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Technical Specification for

Supply of Balance of System items and Installation & Commissioning

For 5 MWp Solar PV grid connected power plant at

BHEL-Haridwar, Uttarakhand

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1.0 Introduction

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up a 5 MWp Grid Connected SPV Power Plant for BHEL-Haridwar, Uttarakhand.

The plant will have PV modules of mono-crystalline / poly-crystalline type mounted on module mounting structures (Fixed type 2.5MWp, Active tracker 1.25MWp and passive tracker 1.25MWp). Electrically, the PV array will have 4 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 oil-cooled transformer of 2.7 MVA rating which will step up the voltage to 11KV.

The solar array will have 36 string monitoring combiner boxes (SMBs) that collect the solar PV generated DC power and provide inputs to the 4 PCUs housed in centralized control room. Control room building will also house HT switchgear panels, ACDB, SCADA, battery bank, FCBC, UPS and other associated panels along with store room and toilets.

There will be 2 Nos. transformers (2700KVA, 11KV/ 350-350V) located in switchyard adjacent to control room. A typical layout of control room and switchyard 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. Supply of 11KV (UE), 3CX240sqmm cable shall be in the scope of vendor. Laying of the cable from four pole structure to substation shall be in BHEL scope.

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 3.2.

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 and switchyard (Autocad drawing of site layout will be provided on request by vendor through e-mail)
3	Tentative Control Room & Switchyard Layout
4	Tentative drawing of String Monitoring box

3.0 Scope of Supply and work

3.1 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 to be fitted to MMS & required hardware	18	Set
3	Independent SMB mounting structure & required hardware	18	Set
4	MC4 connectors	1223	Set
5	HDPE DWC pipe 63 mm	3000	M
6	240 sqmm Cable lugs with bimetallic washers and hardware in SMB	72	Set
7	Cable trays inside CR	90	M
8	Cable tray support structure inside CR	1	ST
9	240 sqmm Cable glands 240 sqmm in PCU DC side	72	Nos
10	240 sqmm Cable lugs with bimetallic washers and hardware in PCU DC side	72	Set
11	1.1KV, 1CX300 sq.mm, Aluminium Conductor, XLPE insulated, Armored, PVC sheathed Cable from PCU to transformer and from aux transformer to ACDB	2000	M
12	300 sqmm Cable glands for PCU AC side transformer LT side	168	Nos
13	300 sqmm Cable lugs with bimetallic washers and hardware for PCU AC side transformer LT side	168	Set
14	Cable trays outside CR	80	M
15	Cable tray support structure outside CR	1	ST
16	11 KV Outdoor LA	3	Nos
17	11KV GOS Isolators with earth switch	1	Nos
18	11KV GOS Isolators without earth switch	2	Nos
19	11KV Dropout Fuse set	3	Nos
20	RSJ poles	4	Nos
21	GI Support channels, ACSR conductor, pin/disc insulators, clamps and hardware etc. as required.	1	Set
22	Reverse power relay	1	No
23	Auxiliary transformer 125KVA	1	No
24	HT cable - 11KV(UE), 3CX240 sq.mm	1700	M
25	Half-cut RCC hume pipes	1	ST
26	HT termination kits - outdoor	3	ST
27	HT termination kits - indoor	6	ST
28	FCBC-110V, 20A	1	No
29	Battery bank 110V, 100AH	1	No
30	ACDB	1	No
31	UPS-5 KVA with battery with UPSDB	1	No
32	Timer DB for passive tracking system	20	Nos
33	Loop in loop out JBs for passive tracking system	384	Nos
34	Weather Monitoring System	1	ST

35	DWC pipe for RS485 cable	1	ST
36	Auxiliary, data and control cables	1	ST
37	12CX2.5sqmm cable	1	ST
38	Auxiliary power cable for passive tracker 2CX2.5 sqmm	10	KM
39	Lugs & hardware for data, auxiliary and control cables	1	ST
40	25X3 GI flat	1	ST
41	25X6 GI flat	1	ST
42	Earthing electrodes for MMS	1	ST
43	Hardware for array earthing	1	ST
44	SMB earthing electrodes	54	Nos
45	Copper cable -16 sqmm for earthing	1	ST
46	Copper cable -2.5 sqmm for earthing	1	ST
47	Copper flat- 50X4 for earthing	1	ST
48	Copper cable -25 sqmm for earthing	1	ST
49	Copper cable -70 sqmm for earthing	1	ST
50	Earthing electrodes	1	ST
51	Switchyard earthing electrodes	1	ST
52	Earth flat for switchyard	1	ST
53	ESE LA and earthing	1	ST
54	Yard lighting system	1	ST
55	Module cleaning system	1	ST
56	Identification tags, markers etc.	1	ST
57	Hoarding board	1	ST
58	Display boards and sign boards	1	ST
59	Electrical insulation mat	1	ST
60	Checkered plate	1	ST
61	Air conditioner	1	ST
62	Tool kits and instruments	1	ST
63	Office furniture	1	ST
64	Fire alarm system	1	ST
65	safety related items	1	ST
66	Spares	1	ST
67	Installation & Commissioning as per respective clauses in specification	1	AU

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.

3.2 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	~16380 Nos
2	Supply and Erection of Solar array structures with modules mounted on structures (MMS), with each having 10 / 20 / 40 Nos. of PV modules MMS shall be in three variants – 2.5MW with fixed type (20 modules per table), 1.25 MW with active tracking system (40 modules per table) and 1.25MW with passive tracking system (10 modules per table)	1 Set Fixed-415Nos, Active-101Nos, Passive-404Nos.
3	Supply of Cable, 1Cx 6 sq-mm (for connection of PV modules to string monitoring boxes)	~ 70 km
4	Supply of Cable, 1.1KV, 2C x 240sq-mm (for connection from SMBs up to PCUs)	~ 8 km
5	Supply of String monitoring boxes (24-in, 1-out)	36 Nos
6	Supply of Power conditioning units (PCUs) of 1250 kW rating along with duct	4 Nos
7	Supply of Transformers 2700kVA, 11KV/350V-350V (1 HV winding, 2 LV windings)	2 Nos
10	Supply of 11KV indoor HT panels with ABT meter	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 transformer foundations and switchyard fencing in switchyard	1 set
15	Construction of boundary wall for the entire plant, pathways, approach road, drains within the solar plant	1 set

4.0 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.

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.

