

	PURCHASE SPECIFICATION; GROUP: PHOTOVOLTAICS SUPPLY OF BOS ITEMS, I&C, O&M FOR 10MW SPV POWER PLANT AT CHANDAPUR VILLAGE, SHIGGAON TALUK, HAVERI DIST., KARNATAKA	PS-439-1097
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Technical Specification for
Supply of Balance of System items, Installation & Commissioning,
Operations & Maintenance
For 10 MW Solar PV grid connected power plant at
Chandapur Village, Shiggaon Taluk, Haveri Dist., Karnataka

Revision details : R 01 Cl. Nos. 2.0,3.1,3.2,5.1,5.3, 5.4, 5.6,5.10,5.11,5.17 modified	Prepared: LNK	Checked: PRV	Approved: SLR	Date: 10.02.2017
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1.0 Introduction

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up a 10 MW Grid Connected SPV Power Plant for KPCL at Chandapur Village, Shiggaon Taluk, Haveri Dist., Karnataka.

The plant will have PV modules of poly-crystalline type mounted on fixed type of structures. Electrically, the PV array will have 8 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 33KV.

The solar array will have 72 string monitoring combiner boxes (SMBs) that collect the solar PV generated DC power and provide inputs to the 8 PCUs housed within inverter rooms. There will be 1 No. Inverter room and 1 No. Control room – cum inverter room building. Inverter room shall house 4 PCUs (1250 KW each), ACDB, SCADA, battery bank, FCBC and other associated panels. Control room shall house 4 PCUs (1250 KW each), ACDB, battery bank, FCBC, SCADA room (air conditioned), store room and toilets.

There will be 2 Nos. transformers (2700KVA, 33KV/ xxx-xxxV) located one each on either sides the inverter room. A typical layout of switchyard is enclosed. There will be one auxiliary transformer of rating 100 KVA, 33KV/433V at control room. 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 final output of 10 MWp solar power plant shall be connected to 33KV substation through 33KV transmission line which will be in the scope of BHEL.

This technical specification provides requirements of BHEL for supply, installation, commissioning of balance of system items and operation and maintenance of power plant for a period of 5 years. 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	Single line diagram of overall power plant	BH-KP10H-004 (AC) & BH-KP10H-005 (DC)
2	Site layout with locations of solar array, control room, inverter room, switchyard (Autocad drawing of site layout will be provided on request by vendor through e-mail)	BH-KP10H-012
3	Control Room Layout	BH-KP10H-010
4	Inverter Room Layout	BH-KP10H-009
5	33KV Switchyard layout	BH-KP10H-006
6	Drawing of C&R panel shed in switchyards	BH-KP10H-CIV-CR-PN-01

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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 O&M for 5 years, as briefly outlined. Vendor shall submit the offer (in two part bids) as per this list and quantity.

#	Scope of supply (as briefly outlined)	Qty
1	Supply of MC4 connectors, cable ties, SMB mounting structure , HDPE pipes, cable lugs , hardware, cable trays, cable tray supports as per clauses 5.5 to 5.15.	1 set
2	Supply of Auxiliary power cables, control cables, data communication cables, 33KV termination kits, lugs and glands as per clauses 5.18, 5.19, 5.25, 5.30 to 5.31.	1 set
3	Supply of switchyard equipment such as auxiliary transformer, 33KV lightning arresters, metering CTs, metering PTs, metering panels with ABT meters, GOS isolators, PSC poles, insulators, ACSR conductor required for four pole and two pole structures, items of switch yard fencing (fence, gate, angles), items for connecting to earthing, with all related miscellaneous accessories and hardware as per clauses 5.17, 5.24 and 5.26.	1 set
4	Supply of ACDB, IRDB, Battery banks, FCBC, UPS with battery, Weather Monitoring System as per the clauses 5.20 to 5.23.	1 set
5	Supply of items of earthing system for solar array field, control room, inverter room panels and switch yard equipment including Earthing electrodes, GI flats, copper strips, copper earthing cables (green) of min 25sq mm, CPVC pipes, Insulation bushes, heat shrinkable sleeves for control room copper strip earthing and all related miscellaneous hardware as per clauses 5.32 to 5.34.	1 set
6	Supply of lightning arrestors for solar array field (ESE type) with earthing items as per clause 5.35.	1 set
7	Supply of items for yard lighting system such as pole pipes, lamps, lamp fittings, CPVC pipes, junction boxes, cables, cable lugs, glands, related accessories, hardware as per clauses 5.36 and 5.38.	1 set
8	Supply of items of module cleaning system such as submersible pumps (for bore wells), booster pumps, water storage tanks, CPVC pipes with fittings, ball valves, nipples, hose pipes as per clauses 5.39 and 5.40.	1 set
9	Supply of miscellaneous items such as cable tags, danger boards, cable markers, hoarding board, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, tool kits, measuring instruments, office furniture as per clauses 5.41 to 5.49.	1 set
10	Supply of safety related items including fire alarm system, fire extinguishers, safety gadgets as per clauses 5.50 to 5.51.	1 set
#	Scope of work (as briefly outlined)	Qty
11	I&C: Temporary site office, arranging electrical power and water for construction, construction of temporary storage yard, unloading and movement of consignments as per clauses 5.1 to 5.4	1 AU
12	I&C: Interconnection of SPV modules, cabling from strings to SMBs, installation of string monitoring boxes including cable terminations, formation of cable trenches and laying of 1CX300 sq-mm cables up to PCUs and inspection thereof as per clauses 5.5 to 5.12.	1 AU
13	I&C: Erection of control room, inverter room and security room electrical panels such as inverters, ACDB, IRDB, Security Room DB, FCBC, Battery bank, erection of cable trays and cable supports, routing and terminations of DC and AC cables up to LV side of transformers in switchyard as per clauses 5.13 to 5.15 and 5.20 to 5.22.	1 AU

