
7.2	All necessary tools and tackles such as crimping tool (including heavy duty tools for crimping cables), screw driver set, power screwdrivers, cutting pliers, nose pliers,	
	spanner sets, adjustable spanners, hole saw cutter set, bending tools, torque	
	wrenches, hack saw blades, pipe wrenches, flat / round files, HV termination tools, drilling machines, welding machines, concrete mixers, steel bar bending tools /	
	templates for RCC works, spade, shovel, hammer etc shall be organized by the vendor.	
7.3	All necessary measuring instruments such as digital multimeters, electrical testers,	
	meggers (1kV, 2.5kV, 5kV), lamp load testers for solar array string measurements,	
	earth resistance meters, weighing machines, water level indicators etc shall be organized by the vendor.	
7.4	Vendor shall make their own arrangements for necessary food, drinking water and	
	accommodation for their labour and employees posted at the site. Similarly, food	
	and drinking water required at the site, during the construction operations, shall	
7.5	also be in scope of vendor. Vendor shall organize all necessary steps to meet statutory requirements such as	
7.5	labour license, PF, ESI etc and also ensure compliance with relevant acts such as	
	minimum wages act, income tax act, employee insurance act, BOCW act etc for their	
	labour deployed at site.	
7.6	Vendor shall maintain updated labour register, with name, age, qualification, salary, attendance details etc at the site. Vendor has to satisfy all the statutory	
	requirements as per the labour law regulations in the state.	
7.7	Vendor shall use danger boards, wherever required, to ensure safety of the persons	
	during the work at site.	
7.8	Vendor shall adhere to all necessary safety norms such as use of helmet, goggles,	
	hand gloves, gumboots, aprons etc. It is the ultimate responsibility of the vendor in all respect to prevent accidents at the site and safeguard their labour from	
	accidents.	
7.9	Vendor shall, at the completion of every work, clear off the debris, which resulted	
	out of the work. In case of excavation work such as cable trench etc, vendor shall	
710	finish the land neatly with necessary leveling, rolling etc.	
7.10	Vendor shall carry out the work without causing inconvenience to other contract groups at the site. In case of conflicts with other groups, vendor shall ensure that	
	the matter is resolved at once amicably so that the progress of work is not affected.	
7.11	Any damages on the building, structures etc attributable to the acts of labour /	
	employees of vendor shall be rectified and made good by the vendor at their own	
7.12	cost. No child labour shall be employed for execution of the present contract.	
1.12	I no cima labour shan be employed for execution of the present contract.	



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7.13	Any miscellaneous materials, which are found essential for technical completion of the contract as per regulations/standards but not mentioned explicitly in this specification, shall be deemed to be included in the specification. Accordingly, such materials shall be included by the vendor as part of the offer.	
7.14	In certain cases, approximate quantities are only mentioned. This is for the purpose of providing guidance to vendors and are as per BHEL estimation. Such quantities shall, therefore, be considered only indicative. Vendor shall, however, take into account the exact quantities that shall be required to meet the functional requirements of I&C activities as per clause 5.0.	
7.15	Special instruction for earthing: In compliance with Rule 33 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. Accordingly, all cases such as cable support structures, cable ladders, cable trays (control room) etc shall be earthed.	
7.16	Any deviations shall be discussed with BHEL site engineers and implementation shall be taken up only after approval from BHEL.	
7.17	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.	
7.18	Vendor has to design all the foundations required as per this specification based on the soil report and site conditions and to be submitted to BHEL for approval before construction. However, minimum requirements are specified in this specification for ready reference. Soil report will be made available to vendor after placement of PO upon request.	
7.19	Supply and installation of all auxiliary supply cables from ACDB to various plant equipment viz., FCBC, building lighting etc., shall be in the scope of the vendor which will be intimated from time to time.	
7.20	All cable terminations shall be done in such a way that bending radius of the cable is strictly as per IS: 1255	
7.21	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 overrun charges shall be paid in case of extension of project schedules	
7.22	Vendor shall prepare and submit as-built drawings after execution of works.	