#	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 months 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, Transformers, Battery banks, Battery chargers, Distribution boards etc), cables, spares, tools, instruments etc. (2) Area of storage yard shall be min. 400 sq.m. However, exact size shall be decided mutually with BHEL based on site conditions. (3) A portion of storage yard area (min. 150 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, Battery, Battery chargers, electrical DBs etc.) in order to ensure that there will not be any water spillage which may	

	damage the 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 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,	

	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. **Note:** For passive tracking structures (1.25MW), each table will have 10 modules, hence two tables shall be electrically interconnected to form 20 module strings. Accordingly vendor shall consider extra MC4 connectors, DWC pipe, cable trench and laying work etc. required for this.	
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 for fixed type of structures (2.5MW), and independent structure with foundations for balance 2.5MW of active and passive tracker systems 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) Design and construction of Foundations required for 2.5MW of SMBs (18 SMBs) will be in scope of vendor. Design shall be carried out as per relevant standards. (5) Drawings of SMB and the fixing arrangement will be provided to the vendor after placement of purchase order. (6) SMB locations will be identified by BHEL and will be provided in the wiring layout. (7) SMBs shall be fixed on the structures using necessary hardware which shall be supplied by vendor. (8) 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 = **1223 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. (3) Cables shall not be loosely hanging.	
5.9	**Underground laying of 6 sq-mm cables between the rows** (1) Where 6 sq-mm cables run between two rows of structure or between every two structures in case of passive tracking system, 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, HDPE couplers and T-bends based on the actual requirement and ensure no shortfall in supply during the time of installation. Qty required~3000 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 25mm. However, exact ID shall be selected to ensure that only a maximum of 60% of the ID space is occupied by the cables.Make: Tirupati Plastomatics, Jaipur or reputed make, as approved by BHEL. (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 **~ 72 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.	
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, HT panels, battery bank, FCBC battery charger panel, 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: 4 sets (each ~2500 Kg) b. HT switchgear panels: 3 Nos (each ~1500 Kg) c. 110V DC Battery bank: 1 sets	

	d. FCBC battery charger panel: 1 No e. ACDB panel: 1 No f. SCADA panel: 1 Nos (~500 Kg each) g. Control desk with PCs and accessories: 1 set (2) Panels 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) Panels shall be suitably grouted using welding / bolting methods as 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 coming out from control room shall be laid over ladder type cable trays up to LV side of 2700 KVA inverter transformer. (9) 7RX1Cx300 sq.mm cables per phase are routed from control room to transformers in switchyard on cable trays through openings in the walls of control room. These openings shall be closed with sealant or foam to prevent entry of rain water and rodents. (10) 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.	
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 **~72 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 transformers using 7 runs of 1Cx300mm^2 Aluminum, armored, XLPE insulated cable per phase. Supply of this cable is in vendor's scope. Approx. length required ~**2000m.** (2) Specification for LT cable: 1.1KV, 1CX300 sq.mm, Aluminum Conductor, XLPE insulated, Armored, PVC sheathed as per IS 7098 (Part-1). (3) 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 **~ 168 Nos**. (4) 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. (5) 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 them with the lugs and terminate them at the respective bus bar provisions within the panels. (6) All tools and accessories required to carry out the termination shall be within scope of vendor. (7) Cable tray supporting structure shall be installed between control room wall and LV side of transformer using ISA angles of minimum 75x6 arranged in vertical and horizontal orientations and joined using welding. The level of structure shall be at a minimum height of 400 mm above the ground level. Adequate number of horizontal angles shall be provided to minimize gap between two angles so that cable sagging is avoided. Vertical angles shall be grouted using concrete foundation with depth of minimum 400mm. PCC layer 1:3:6 of 100mm thick shall be used. Cross section of foundation shall be minimum 200x200mm. All items required for the structure shall be in vendor scope of supply. Cable shall be laid on ladder type cable trays. Structure shall be painted using red oxide and BHEL approved black paint. Suitable arrangement, such as fixing perforated cable trays in inverted position, shall be provided to cover the laid cables. Drawing of cable supporting structure shall be submitted to BHEL for approval. (8) Quantity of cable support structure with cover =4 sets. (9) Supply of cable trays and tray support structures is in the scope of vendor.	
5.16	**Installation of 2700kVA, 11KV /350-350V transformers supplied by BHEL** (1) Transformers are located in switchyard adjacent to control room. (2) Construction of RCC foundations of transformers shall be in BHEL scope. (3) Transformer and its accessory parts such as radiators, cable boxes, hardware etc. as supplied by BHEL shall be moved from storage yard and positioned on foundation pedestal. All parts and hardware shall be assembled as per guidance at site provided by BHEL / transformer vendor. (4) Vendor shall provide all necessary support and assistance to the representative of transformer manufacturer during installation: (a) Oil filling in all transformers. (b) Measurement of parameters: insulation resistance, Winding resistance etc. (c) Connections to marshalling box	
5.17	**Installation of Isolators, Lightning arresters on four pole structures in outdoor switchyard at Control Room** Outdoor switchyard at control room shall consist of inverter transformers. one four pole structure and auxiliary transformer. Four pole structure shall consist of following items: 1. 11 KV Outdoor LA (3 Nos) 2. 11KV GOS Isolators with earth switch (1 Nos) 3. 11KV GOS Isolators with earth switch (2 Nos) 4. 11KV Dropout fuse set for auxiliary transformer (3 Nos)	

	5. RSJ poles (4 Nos) 6. GI Support channels, ACSR conductor, pin/disc insulators, clamps and hardware etc. as required. Supply and installation of all these items including civil works required for four pole structure are in the scope of vendor. Vendor shall submit general arrangement and detailed drawings with bill of materials/quantities of the four pole structure set as per relevant STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/CEA standards, with individual item description, quantity, make, specs / ratings etc. for BHEL approval. Vendor shall submit GTPs and GA drawings of all the items such as LA, ACSR conductor, GOS, insulators, RSJ poles etc. Note: All metal parts of Four pole structures shall be galvanized. All 11KV panel and switchyard works shall be carried out by a licensed electrical contractor as per STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/ CEA regulations.	
5.18	**Supply of reverse power relay** 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.	
5.19	**Supply and installation of auxiliary transformer** Vendor shall supply and install 1 No. auxiliary transformer of rating 125KVA in switchyard adjacent to control room. Foundation of auxiliary transformer shall be constructed by BHEL. Specification for auxiliary transformer shall be as below: (1) Outdoor, Oil immersion type, ONAN, 3-phase, 125kVA, 11kV/433V (+/-10%), 50Hz +/- 3% transformer, Dyn11, Class A insulation, off circuit tap changer with range ±5% in steps of 2.5%, cable box with bottom side cable entry on HV side and LV side, as per IS: 2026 / IS:1180 as applicable. (2) Transformer shall be mounted on a suitable RCC foundation which is in the scope of BHEL. The mounting arrangement and foundation details shall be submitted by the vendor for approval by BHEL. (3) Vendor shall submit general arrangement and detailed drawings with bill of materials / quantities with individual item description, quantity, make, specs / ratings etc. for BHEL approval. Approved makes: Schneider/ PETE/ Kamat/ Universal or reputed equivalent, as approved by BHEL.	
5.20	**Cable trench and laying of HT power cables** Following HT cables shall be laid in switchyard: (a) Output from inverter transformers to incoming feeders of indoor HT panels. (b) From outgoing feeder of HT panels, to four pole structure. (c) From four pole structure to auxiliary transformer Vendor shall construct underground cable trenches and lay HT cables as listed above. (1) Supply of HT cable shall be in the scope of vendor. Quantity required **~200m.** (2) In addition, vendor shall supply 1500m of HT cable which shall be laid by BHEL	