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14	I&C: Erection of switchyard equipment such as transformers, VCB panels, C&R panels, CT, PT, GOS, 2P/4P/6P structures, 33KV cable laying and terminations, foundations, Switchyard leveling, jelly spreading, fencing including gates as per clauses 5.16, 5.17, 5.24 to 5.27.	1 AU
15	I&C: Cable trenches, cable laying, cable terminations for 33KV cables as shown in SLD between inverter room and control room and from control room up to two pole structure at plant boundary as per clauses 5.18, 5.19 and 5.25.	1 AU
16	I&C: Cable trenches, cable laying, cable terminations for control, communication and OFC cables (between IR and control room & from SMBs to SCADA panels in IR and CMCS) related to inverters, transformers, VCB Panels, C&R panels, SCADA and other equipment as per clauses 5.28 to 5.31.	1 AU
17	I&C of earthing system for solar array field, control room panels, inverter room panels and switchyard equipment including installation of Chemical earthing electrodes, erection & electrical interconnection of earth chambers, earthing of module mounting structures, laying of copper earth strips in control room installation of lightning arrestors (ESE) as per clauses 5.32 to 5.35.	1 AU
18	I&C of yard lights for approach road, switchyard and boundary wall including cable trenches, cable laying and cable terminations at the yard lighting poles as well as ACDB panel in control room and IRDB panel in inverter room as per clauses 5.36 to 5.38.	1 AU
19	I&C of module cleaning system including construction of borewells, installation of water storage tanks, trenches for pipelines, laying of pipelines from bore wells to solar array field through water storage tanks, erection of submersible and booster pumps, ball valves, non-returnable valves as per clauses 5.39 and 5.40.	1 AU
20	I&C of miscellaneous and safety items such as WMS, cable tags, danger boards, cable markers, hoarding board, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, office furniture, fire extinguishers, fire alarm system as per clauses 5.23, 5.41 to 5.51.	1 AU
21	I&C: Pre-commissioning inspections / checks / tests, MRT tests and coordination with state and central departments such as KPTCL/CEIG/SECI etc. for necessary approvals/ clearances for commissioning, synchronization with grid and post-commissioning operation of the plant as per clause 5.52.	1 AU
22	Operations and Maintenance of PV plant for FIVE years (60 Months) as per clause 8.0. 1 AU = 3 Months	20 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.

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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. The receipt, unloading, storage, handling, erection and commissioning of all these items are within the scope of vendor.

#	BHEL Scope of supply	Qty
1	Supply of Solar PV Modules: BHEL make, 305 to 315 Wp min. (Type L24270P)	~ 32960 Nos
2	Supply and Erection of Solar array structures with modules mounted on Fixed type structures (MMS), with each having 20 Nos. of PV modules	1648 sets
3	Supply of Cable, 1Cx 6 sq-mm (for connection of PV modules to string monitoring boxes)	approx. 130km
4	Supply of Cable, 1.1KV, 1C x 300sq-mm (for connection from SMBs up to PCUs in inverter room)	approx. 32 km
5	Supply of String monitoring boxes (24-in, 1-out) along with mounting structure, lugs and glands	72 Nos
6	Supply of Power conditioning units (PCUs) of 1250 kW rating	8 Nos
7	Supply of Transformers 2700kVA, 33KV /xxxV-xxxV (1 HV winding, 2 LV windings)	4 Nos
8	Supply of Cable, 1.1KV, 1Cx 300 sq-mm for AC side power connections from PCUs to LV side of transformers	approx. 3 km
9	Supply of Cable, 33KV, 1Cx 300 sq-mm for HV side power connections from transformers to VCBs and from inverter room to control room	approx. 3 km
10	Supply of 33KV outdoor PCVCB along with CT, PT, C&R panel and mounting structures	1 set
11	Supply of SCADA system with PC, accessories and software	1 set
12	Supply of Optical Fiber Cable and RS-485 cable for SCADA	1 set
	BHEL Scope of work	
13	Construction of control room, inverter room and security room including partitions.	1 Set
14	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.

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5.0 Detailed technical specification for supply, installation and commissioning

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

#	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 1 porta cabin of minimum 160 sq.ft along with chemical toilet including 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 3 months after commissioning. (3) Cabin shall be furnished with essential amenities such as one computer with internet connection, two work tables, six chairs and necessary number of power points, lamps, air conditioner and fans. (4) Separate arrangement shall be made for pantry shed for preparation of beverages such as Tea/ Coffee etc. All the utensils, facilities such as LPG/electric stove and service requirements shall be included in vendor's scope.	
5.2	Electrical power and water for construction (1) Vendor shall organize necessary electrical power supply such as DG sets etc required for construction activities in vendor's scope and also for the porta cabin. (2) Vendor shall also establish, on their own, water source such as bore wells, water tankers etc for construction activities in vendor's scope and for site office. (3) Vendor shall arrange drinking water for the site engineers of BHEL and the staff/employees of vendor.	
5.3	Construction of temporary yards for safe storage of all BHEL as well as vendor supplied items (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. This includes storage of all items such as electrical panels (PV Modules, PCUs, HT panels, Transformers , Battery banks, Battery chargers, Distribution boards etc), cables, string monitoring boxes, Module Mounting structures , spares, tools, instruments etc. (2) Area of storage yard shall be min. 1500 sq.m. However, exact size shall be decided mutually with BHEL based on site conditions. (3) A portion of storage yard area (min. 500 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	