8.0 Defect Liability Period

8.1	Date of commencement of defect liability period: Zero date for defect liability period shall be the actual date on which the complete 7.5 MW capacity is commissioned with synchronization / export of power to 11kV grid and completion of all the works in the scope of the vendor.	
8.2	Work during defect liability period: Vendor shall post competent person/s at site on daily basis to attend the problems that may arise in the plant during defect liability period within 24 hours.	



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
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
9.0 Documents to be submitted for BHEL approval after receipt of purchase order


9.1	BHEL approval shall be obtained for the following technical documents, which shall be submitted to BHEL in phased manner based on priority sequence of activities. However, it shall be ensured that all documents are submitted within 14 days from date of purchase order.	
9.2	Vendor, make, model number / part number, specification / sizes / dimensions / drawings / datasheets of all the vendor supplied items.	
9.3	General arrangement drawings/ schemes/ layouts etc. with bill of materials / quantities shall be submitted for the following (list is indicative and not limited to): (1) SMB Mounting structure (2) Cable trench layout in array yard (3) Details of power, control, communication cable (4) ESE Lightning arrestor arrangement with foundation details (5) Yard lights –compound wall, approach road. (6) Water pipeline layout from storage tank to solar array field for module cleaning system with pressure calculations (7) Fire alarm system scheme / layout (8) Cable support structures and cable ladders within control room (9) Cable support structure for LT cables between inverters and transformers	
9.4	Quality assurance plans for items listed under clause 6.0	
9.5	Detailed activity-time chart for project implementation.	
9.6	Detailed manpower deployment schedule.	

10.0 Codes and Standards:

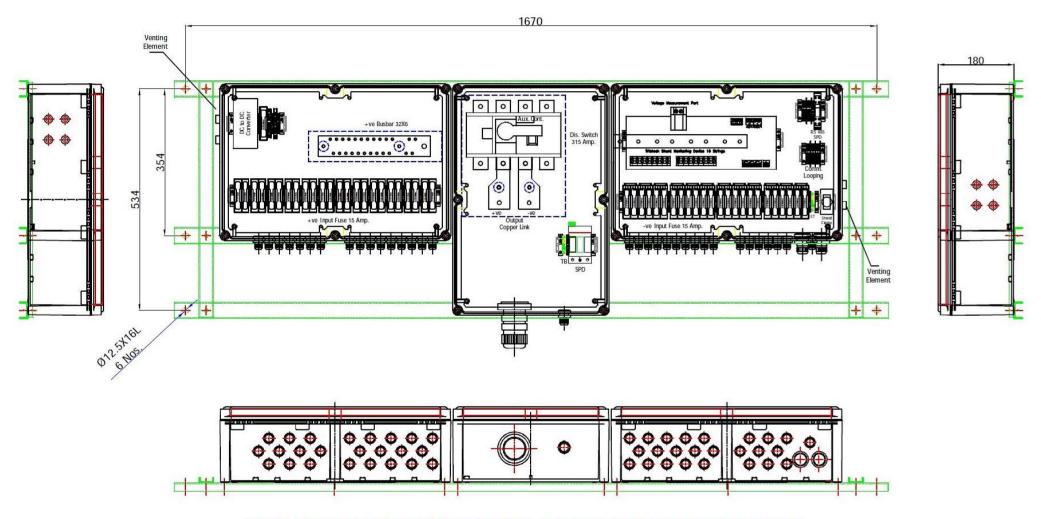
IS:7098 (Part -I)	Specification for XLPE insulated PVC sheathed cables. Part-I: For working voltages up to 3.3 KV
IS:7098 (Part -II)	Specification for XLPE insulated PVC sheathed cables. Part-I: For working voltages from 3.3 KV up to and including 33 KV
IS:1554 (Part-I)	Specification for PVC insulated cables for working voltages upto and including 1100V
IS: 3975	Low Carbon Galvanized steel wires, formed wires and tapes for armouring of cables
IS: 4905	Methods for random sampling
IS: 5831	PVC insulation and sheath of electrical cables
IS:8130	Conductors for insulated electrical cables and flexible cords
IS: 10418	Specification for drums for electric cables
IS: 10810	Methods of tests for cables
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 KV rating







TANTATIVE DRAWING OF SMB



NOTE: THIS DRAWING IS TENTATIVE AND FOR TENDER PURPOSE ONLY.