	from four pole structure to substation. (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) Half-cut RCC hume pipes shall be provided over HT cables in switchyard. (6) Trench layout and trench drawings shall be submitted to BHEL for approval.	
5.21	**Power cable terminations on AC HT side (11KV)** (1) Vendor shall carry out HT power cable terminations on HV side of 2700 kVA transformers (2 sets), on HV side of auxiliary transformer (1 set), on all feeders of HT panels (3 sets) and on four pole structures (3 sets). HT termination kits and all necessary hardware shall be within vendor scope of supply. HT termination kits shall be indoor / outdoor 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 **6 sets** of indoor type for 11KV 3Cx240 sq-mm cable, **3 sets** of outdoor 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.	
5.22	**Supply and installation of FCBC, Battery banks** One set of 110V, 20A Float cum boost charger and 110V, 100AH, VRLA type battery bank required for breaker panels shall be supplied and installed at control room by the vendor. Battery bank shall be rated at 10 hours discharge rate. Vendor shall submit, GA and GTP of battery and charger for approval. FCBC shall have minimum of five outgoing feeders. Makes: Exide, HBL, Amararaja or equivalent which shall be approved by BHEL.	
5.23	**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 drawing showing the details of feeders for HT panels, transformers, internal lighting, module cleaning pumps, FCBC, Air conditioner, periphery lighting, passive tracker system 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).	
5.24	**Power cable from auxiliary transformer to ACDB panel** (1) Vendor shall lay 4 runs of 1CX300 sq.mm, Al conductor, armoured, 1100V, XLPE insulation, PVC sheathed cable at LV side of auxiliary transformer up to ACDB. Supply of this cable shall be in vendor scope. Cable trenches, laying and termination of this cable shall be in vendor's scope. 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.	
5.25	**Supply and installation of outdoor timer JB and loop in loop out JBs for passive tracker system heaters** In passive tracker type module mounting structures, heaters are provided for tilting function. These heaters shall require auxiliary supply during night time. The following items are to supplied and installed by vendor for this purpose. (1) **Junction box with digital time switch: (Qty -20 Nos)** Junction box shall be of Sintex make (model GSJB 1414) /Hensel make with min. dimensions 140 x 140 x 95, IP65 containing 1 No. digital time switch of L&T make (model-67DDT0) and 10 Nos. terminal blocks suitable for 2.5 sqmm cables mounted on DIN rail. JB shall be fitted with 4Nos. polycarbonate glands in bottom suitable for 2CX2.5 sqmm cables. (2) Loop in loop out JBs: **(Qty – 384 Nos.)** Junction box shall be of Sintex make (model GSJB 1414) /Hensel make, IP65 containing 8 Nos. terminal blocks suitable for 2.5 sqmm cables mounted on DIN rail. JB shall be fitted with 3Nos. polycarbonate glands in bottom suitable for 2CX2.5 sqmm cables. The above JBs shall be fixed to the structure member of tracker system by suitable arrangement.	
5.26	**Supply and installation of UPS** Vendor shall supply and install 1No. 5KVA UPS and 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.	
5.27	**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:** l. Spectral Response- 300 to 2800 nano meters. 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 +/- 0.2degC.	
5.28	**Erection of switchyard fencing with gate** Supply, installation including civil works of Switchyard fencing with gate is in BHEL scope.	
5.29	**Switchyard leveling, jelly spreading** (1) After installation of switchyard equipment such as transformers and four pole structures vendor shall level the ground with an appropriate magnitude and direction of slope to facilitate draining of rain water away from switchyard. Accordingly, to prevent stagnation of water within switchyard, vendor shall, wherever necessary, fill up the land with suitable soil and compact the filled-up portions either manually or with rollers, as applicable, as per site conditions, to achieve required slope. (2) Stone jellies of 20mm or 40mm shall be spread uniformly with a layer of minimum 100 mm thick throughout the switchyard area.	
5.30	**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 SMBs (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: oil/winding temperatures (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. (b) Data cable laying from PCUs, transformers, VCBs, ACDB panels to SCADA. (c) Data cable terminations at PCUs, ACDB panels, transformers and VCB panels.	
5.31	**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 than10 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 of required length 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.	
5.32	**Auxiliary, Data & Control cables in array, control room and switchyard** Vendor shall carry out following data cable terminations at 2700 kVA transformers, VCB panels, ACDB panels and PCUs. (1) Terminations at marshalling box of transformers (Buchholz relay, pressure release valve, low oil level, WTI, OTI, Analog 4-20mA signals of OTI and WTI etc). (2) Terminations at VCB panels (Buchholz relay, pressure release valve, low oil level, WTI, OC/EF relay, OV/UV relay, MFM etc) for SCADA. RS485 cable for MFM and numerical relay to SCADA shall be supplied by BHEL. (3) Terminations at PCUs 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) Supply and termination of control cables from VCB panels to transformer: 12core X 2.5 sq-mm **~100m**. (8) Vendor has to lay the control cable from each transformer to VCB panel with 12Cx2.5 sq.mm cable. Cable Specification is as follows: Cable, 1.1kV grade, copper conductor, stranded, PVC type-A insulation, ATC drain wire of 2.5 sq.mm, 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. (9) For 1.25MW of passive tracker system, vendor shall supply 1.1KV, 2CX2.5sqmm, copper conductor, armoured, PVC sheathed cable for auxiliary supply to heaters. **Qty required ~ 10KM.** This cable shall be laid underground in HDPE DWC pipe. Wherever possible, HDPE pipe of 6 sqmm cable can be used for this purpose. (10) 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 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).	
5.33	**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 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. (10) 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 **~36 Nos.** (11) Power SPD inside SMB shall be earthed using min. 16 sq.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.	
5.34	**Earthing lines for control room panels – PCUs, Battery banks, FCBC charger, ACDB, 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 one No. earthing pit shall be considered for each of control room panels such as PCUs, HT panels, ACDB, battery charger 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 **~ 15 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.	