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	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) Watch and ward security personnel shall be provided for the yards on round-the-clock basis. (9) Unloading, storage and security of BHEL supplied items as listed in Clause 3.2 shall be taken care by BHEL.	
5.4	Receipt, unloading, safe storage and movement of all BHEL and vendor supplied items: (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 all 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. (6) For PV Modules and MMS which are to be erected by other BHEL contractors, vendor shall issue the items to other BHEL contractors for erection as instructed by BHEL site engineer with proper documentation. For items supplied by BHEL and other BHEL vendors: (1) Receipt, unloading, storage, security guards shall be in scope of BHEL and other vendors. (2) However, movement of those items related to vendor scope of I&C from their respective storage locations to the points of construction is in scope of vendor. Accordingly, vendor shall organize all necessary resources such as labour, machinery and tools (cranes, hydra, forklifts, transportation trucks/ trolleys, lifting accessories etc) for this purpose.	
5.5	Interconnection of SPV modules to form strings. Supply of SPV modules is in BHEL scope. 32960 Nos. of BHEL make PV module of L24270P type, 305 to 315 Wp shall be supplied.	

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	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). - 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. - This way, 20 modules shall be connected in series for L24270P type. Each set of connections is called as a series string. Thus, 1648 series strings shall be formed with 32960 modules. - 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 SMB's. Vendor shall implement the interconnection as per these drawings. - Interconnected cables shall be neatly routed and dressed using UV resistant nylon cable ties of appropriate dimension. - These cable ties shall be in vendor scope of supply. Recommended make: 3M, Phoenix contact, Weidmuller, Hellermannntyton, 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. - Cables shall not be loosely hanging.	
5.6	Installation of string monitoring boxes: - Supply of string monitoring boxes (SMB), 72sets is in BHEL scope. These are 24-in and 1-out type. - Vendor shall install the SMBs on independent structure with foundation in the solar array field as per final array layout. - Design, supply of SMB mounting structure using GI channels/angles and necessary hardware required for installation of SMBs are in the scope of vendor BHEL. - Design and construction of foundation for SMB mounting structure is in the scope of vendor. - Drawings of SMB and the fixing arrangement will be provided to the vendor after placement of purchase order. - SMB location will be identified by BHEL and will be provided in the wiring layout. - SMBs shall be fixed on the structures using the hardware that are supplied by BHEL as part of SMB assembly kit. - All tools necessary for mounting shall be in vendor scope.	
5.7	Interconnection of SPV module cable to 6 sq-mm cable: - 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. - SPV module is provided with positive and negative cables (4 sq-mm) having male and female parts of MC4 type connectors. - 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. - MC4 connectors shall have rating of 1000VDC (IEC), rated current of 25A (min.), Type approved by TUV Rheinland for product safety. - The make of MC4 connector (for the 6 sq.mm cable at PV module end) to be	

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	supplied shall be same as that of MC4 connector connected to PV module which shall be informed by BHEL after placement of P.O. (6) Total quantity of MC4 connector sets required = 1648 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) In addition to the above safety margin, vendor shall supply 152sets extra as spares for contingency use during post-commissioning period. (9) Four sets of tool kits (with plastic box enclosure) shall be supplied and stored at the site as O&M tools. This shall include crimping plier MC4, open end spanner set MC4, stripping plier MC4, socket wrench insert to tighten, socket wrench insert to secure, inserts for both 4 sq-mm and 6-sqmm (of both pliers). Vendor should make available extra MC4 tool kits of at least 20 nos., during execution for simultaneous working on the array. Note: For any other equivalent make of plug connectors and tool sets, BHEL approval shall be taken prior to procurement.	
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, Hellermannntyton, 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, 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. (3) Specification of HDPE DWC pipe: As per IEC 61386 part 1-4; Inner Diameter (ID) shall be selected to accommodate the number of 6 sq-mm cables to be guided. However, Inner diameter shall be limited to a minimum of 63mm. Qty required ~5000 M (4) Make: Tirupati Plastomatics, Jaipur or reputed make, as approved by BHEL. (5) Make, part number, sizes / dimensions, datasheet shall be submitted to BHEL for approval. (6) Details of cable trench: - Trench depth = 600 mm minimum. - Trench width = 200 mm minimum. - Bottom layer shall be sand of IS: 383 with 100mm thick. - HDPE conduit shall be laid over the sand layer. - Another layer of sand of 100 mm thick. - Then, a single layer of class-2 brick (burnt clay type) of 75 mm thickness shall be laid. - Trench shall, then, be filled with refill soil and compacted. (7) Vendor to procure necessary quantity of HDPE pipes based on the actual requirement and ensure no shortfall in supply during the time of installation.	
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	

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	strings shall be terminated at the input side of SMBs. Vendor scope includes removal of sleeve at the cable end, routing of cable through glands fitted to SMBs, crimping with suitable copper cable lug & termination in SMB. Supply of copper lugs for 6-sqmm cable shall be in vendor's BHEL scope of supply. Make: Dowell's / 3D / 3M or any other reputed equivalent as shall be approved by BHEL. Termination arrangement in SMB in through terminal blocks. Qty required ~ 3500 Nos + 200 Nos as spare. (2) All necessary tools such as pliers, strippers, crimping tool etc shall be within vendor scope.	
5.11	Connecting the 300 sq-mm cables on output side of SMBs (1) Cables of 1Cx 300 sq-mm (Aluminium, armoured, XLPE insulation, PVC sheathed) cables of positive and negative polarities shall be terminated at the output side of SMBs. Supply of this cable is in BHEL scope. (2) Overall diameter of cable ~ 30mm. (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) Cable lug shall be in vendor BHEL scope of supply. Lug shall be bimetallic (Cu and Al) of appropriate duty and size. Make: Dowell's / 3D / 3M or any other reputed equivalent as shall be approved by BHEL. Quantity required ~ 144 Nos + 16 Nos extra as spare. (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 inverter room: (1) 1Cx 300 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 the respective inverter rooms. (2) Overall diameter of cable ~ 30 mm. (3) These cables shall be laid underground from the point near SMB to inverter room. (4) Two cables (+, -) from each of the 72 SMBs have to be routed to respective inverter rooms. (5) Tentative Array layout with location of SMBs and inverter rooms 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. (6) 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. (7) Vendor shall construct the underground trench as follows: - Trench depth = 750 mm minimum. - Trench width shall vary en route to inverter 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. - Sand as per IS: 383 of 100 mm layer thickness shall be laid at the bottom most level of trench. - Over the sand layer, cables shall be laid one adjacent to the other. Cables	