5.35	**Earthing of switchyard equipment and fencing** Vendor shall install Ground mat for switchyard as per IS. The minimum quantity of earthing electrodes equipment wise is as below: (1) Inverter Transformers body earth – 2x 2 Nos each = 4 Nos. (2) Inverter Transformers shield earth – 2x 2 Nos each = 4 Nos. (3) Auxiliary Transformer body earth – 2 No (4) Auxiliary transformer neutral earthing – 2 No (5) GOS earth switch earthing – 1 No each (6) 4P structure body earth – 1 No (7) Lightning arrestors– 3 Nos (8) Switchyard fencing – 2 Nos Vendor shall submit earthing design calculation as per standards. GI strips of min. 50x6 mm shall be used for forming a grid for all the body earthing in order to achieve a good earth resistance value. Extra number of electrodes may be supplied and installed if the overall resistance in switchyard shall be more than 0.5 ohm. GI strips shall be laid underground at a depth of ~ 500 mm. Earth electrodes, GI strips, all hardware required for making the connections shall be within vendor scope of supply.	
5.36	**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.	
5.37	**Yard lights for switchyard, approach roads and compound wall (periphery lighting):** (1) Vendor shall supply and install required number of lights in switchyards, 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 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.	
5.38	**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.	
5.39	**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 1-inch CPVC pipes of required length.	
5.40	**Water supply for O&M, electrical cabling and plumbing works.** (1) BHEL will provide water outlet 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 of PVC water storage tanks of 5000 liters capacity each on control room (2 Nos.).	
5.41	**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 2-inch 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 pumps of required capacity shall be supplied and installed one each 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 (2 set-1 set for each pump) 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 system from storage tank to solar array field.	
5.42	**Identification markings using ferrules, paint and cable tags, as applicable to the individual cases and as approved by BHEL, shall be provided:**	

	(1) String monitoring junction boxes: Identification marking by way of painting on nearby module structure. (2) All equipment such as PCUs, transformers, VCB panels, CT, PT, GOS and metering panels shall be provided with suitable identification markings using painting, with inscriptions as approved by BHEL. (3) Cable sizes with arrow marks in switchyard (for HT cables) using painting. (4) Identification markings for all the earth chambers (using painting) with inscriptions as approved by BHEL. (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 panels such as PCUs, LT panels, Batteries, FCBC chargers, ACDB panel etc.	
5.43	**Cable markers** (1) Steel cable markers with suitable labels (DC cable, LT cable, HT cable, Data cable, CPVC water pipeline etc)and arrow marks (pointing to the cable destination) shall be supplied and installed along the cable trenches at appropriate locations for following cases: a) For DC cable from string monitoring boxes to respective inverters b) For data communication cables from string monitoring boxes to control room c) For cables of yard lights of solar array field, compound wall/chain-link fencing and switchyard fencing d) For electrical cables of pump connections e) For HT (11KV) cables within switchyard f) 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 foundation shall be minimum 200mm diameter. (3) Cable markers shall have a minimum height of 300 mm above the ground level. (4) Cable markers shall be suitably painted.	
5.44	**Hoarding board for the solar power plant.** (1) 1 No. hoarding for the plant shall be made of 1500x1800x 3mm thick MS plate. Approximate dimension of board 1500x1800 mm. (2) Board shall be given a red oxide coat and painted background. Colour for background and letters shall be as approved by BHEL site in-charge. (3) Board shall be fixed on a frame constructed using ISA 50x50x8 angles. Diagonal supports shall also be provided. The frame shall be supported by two vertical legs of ISA 75x75x8 that is grouted with concrete foundation. (4) Depth of foundation shall be 600 mm below ground level, with 100mm thick PCC layer 1:4:8 of 400x400mm, M25 concrete of 300x300mm, foundation pedestal of 200mm height above ground level. (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 BHEL for approval.	
5.45	**Display boards and sign boards**	

1	Board displaying instruction chart for restoration of person from Electric Shock	1 No
2	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
6	Board showing list of O&M staff with name, qualification and work responsibility	1 No
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 string monitoring boxes, PCUs, LT panels, Transformers, HT panels, Four pole structures in switchyard etc.	Qty as required	
9	Identification boards, of suitable sizes, within control room such as scada room, store room, battery room, security room, gents / ladies toilets, pantry etc shall be supplied by vendor. BHEL will provide the list.	Qty as required	

(a) 5mm thick sun board with LG make vinyl sticker (computerized cutting and pasting) shall be used for Sl Nos 4, 5, 8 and 9.
(b) For others, flex banner with design & printing shall be used.

Required number of danger notice plates shall be provided wherever necessary Suitable size of each Danger Notice plates shall be provided as per statutory requirement , made of mild steel sheet and at least 2mm thick, and vitreous enameled white on both sides, and with inscription in signal red colours on front side as required. The inscriptions shall be in Tamil and English language.

5.46 Electrical insulation mat

(1) Vendor shall supply required number of electrical insulating mats as follows:
   (a) Make: Vardhman House Private Ltd or reputed equivalent as shall be 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
(3) Vendor shall lay the mats in front of electrical panels (PCUs, HT panels, FCBC, ACDB panels) in control room.

5.47 Checkered plate for closing the cable trenches (a) behind the panels such as PCUs, VCB panels , ACDB panels etc. in control room and also (b) other open areas of cable trench

(1) Vendor shall supply and install Checkered plate. Plate shall have a suitable handle (welded to the plate) to facilitate ease of lifting and movements.
(2) Plate thickness = 6mm min.
(3) Width = 1000 mm max, total length as required
(4) These width and length dimensions are indicative. Actual dimensions shall be based on site conditions.
(5) Plate shall be red oxide coated followed by black painting.
(6) BHEL approval shall be obtained for overall arrangement of checkered plate.

5.48 Air conditioner

Vendor shall supply and install 1 No. Split air conditioners of 1.5T capacity (min BEE 3 star rating) with stabilizers in SCADA room. Make: LG, Videocon, Bluestar, Godrej or reputed equivalent that shall be approved by BHEL. Construction of SCADA room and partitioning is in the scope of BHEL.

5.49 Tool kits and instruments

Vendor shall supply the following tool kits and instruments:

A. Measuring instruments

1	Digital Earth Resistance Tester	Cambridge Instruments/equivalent	1 Nos
2	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, Nippen/equivalent	1 Nos
7	Electrical Tester	Reputed Make	4 Nos

Note: Make/model number 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 gear power, hand operated	1 Set
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 / cleaning.	1 No.
18	Blowers for cleaning the panels	1 No.
19	MC4 tool kits consisting of crimping plier, open end spanner set, stripping plier, socket wrenches	4 Sets

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

5.50 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.

5.51 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 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.

5.52 Other safety related items

(1) Safety gadgets:

1	Gas Mask	2 Nos
2	First Aid Box with essential medicines and bandage cotton, antibiotic cream, Dettol, etc.	2 set
3	Hand Gloves 11 KV for GOS operation	2 sets
4	Hand Gloves 1KV for Maintenance of SMB	2 sets
5	Discharge rod	2 Nos
6	Safety Helmet	5 Nos
7	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 extinguisher (stored pressure type)	Capacity: 9 Kg IS: 2171, IS:10658 CM/L-7759096 Suitability for Class A, B & C fire, related to solid combustibles, flammable liquid and gases.	6 Nos

		2	Carbon di-oxide (CO2) type fire extinguisher with trolley	Capacity: 9 Kg IS: 2878 Suitability for Class B&C fires Involving flammable liquids & gases, electronic equipment.	6 Nos	
		2	Sand buckets	GI fire buckets (as per IS: 2546) with 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.	4 sets	

5.53 **Spares to be supplied along with main supply:**

a) MC4 Connectors – 177 Pairs
b) Timer JBs – 2 Nos
c) Loop in loop out JBs- 5 Nos
d) Indoor type HT termination kit - 1 set
e) Outdoor type HT termination kit - 1 set
f) Weather Monitoring System spares: Pyranometer-1 No., Anemometer-1 No., and Temperature sensor – 1No.

5.54 **Pre-commissioning inspections / checks / tests and coordination with state departments for necessary approvals and clearances for commissioning, synchronization with grid and post-commissioning operation of the plant:**

(B) Vendor shall carry out following minimum pre-commissioning checks:

(1) Verification of firmness of terminations in all electrical equipment: SMBs, PCUs, VCB panels, transformers, 4P structure items (GOS, LAs etc), SCADA stations, weather monitoring equipment and PV array earthing.
(2) Verification of earthing for all these electrical equipment.
(3) Measurement and verification of parameters at string monitoring boxes at solar array field: string current, voltage, combined SMB output current, module temperature, SMB temperature.
(4) Measurement and verification of parameters on DC input side of PCUs: DC current and voltage; Vendor shall support the PCU engineer on these tests.
(5) Insulation resistance measurements (megger tests) for all the electrical equipment of control room and switchyard.
(6) Functional checks for PCUs: Vendor shall support the PCU engineer during the pre-commissioning tests.
(7) Functional checks for transformer marshalling box:
Availability of AC/DC power supply, (b) Responses of the relays at VCB panels and corresponding indications at annunciation panel by simulating the alarm / trip of Buchholz, PRV, WTI, OTI, LOLA at marshalling box.

(8) Functional checks for VCB panels:
(a) Availability of AC/DC power supplies (b) VCB on/ off, (c) spring charging, (d) LED indications, (e) functioning of electromagnetic and numerical relays, (f) responses at VCB panels to operations from SCADA (g) indications on windows, alarm accept/reset operations /SCADA.
(b) Verification of interlock operations related to incomer and outgoer

VCBs.

(9) Verification of parameters at SCADA station: (a) DC/AC parameters from SMBs, HT panels, ACDB panels, Metering panels, (b) status of ACB/VCB breakers and transformer protection relays, (c) weather monitoring parameters.

(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, CTs, PTs, Lightning arrestors, GOS switches, 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/CEA/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

(e) GOS switches: IR and contact resistance 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/CEA/SECI and obtain their approval through necessary liaison activities.

(D) Vendor shall coordinate and liaison with STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/CEA 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) CEA inspection of power plant

(d) Provisional CEA 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 CEA norms and getting approvals.

(F) Vendor shall implement corrective steps on the observations of CEA, 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, CEA 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) Auxiliary transformer 2) Lightning Arrestors 3) Gang operated switch with earth switch 4) ACSR conductor 5) All cables under vendor scope (LT, data, control and communication cables) 6) Earthing electrodes & earth strip 7) Lightning arrestor (ESE) 8) Fire alarm system 9) ACDB 10) FCBC, Battery bank 11) 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 also be in scope of vendor.	
7.5	Vendor shall organize all necessary steps to meet statutory requirements such as 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 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 cost.	
7.12	No child labour shall be employed for execution of the present contract.	
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, PCU ducting exhaust fans 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

8.1	Date of commencement of defect liability period : Zero date for defect liability period shall be the actual date on which the complete 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.	

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	GA drawings / schemes / layouts etc with bill of materials / quantities shall be submitted for the following (list is indicative and not limited to): (1) Auxiliary transformer (2) SMB Mounting structure (3) Cable trench layout in array yard, switchyard (4) GTP and drawings of Switchyard equipment – GOS, LA, ACSR, CT, PT (5) Details of power, control, communication cable (6) ESE Lightning arrestor arrangement with foundation details (7) Yard lights –switchyard, compound wall, approach road. (8) Water pipeline layout from storage tank to solar array field for module cleaning system with pressure calculations (9) Fire alarm system scheme / layout (10) Cable support structures and cable ladders within control room (11) 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 -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
IS: 2026 / IS: 1180	Transformers