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	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, battery banks, FCBC battery charger panels, SCADA panels, ACDB, IRDB, and security room distribution panels located inside control room, inverter room and security 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: - PCU panels: 8 sets (each ~2500 Kg) 110V DC Battery banks: 2 sets - FCBC battery charger panels: 2 Nos - ACDB panel: 1 No - IRDB panel: 1 No - SCADA panels: 2 Nos (~500 Kg each). - Control desk with PCs and accessories: 1 set. (2) Panels shall be placed over the cable trenches in control room or inverter 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 and inverter room for laying DC, AC & signal cables over the trays. Vendor shall supply cable trays as follows: - Ladder type GI cable trays - Hot dip galvanized - Depth = 40 mm min. - Width = 600 mm min. (5) Vendor shall fix the cable trays on the projecting steel sections in cable trench of control room and inverter rooms. 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) For DC input cables of PCU, cable support structure within inverter room (close to the entry holes) shall be provided to avoid sagging strain on the cables. Supports shall be made using suitable ISA MS angles (75x6 minimum) suitably painted with red oxide and BHEL approved black paint. BHEL approval shall be	

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	taken for the support arrangement. (9) Similarly, cable ladders shall be provided for AC output cables of PCU to avoid sagging strain, near all the exit points, through which the cables approach transformers placed at the switchyard. Cable ladders shall be made of MS, painted using red oxide and black paint. Drawing of ladder arrangement shall be submitted to BHEL for approval. (10) Cables from AC side of PCU shall be laid over ladder type cable trays up to LV side of 2700 KVA inverter transformer. (11) 1Cx300 sq-mm cables are routed from inverter room to transformers in switchyard on cable trays through an opening in the walls of inverter room. These openings shall be closed using a suitable sheet made of steel / aluminum / fiber etc. to arrest entry of rodents. These cable support structures at the entry and exit are to ensure that cable enters the control room/inverter rooms at an elevated level than the ground level. This will be useful to avoid any sort of water ingress into the cable trench in the control room/inverter rooms.	
5.14	Power cable terminations on DC side of PCUs in inverter room (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 – unsleeving, crimping and connecting. (2) BHEL shall supply the cables (1CX300 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 BHEL. (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 6 runs of 1Cx300mm² Aluminum, armored, XLPE insulated cable per phase. BHEL will supply the required cable. (2) For cable terminations at PCUs, BHEL shall supply the cable glands, cable lugs, bolts, nuts, plain washers and spring washers. (3) For cable terminations at transformer end, vendor shall supply the required number of cable glands, cable lugs, bolts, nuts, plain washers, spring washers. Bimetallic lugs (Al-Cu) shall be supplied. Bolts, nuts, plain washers shall be of SS304 type. Spring washers shall be zinc plated steel. All these shall be of Dowell's / 3D / 3M or reputed equivalent as approved by BHEL. 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. Quantity required ~ 144 Nos + 16 Nos extra as spare. (4) Vendor shall make the measurements between the equipment, cut the cables to the required lengths, fix them with glands, unsleeve them at the ends, crimp them with the lugs and terminate them at the respective bus bar provisions within the panels. (5) There are 8 PCUs of 1250KW, and 4 Transformers of 2700KVA rating. (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 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	

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	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 =8 sets. (9) Supply of cable trays (ladder type and perforated type) is in the scope of vendor.	
5.16	Foundation pedestals and outdoor installation of 2700kVA, 33KV /xxx-xxxV transformers supplied by BHEL (1) Number of transformers = 4 Nos. Transformers are located one each on either side of inverter room and control rooms. (2) Vendor shall construct RCC foundation for each set of transformer. Design of foundation shall be prepared by the vendor considering soil report that shall be provided by BHEL. Following are the minimum requirements for foundations: (a) Weight of each transformer ~ 8000 Kgs (b) Size of foundation ~ 2500 x 2500 mm (L x B). (c) Foundation below ground level shall include PCC 1:3:6 layer (~200 mm) and if required based on site conditions, sand and boulder layers also shall be required to strengthen the foundation, in which case overall foundation depth shall be ~ 600mm below ground. (d) Foundation pedestal height above the ground level ~ 500 mm that includes M25 concrete with steel rods of 8mm minimum diameter for skin reinforcement all around with inside steel chairs etc. (e) Hardware arrangements (steel bolts, plates, nuts, washers etc), which will be part of foundation pedestal for anchoring the transformer, shall be provided as per BHEL drawing. (f) Pedestal shall be provided with cement plastering all around to achieve a smooth finish and painted with two coats of approved brand and colour water proofing cement paint. Second coat of painting shall be carried out after installation of transformer. (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 etc. (c) Connections to marshalling box (5) Vendor shall submit drawing of transformer foundation to BHEL for approval.	
5.17	Installation of equipment in outdoor Switchyards at Control Room and Inverter Room Output from inverter transformer is connected to outdoor type Porcelain Clad Vacuum Circuit Breaker (PCVCB) as shown in the typical switchyard layout enclosed. Outdoor switchyard at control room and inverter rooms shall consist of the following items apart from inverter transformers.	

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	1. 33KV Outdoor PCVCB with CT, PT and structure (7 sets) 2. Outdoor Control and Relay panels for each VCB (7 Nos) 3. 33 KV Outdoor LA (27 Nos) 4. 33KV Outdoor metering CT (3 Nos) 5. 33KV Outdoor metering PT (3 Nos) 6. Outdoor ABT metering panel with main and check ABT meters (1 No) 7. 4-pole, 6-pole and 2-pole structures using PSC poles (As required) 8. 33KV GOS (Isolators) mounted on 4-pole, 6-pole and 2-pole structures (9 Sets) 9. ACSR COYOTE conductor, pin/disc insulators and hardware as required. Supply of PCVCBs and associated CTs, PTs, C&R panels along with their mounting structures is in the scope of BHEL. However, Erection of these BHEL supplied items including associated civil works shall be in vendor's scope. Supply and installation of all other items is in the scope of vendor. Vendor shall supply and install 33KV Outdoor metering CTs, metering PTs and metering panel with ABT meters (main & check) at switchyard near control room as per KPTCL/KPCL/CEIG requirements. Further, vendor shall also supply 33KV Outdoor metering CTs, metering PTs and metering panel/s with ABT meters (main, check & standby) as per KPTCL/KPCL/CEIG requirements which will be installed by BHEL/KPCL at evacuation substation. Separate CTs and PTs shall be provided as per KPTCL/KPCL/CEIG regulations for standby meter as per plant SLD attached. Vendor shall construct RCC foundations for all the outdoor switchyard equipment as per KPTCL standards. Design of foundation shall be prepared and submitted for approval by the vendor considering soil report that shall be provided by BHEL. For Control and Relay panels, vendor shall construct covered sheds with Galvalum sheets including foundation within switchyards one each at control room and inverter rooms. Clearances shall be provided around the C&R panels for maintenance and as per CEIG regulations. Flooring shall be cement concrete IPS flooring. Light and exhaust fan shall be provided in the sheds. Typical drawing enclosed. Vendor shall submit general arrangement and detailed drawings with bill of materials/quantities of the six pole/four pole/two pole structure set as per relevant CEIG/KPTCL standards, with individual item description, quantity, make, specs / ratings etc for BHEL approval. Vendor shall submit GTPs and GA drawings of all the items in vendor's scope of supply such as LA, CT, PT, ABT meters, metering panels, ACSR (COYOTE conductor), GOS, insulators, PSC poles etc. Note: All MS parts of 4-pole/6-pole/2-pole structure shall be suitably painted using red oxide and BHEL approved silver colour paint. Spares to be supplied: (1) 33KV Isolator- 1 set (2) 33KV metering CT- 3 Nos (3) 33KV metering PT – 3 Nos (4) 33KV LA – 3 Nos	
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Detailed specifications for 33KV switchyard equipment is as below:

A) Specification for 33KV Isolators:

TYPE AND RATING

Isolating switches are used to isolate the equipment. The Isolators shall be suitable for outdoor operation.

STANDARDS

The isolator switches shall comply in all respects with IS:9921 or IEC publication No.129 latest edition.

ISOLATOR PARAMETERS:

- a) Rated Voltage : 36 kV
- b) Nominal system Voltage : 33 kV
- c) Type of installation : Outdoor
- d) Rated normal current : $\geq 400A$
- e) Rated short-circuit making current for earth switch : 25 kA
- f) Operation:
 - i) Isolator : Manual - Gang operated
 - ii) Earth Switch : Manual - Gang operated
- g) Rated short time current:
 - i) 1 sec. KA rms : As per relevant IS
 - ii) Peak withstand KA : As per relevant IS
 - iii) Temperature rise : Maximum Temp. rise not exceeding 40 deg.C over an ambient Temperature of 50 deg.C
- h) No. of poles : Three
- i) Operation Main switch : Horizontal break
- j) No. of breaks per circuit per pole:
 - Main Switch : Two
- k) Insulation level : As per IS 9921
- l) Minimum creepage distance : As per IS 9921

CONSTRUCTIONAL FEATURES OF HORIZONTAL DOUBLE BREAK TYPE

The Horizontal double break type, three phase isolators shall be centre pole rotating, manual gang operated mechanism. The design of the isolators shall be such that the switch can be changed to right or left hand operations. The live parts shall be designed to eliminate sharp points, and other surfaces likely to produce corona and adequate shield shall be provided. Live parts shall be manufactured from non-rusting, non-corroding metal. Current carrying parts shall be of hard drawn electrolytic grade copper. Bolts, screws and pins shall be provided with lock washers, keys or other equipment locking facilities and if used on current carrying parts, shall be made of copper silicon alloy or equivalent material. The isolator shall not require lubrication of any part at frequent intervals.

The isolators shall be suitable for being mounted in upright positions (with blades