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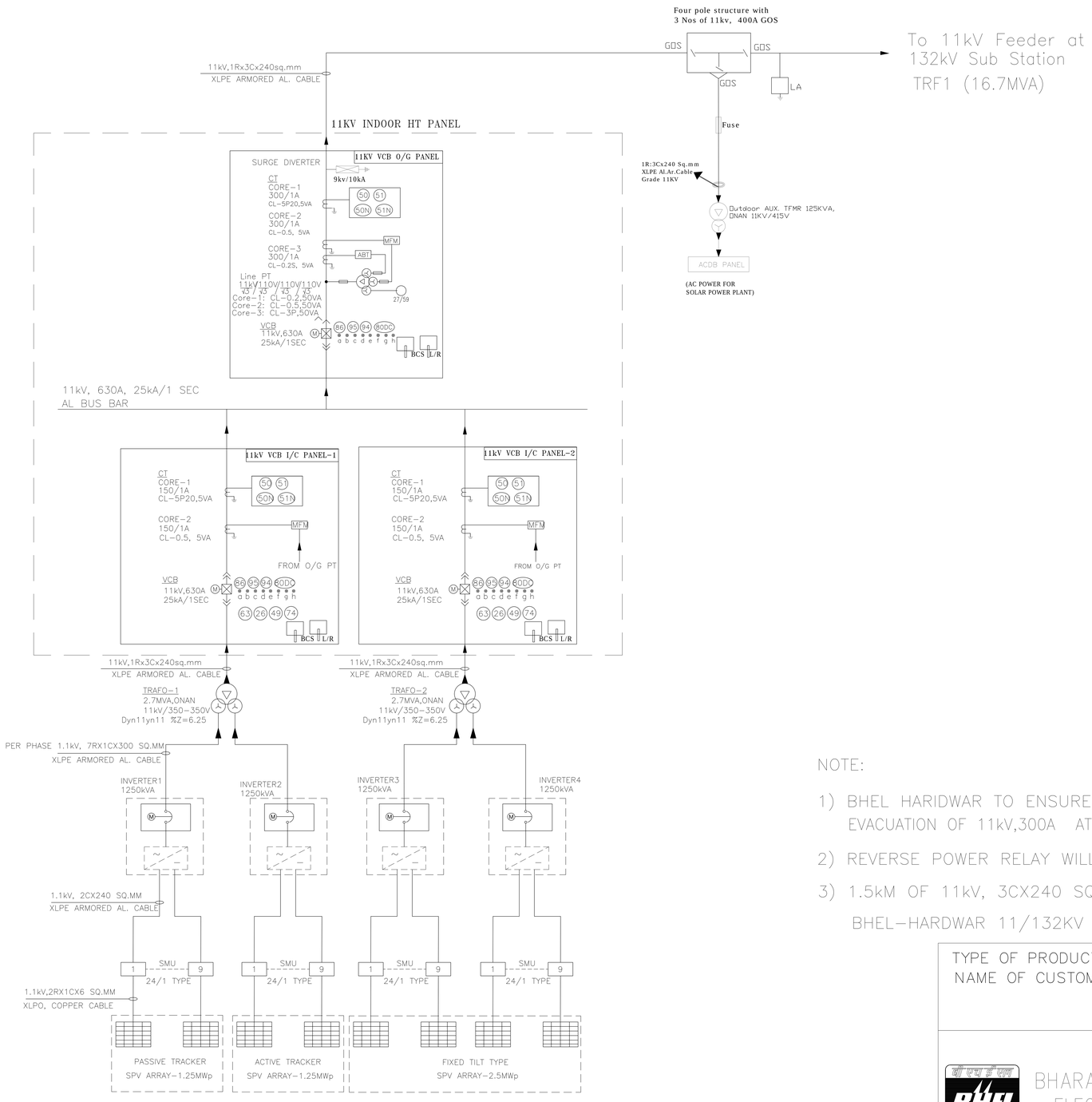
DRAWING NO. 3-679-05-00907



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1		TRANSFORMER 2.7MVA
2		VCB 11kV,630A 25kA/1SEC
3		SURGE DIVERTER, 9kV/10kA
4	86	MASTER TRIP RELAY
5	95	TRIP CIRCUIT SUPERVISION RELAY
6	94	ANTI PUMPING RELAY
7	63	BUCHHOLZ RELAY
8	26	MAGNETIC OIL LEVEL GAUGE
9	49	WINDING TEMP INDICATOR AND OIL TEMP INDICATOR
10	74	PRESSURE RELIEF DEVICE
11	a	VCB ON
12	b	VCB OFF
13	c	SPRING CHARGE
14	d	AUTO TRIP
15	e	TRIP CIRCUIT HEALTHY
16	f	SERVICE POSITION
17	g	TEST POSITION
18	h	DC SUPPLY HEALTHY
19	50	INST OVER CURRENT RELAY
20	51	IDMT OVER CURRENT RELAY
21	50N	NEUTRAL INSTANTANEOUS OVER CURRENT RELAY
22	51N	IDMT EARTH FAULT RELAY
23	MFM	MULTI FUNCTION METER
24		CURRENT TRANSFORMER
25	27	UNDER VOLTAGE RELAY
26	59	OVER VOLTAGE RELAY
27		POTENTIAL TRANSFORMER
28		FUSE
29	TEM	TARIFF ENERGY METER
30	80DC	DC FAILURE INDICATION
31		INVERTER, 1250kVA

NOTE:

1) BHEL HARIDWAR TO ENSURE AVAILABILITY OF SPARE FEEDER FOR SOLAR PLANT POWER EVACUATION OF 11kV,300A AT TRF1 AT 132KV SUBSTATION.
2) REVERSE POWER RELAY WILL BE INSTALLED AT 11kV INCOMER OF TRF1 16.7MVA.
3) 1.5kM OF 11kV, 3CX240 SQ.MM XLPE AL ARMORED CABLE CONSIDERED FROM SPV PLANT TO BHEL-HARDWAR 11/132KV SUBSTATION.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 5 MWp SOLAR PV POWER PLANT BHEL HARIDWAR

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

	NAME	SIGN.	DATE
DRN			
CKD	VCP		NOV'17
APPD	MS		NOV'17

No. OF VAR

REV.	DATE	ALTERED / CHECKED / APPROVED	REV.	DATE	ALTERED / CHECKED / APPROVED	REV.	DATE	ALTERED / CHECKED / APPROVED

DEPT. | CODE | FOR UNSPECIFIED-TOLERANCES REFER ED 0230499 | SCALE | WEIGHT(Kg) | REF. TO ASSY. DRG. | ITEM NO. | No. OF ITEM

TITLE: SINGLE LINE DIAGRAM (SLD)

DRAWING NO. 3-679-05-00907 REV. 01

SHEET NO. 01 NO. OF SHEETS 01

REF. DRG.NO. | SIGN & DATE | INVENTORY NO.