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	moving in the horizontal plane) on the steel support structures and also suitable for mounting on the high type structures in the outdoor yard. The double break isolator shall consist of three identical pole units. Isolators are required to be double break, three posts per phase, triple pole, single throw, rotating center post through double tandem pipe, silver plated contacts, with horizontally operating blade and insulator posts arranged vertically. The manual operating mechanisms shall be of robust construction, conveniently located for operation and easily operatable by a single person. The length of the operating rod shall be such that the height of the manual operating handle above the ground is atleast 600 mm. The isolator shall be so constructed that the switch blades will not fall to the closed position, if the operating shaft gets disconnected. The moving blades of double break isolator shall be HDEC (hard drawn electrolytic copper) tube of suitable thickness or one solid copper piece with contact surface silver plated to carry continuous/short time current. Construction shall be so designed that no part of the blade can move relative to the other parts. The thickness and section of the blade shall be such that it retains its form and straightness under all conditions of operation including the flow of system fault current for the specified period. It shall also be capable of withstanding all torsional and bending stress due to operation of the isolators. Wherever necessary the blades shall be counter balanced by weights or springs. Fixed guides shall be provided so that proper seating of contacts will be achieved while closing even when a blade is out of alignment by 3 cm or less. Further the main blade shall pass through the main actuator assembly without any joints so that there is no necessity of shunting by flexible copper conductors. The design and construction shall be such as to provide positive control of blades in all positions with minimum mechanical stress on insulators. Fixed guides shall be provided so that proper seating of contacts shall be obtained. CLEARANCES Clearances between live parts and grounded structures shall not be less than those specified in the latest edition of IS. Length of break in full open position shall be such that there is absolutely no possibility of arc over from the live parts to the de-energized parts on which any maintenance works may have to be done. The necessary arcing contacts shall be provided on the moving blades. ISOLATOR INSULATION Insulation to ground, insulation between open contacts and the insulation between phases of the completely assembled isolator shall be capable of withstanding the dielectric test voltages specified in the data sheets enclosed. Insulation between open contacts of a pole shall be atleast be 15% more than the insulation between live parts of a pole to ground so that if any flash over occurs when isolator is open, it shall be to the ground. The insulators should be of solid core of multiple stack, shall conform to IS:2544 or other internationally recognized standards. The insulators selected shall be for use in heavily polluted atmosphere and shall be specifically suited to meet the particular requirements of ultimate torsional strength and cantilever loads, which they will be called upon.	
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	The porcelain shall be homogenous and free from all cavities and flaws. Design of the insulators shall ensure ample insulation, mechanical strength and rigidity for satisfactory operation under site conditions. The design, shall also ensure that the losses caused by capacitive currents or conduction through dielectric are minimum and that the leakage due to moist and dirty insulators surface is least. All metal caps and supports shall be connected to the porcelain whereas the blades and contact blocks shall be bolted to the metal parts of insulator thus making the replacement of damaged insulator easy. OPERATING MECHANISM The design of operating mechanism shall be such that minimum of energy is required for operation and one man shall be able to operate the switch without undue effort. The operating mechanism and its controls shall be so designed that under no circumstances the switch blade travel is interrupted before it reaches the fully close or open position Two Nos. of earthing terminals shall be provided on the operating mechanism, to enable proper grounding. Flexible conductors of adequate cross section shall be provided at the lower end of the vertical operating shaft for connection to the station ground. INSULATION LEVEL The isolators shall have minimum insulation levels as per IS:9921 and IEC publication No. 129. CONTACTS The isolator shall be provided with high pressure self-aligning adjustable silver plated copper contacts. The contacts shall be designed such that the contact pressure is released before any movement of the blades in the opening direction takes place and is applied after the closing travel is completed. The blades shall have a turn and twist movement in case of double break isolators so that there shall be sufficient wiping action of the contacts to make them self-cleaning. The earth switches should be provided with three sets of suitable type of fixed contacts below the fixed contacts assemblies of the main switch on the incoming supply side and three sets of moving contacts having ganged operation. These contacts shall be fabricated out of electrolytic copper and dimensioned to withstand the rated currents. The temperature rise of the contacts and other current carrying parts shall not exceed value specified in IS:9921 at an ambient air temperature of 40 Deg. C while carrying the rated current continuously. The temperature rise due to the passage of the rated short circuit current for a period of 1 sec. shall not cause any annealing or welding of the contacts. ARCING CONTACTS : Arcing contacts provided shall close first and open last so that no damage due to arcing shall be caused to the main contacts. TERMINAL CONNECTORS Each isolator shall be provided with rigid type aluminum/bimetallic alloy connectors suitable for ACSR COYOTE conductor. The terminal connectors shall be	
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	suitable for horizontal or vertical takeoff. The required quantity of terminal connectors shall be supplied. ISOLATOR BLADES AND JAWS: The isolator blades shall be HDEC (hard drawn electrolytic copper) tube of suitable thickness or one solid copper piece with contact surface silver plated. Construction shall be so designed that no part of the blade can move relative to the other parts. The thickness and section of the blade shall be such that it retains its form and straightness under all conditions of operation including the flow of system fault current for the specified period. It shall also be capable of withstanding all torsional and bending stress due to operation of the isolators. Wherever necessary the blades shall be counter balanced by weights or springs. Fixed guides shall be provided so that proper seating of contacts will be achieved while closing even when a blade is out of alignment by 3 cm or less. The isolators to be supplied against this contract shall be employed with turn and twist motion and shall have no problem with the contact alignment. Further the main blade shall pass through the main actuator assembly without any joints so that there is no necessity of shunting by flexible copper conductors. The sharp edges in the fixed contact terminal casting and bolt heads have to be rounded off to minimize the corona discharges. The ends of the blade arm pipes shall be suitably plugged by metal or nylon plugs to prevent entry of water or insects and corona discs shall be provided where ever necessary. SUPPORT STRUCTURES The required quantity of Concrete Poles for mounting the isolator on the ground shall be supplied for mounting the isolators in upright positions. The live terminals of the equipment shall be min 3700 mm from the ground level. The concrete poles shall in general conform to the latest issue of IS. DESIGN, MATERIALS & WORKMANSHIP The vendor shall assume full responsibility for co-ordination and adequate design. All materials used in the construction of the equipment shall be of the appropriate class, well finished and of approved design and make. All similar parts should be accurately finished and interchangeable. All ferrous parts shall be hot dip galvanized. Bolts, nuts, pins and washers etc., used on the isolators shall also be galvanized. Special attention shall be paid to give tropical treatment to all the equipment as they will be subjected during service to extremely severe exposure to atmospheric moisture and to long period of high ambient temperature. All current carrying parts shall be of non-ferrous metal or alloys and shall be designed to limit sharp points, edges and similar sharp faces. FASTENERS Nuts, bolts, studs and washers for use in the plant shall conform to the requirements of the appropriate standards, where the contract includes nuts and bolts of different standards; the necessary tools shall be provided in compliance with this specification and shall include spanners, taps and dies for these nuts and bolts. TESTS Each isolator and earth switch shall strictly comply with the requirements of all the	
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approved type tests and shall be subjected to all routine/acceptance tests stipulated in the relevant standard.

B) Specification for 33KV Current Transformers:

TYPE AND RATING

The 36 kV Current transformers shall be Outdoor, Dead tank type, Copper wound, single phase, 50 Hz, oil immersed, self-cooled and suitable for operation under site climatic conditions without any protection from sun and rain.

STANDARDS

The Current transformers shall comply with the latest issue of IS 2705 (Part I,II,III and IV) or IEC 185 except where specified otherwise. Equipment meeting any other authoritative standard, which ensures an equal or better quality than the standard mentioned above, is also acceptable.

The Current transformers shall have the following ratings.

- | | |
|---|---------------|
| a) Rated /Nominal System voltages | : 36KV / 33kV |
| b) One minute power frequency | : 70 kV rms. |
| c) 1.2/50 micro second impulse | : 170 kV Peak |
| d) Creepage distance for
Equipment (Min.) | : As per IS |
| e) No. of phases | : 3 |
| f) Frequency | : 50 Hz |
| g) Short-circuit current (withstand for 1 sec.) | : 25 kA |

NOTE: The current ratio, No. Of cores, burden and knee point voltage and other parameters shall be decided during detailed engineering stage. Please ensure 0.2s accuracy class for ABT metering core.

GENERAL

The Current transformers shall be of single phase, oil immersed and self-cooled, suitable for the services indicated, complete in all respects, conforming to the modern practice of design and manufacture.

The core shall be of high grade, non-ageing, electrical grade silicon laminated steel of low hysteresis loss and high permeability to ensure high accuracy at both normal and over currents and voltages.

The current transformers shall be sealed to eliminate breathing and prevent air and moisture from entering the tank. These shall be provided with oil level gauge and a pressure relieving device capable of releasing abnormal internal pressure. The temperature rise shall be as specified in the latest IS 2705.

Secondary terminals of current transformers shall be brought out in a weatherproof terminal box. Glands and lugs for terminating cable connections shall be provided.

Terminal and polarity marks shall be indelibly marked on each current transformer on the associated terminals and these marks shall be in accordance with relevant standards.

The current transformers shall be provided with the following accessories.



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- a) Primary terminal connectors suitable for ACSR Coyote conductor.
- b) Two earthing terminals on tanks on opposite sides for connecting earthing conductors.
- c) Facility for lifting bushings and tank.
- d) The quantity of insulating oil required for first filling. Di electric dissipation factor of the oil shall not exceed 0.005. Insulating oil shall comply with applicable standards.
- e) Rating and diagram plate as per relevant standards.

Current transformers shall be given tropicalized treatment for satisfactory operation in hot and humid condition.

The temperature rise shall not exceed the figures given in applicable standards for operation under ambient temperature conditions.

The tanks/bases and all exposed ferrous parts shall be hot dip galvanized and painted conforming to applicable standards.

In the case of multi-core CTs, it shall be possible to adjust the tap settings on any core independent of the setting on the other cores, for which purpose these tapings will have to be provided on the secondary windings.

In case of multi ratio current transformers, the minimum specified requirements in respect of VA, accuracy, knee point voltage and maximum secondary resistance shall be met at all taps.

Magnetizing characteristics (extending well beyond knee point voltage) and secondary impedance values shall be furnished for all protection cores.

INSULATORS/BUSHINGS

Insulators / bushings shall conform to applicable standards and shall be made of homogeneous vitreous porcelain, the glazing of which shall be of uniform brown or dark brown in colour.

Oil filled insulators/bushings shall be hermetically sealed to prevent ingress of moisture. Metallic bellows/Nitrogen gas shall be used for cushioning and to allow for expansion.

TESTS :

The following routine tests shall be carried out on all the current transformers in the presence of the purchaser's representative as per the relevant latest IS and 6 sets of test certificates shall be furnished for approval before dispatch. No equipment shall be dispatched before the approval of test certificates and dispatch instructions are conveyed by the purchaser.

- a) Verification of terminal markings and polarity.
- b) Power frequency voltage with stand test on primary windings.
- c) Power frequency voltage with stand test on secondary windings.
- d) Over voltage inter turn test.
- e) Determination of errors according to the requirements of the appropriate accuracy class.
- f) Partial discharge tests

The following type tests shall be carried out on one of the current transformers. If

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the manufacturer has already carried out type test on similar (33KV class) equipment, a copy of the same shall be furnished for purchaser's reference. If type test is not carried out, the same shall be conducted free of cost and test certificates furnished for purchaser's approval.

- a) High voltage power frequency test on primary windings.
- b) High voltage power frequency test on secondary windings.
- c) Determination of errors according to the requirements of the appropriate accuracy class.
- d) Short time current test.
- e) Temperature rise test.
- f) Impulse voltage test.

A copy of the type test certificate for the following type tests carried out on one of the bushings shall be furnished for purchaser's reference.

- a) Power frequency visible discharge test.
- b) One minute power frequency withstand test.
- c) Full wave impulse voltage withstand test.
- d) Under oil flash over or puncture withstand test.

C) Specification for Potential Transformer

The Potential transformers shall have the following ratings.