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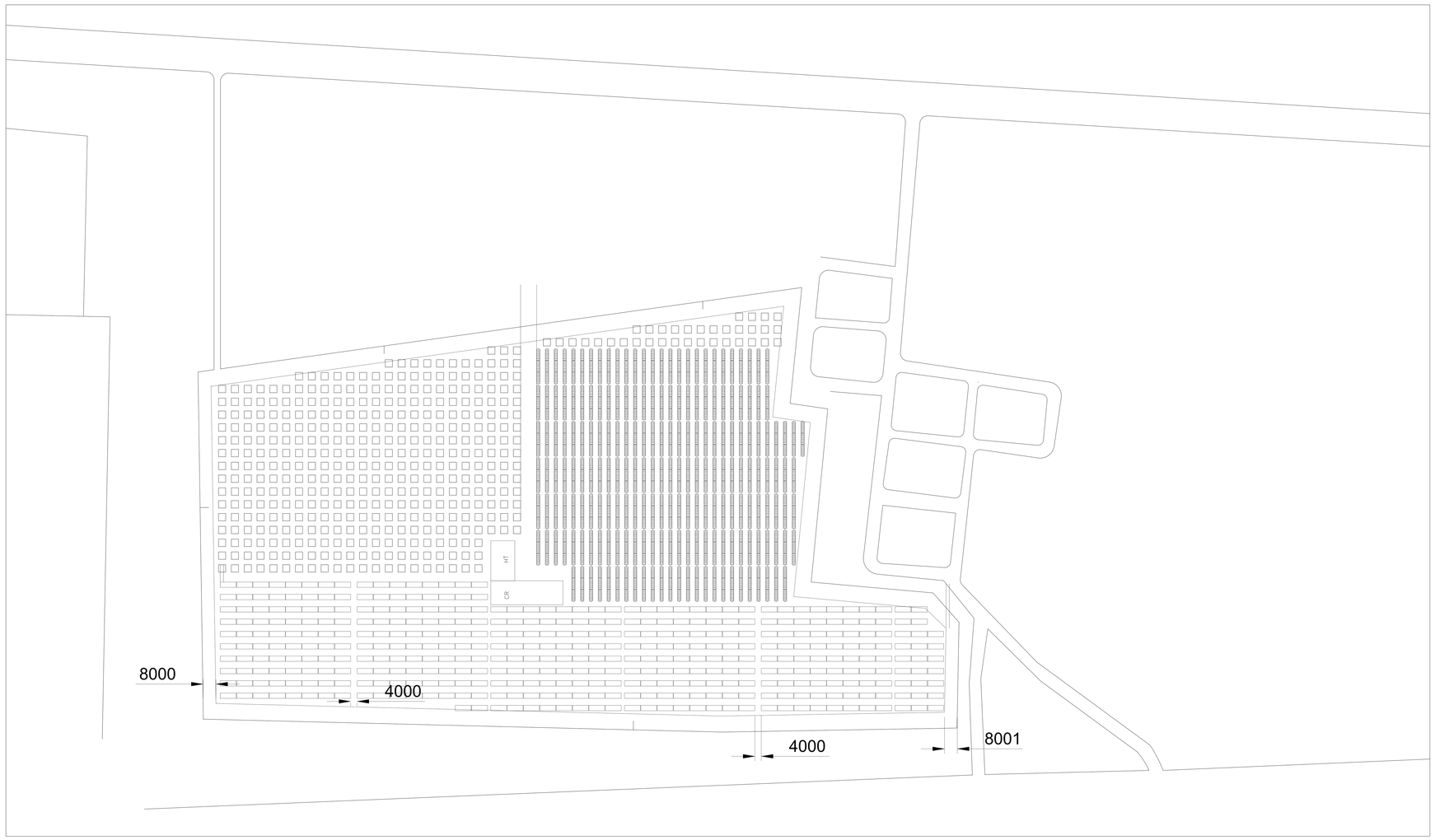
DRG. No. 3-679-05-899



FIXED ARRAY DETAILS

PV ARRAY CAPACITY	2.5 MWp
Total no.of PV Modules	8080 nos
Number of module in 1 Table	20
Total No. of Table	404 nos.

ACTIVE TRACKER DETAILS

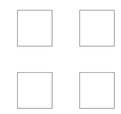
PV ARRAY CAPACITY	1.25 MWp
Total no.of PV Modules	4200 nos
Number of module in 1 Tracker	7
Total No. of Tracker	600 nos.

PASSIVE TRACKER DETAILS

PV ARRAY CAPACITY	1.25 MWp
Total no.of PV Modules	4180 nos
Number of module in 1 Tracker	10
Total No. of Tracker	418 nos.

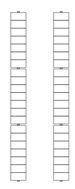
LEGEND

	2X5-310W STRUCTURE
	1X7-310W STRUCTURE
	2X10-310W STRUCTURE
CR	CONTROL ROOM



Typical Tracker arrangement
Passive Type

Typical Table arrangement
Fixed Type



Typical Tracker arrangement
Active Type

PROJECT : 5MWp SOLAR POWER PROJECT
CUSTOMER : BHEL HARIDWAR

REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED
		APPROVED			APPROVED

	NAME	SIGN	DATE
DRAWN	NY		241017
CHECKED	PM		241017
APPROVED	MS		241017

DISTRIBUTION OF PRINTS

DEPT.	CODE
SC&PV	439

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

TITLE: TRCKER LAYOUT

No. OF SHEETS	01
SHEET No.	01
REV	01

BHEL DRG. No. 3-679-05-899

REF. DRG. No.
SIGN. & DATE
INVENTORY No.

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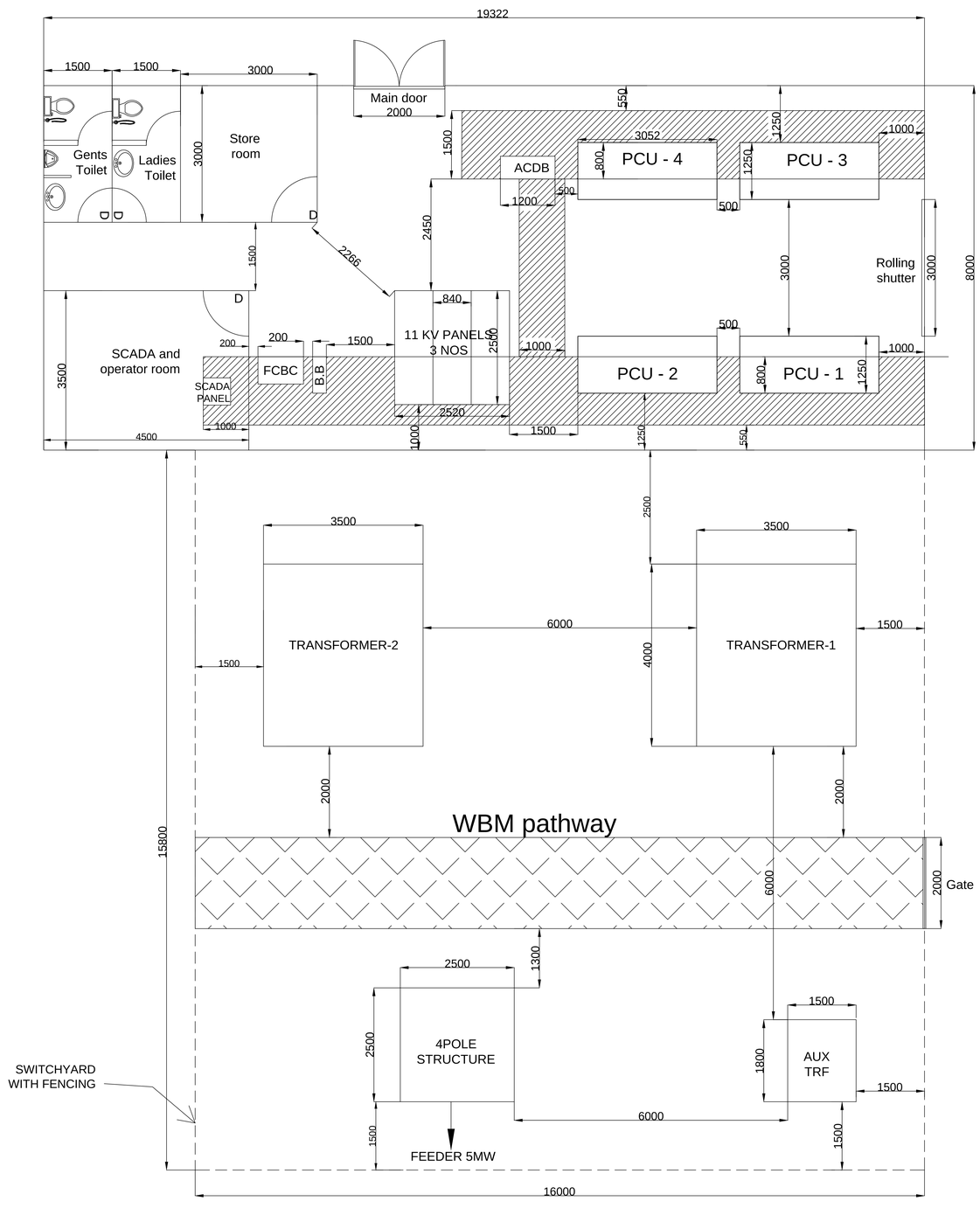
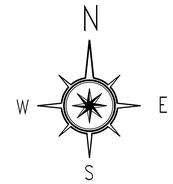




NOTES :

1. 2 TRANSFORMERS EACH OF FOOTPRINT - 3.5X4 M
2. 4 PCUS EACH OF FOOTPRINT - 3.052X1.25 M
3. APPROX FLOOR AREA OF CONTROL ROOM = 154.5 Sqm.
4. TENTATIVE TRENCH LAYOUT DEPICTED.
5. ALL DIMENSIONS ARE IN mm.
6. ORIENTATION OF BUILDING TO SUIT 11KV EVACUVATION LINE POINT AND ACCESS TO ROAD.

REV.	DATE	ALTERED / CHECKED / APPROVED	REV.	DATE	ALTERED / CHECKED / APPROVED
					FIRST ISSUE

	NAME	SIGN	DATE
DRAWN	LNK		211117
CHECKED	VCP		211117
APPROVED	MS		211117

DEPT.	CODE
SC&PV	439

BHARAT HEAVY ELECTRICALS LIMITED
ELECTRONICS DIVISION, BANGALORE

CARD CODE

PROJECT: BHEL HARIDWAR 5MW SPV PLANT — No. OF SHTS: 01

TITLE: LAYOUT OF CONTROL ROOM & SWITCH YARD — SHT No.: 01

M.O. No.

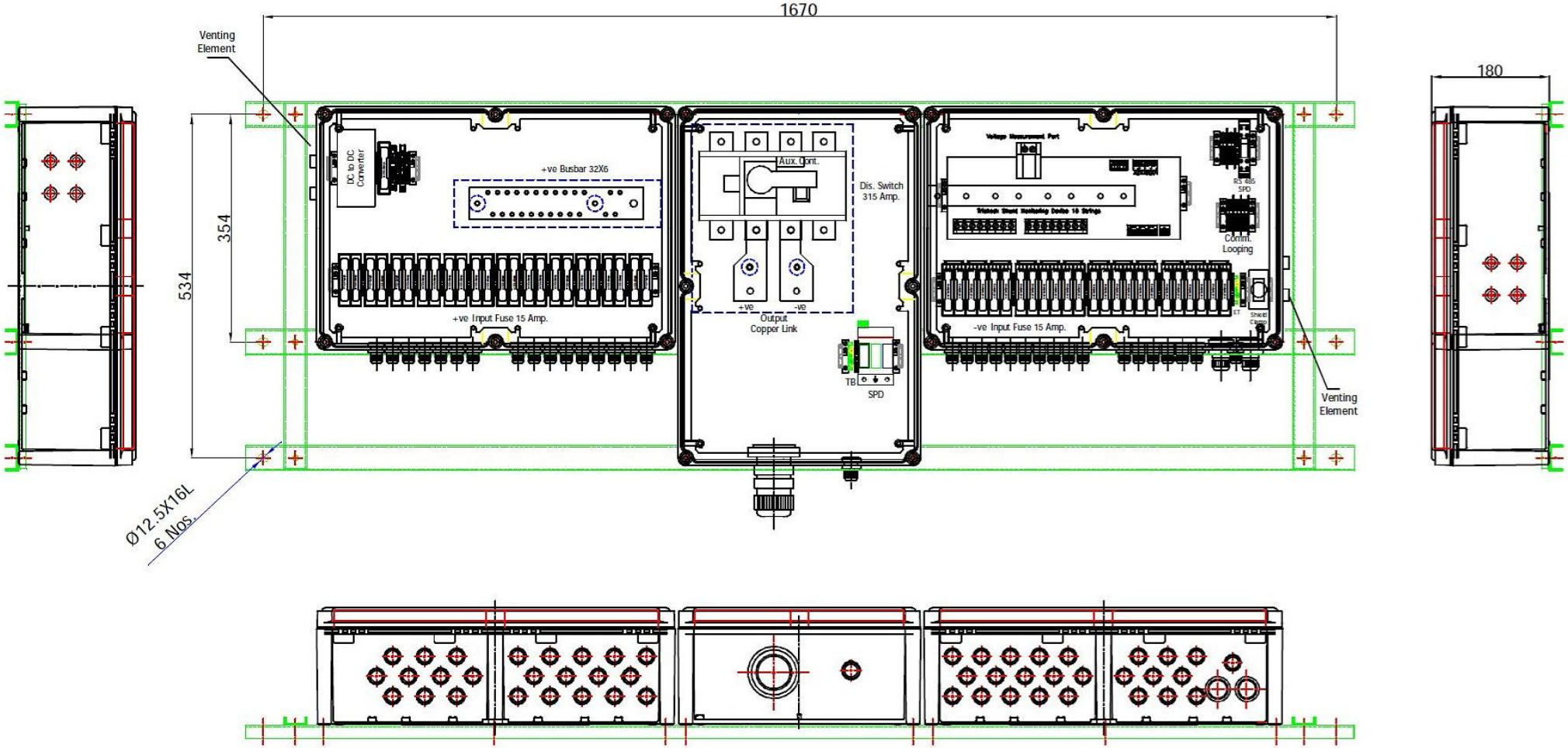
DRG. No. 3-679-05-00912 — REV 00

REF. DRG. No.

SIGN. & DATE

INVENTORY No.

TANTATIVE DRAWING OF SMB



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