- a) Rated /Nominal System voltages : 36 / 33kV.
- b) Rated primary voltage: : $33/\sqrt{3}$
- c) Rated secondary voltage : $110 \text{ v} / \sqrt{3}$
- d) One minute power frequency : 70 kV rms
- e) 1.2/50 micro second impulse : 170 kV Peak
- f) With stand voltage for secondary : 2 kV rms
- g) Creepage distance for Equipment (Min.) : As per IS 3156
- h) No. of phases : 3
- i) Frequency : 50 Hz
- j) Short-circuit current (withstand for 1 sec.) : 25 kA

NOTE: The core details, accuracy, burden and other details shall be decided during detailed engineering stage. Please ensure 0.2 accuracy class for ABT metering core.

Potential transformer, design, Temperature rise and testing etc. should be in accordance with IEC: 186

The PTs should be single phase, oil immersed, self-cooled type suitable for outdoor installation of 33 kV class required. The core should be of high grade non ageing electrical silicon laminated steel of high permeability. The PTs should be hermetically sealed to eliminate breathing and prevent air and moisture entering the tank. Oil level and pressure releasing device etc. should be provided.

Temperature Rise

The maximum temperature of the windings, cores etc. should not exceed 45°C over ambient, while max. Temperature of oil at top should not exceed 35°C over ambient. The PTs should be suitable for mounting on steel structures. All nuts, bolts, flanges and base should be hot dip galvanized. The terminal connectors

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	should be such as to give intimate contact between conductor & terminal and offer protection against and effects of electrolytic and atmospheric corrosion and should also have sufficient mechanical strength. The connectors should conform IS 5556: 1970. TERMINAL BOX: The materials used for the terminal boxes shall possess excellent mechanical and electrical properties. The terminal blocks shall be rigid and shall withstand handling while making repeated terminations. The terminal blocks shall be of stud type (Bolt and nut type) and shall be suitable for 6 sq. mm cable of reputed make. Each unit shall be complete with copper terminal studs, nuts and washers together with label carriers, with blank label strips and suitable cable lugs. The terminal block shall be mounted on galvanized rolled steel strip of sufficient length and size which acts as a support bar for fixing on hylem sheet of 10 mm thick brass studs. Each terminal block shall be suitably numbered. Spare terminals shall also be provided for future use. Then terminal studs, nuts, washers and links shall be made of best quality copper and shall be suitable for copper conductor of size 6 sq. mm. Sufficient quantity of suitable size cable lugs for copper conductor of size 6 sq. mm shall be supplied. All terminal blocks shall be designed for voltage rating of 1100 volts and continuous current rating of 25 A, AC or DC. The terminals shall be of good mechanical construction providing adequate electrical contact for the appropriate size of the copper cable used. Terminal connectors shall be such that the conductors may be connected by screw or other equivalent means to maintain the necessary contact pressure permanently. Terminals shall not run or be displaced when the connecting screws are tightened and the conductor shall not become displaced. Terminals shall be so mounted that the appropriate wire or cable may be connected without impairing the normal performance of the unit. No contact pressure shall be transmitted through insulating material and the gripping of the conductor shall take place between metal faces. EARTHING TERMINAL : Two numbers of 12 mm diameter brass bolts and nuts with spring washers for each box shall be provided by the side of the body of the terminal box for fixing copper /GI 50X 6 mm flat. The earthing terminal shall be identified by means of the sign marked, in a legible and indelible manner on or adjacent to the terminal. TESTS : Routine tests shall be carried out on PTs as per relevant standards and type test reports shall be submitted for a similar (33KV class) PTs. D) Specification for 30KV Lightning Arresters: TYPE AND SYSTEM DATA: The lightning arresters shall be of 30 KV, gapless metal oxide and suitable for outdoor operation under system and climatic conditions as specified in the tender	
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specifications without protection from sun and rain. STANDARDS: The lightning arresters and associated accessories shall conform to the requirement of the latest IS: 3070 (part-I), IEC:99-4 for the gapless metal oxide lightning arresters. PARAMETERS: <table border="0"> <tr> <td>a) Type</td><td>: Gapless metal oxide, Outdoor type</td></tr> <tr> <td>b) Rated Voltage of Arrestor</td><td>: 30 kV</td></tr> <tr> <td>c) Nominal system voltage</td><td>: 33 kV</td></tr> <tr> <td>d) Nominal discharge current (8/20 micro sec. impulse)</td><td>: 10 KAp</td></tr> <tr> <td>e) Maximum residual voltage at lightning impulse of 8/20 micro sec wave</td><td>: As per IS 3070</td></tr> <tr> <td>g) Maximum continuous operating voltage</td><td>: As per IS 3070</td></tr> <tr> <td>h) Line discharge class</td><td>: 3</td></tr> <tr> <td>i) Single impulse energy capability</td><td>: As per IS 3070</td></tr> <tr> <td>j) High current short duration test value</td><td>: As per IS 3070</td></tr> <tr> <td>k) Pressure relief device</td><td>: Class A</td></tr> </table> DEFINITIONS: For the purpose of this specification, all technical terms used herein shall have the meaning as defined in IS: 3070(part-I), IEC:99-4 for gap less zinc oxide lightning arresters with latest revision thereof, if any. CONSTRUCTIONAL FEATURES The arresters shall be of modern design consisting of hermetically sealed units incorporating non-linear resistors (metal oxide) stacked vertically. The arresters shall be designed to have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. The arresters shall be suitable for mounting on outdoor structures. Supporting structures, terminal connectors, grading ring and other components shall form part of the arresters. All metal parts shall be of non- rusting and non-corroding metal. Bolts, screws and pins shall be provided with lock washers, keys or equivalent locking facilities. All similar parts, particularly removable ones shall be interchangeable. Self contained discharge counter, requiring no auxiliary battery supply shall be provided for each single pole unit. The terminals shall be robust and shall be located such that incoming and outgoing connections could be made with minimum possible bends. Suitably sized by pass shunts of copper to facilitate by passing the discharge counter shall be designed and supplied. The design of the terminal connectors shall permit the connection of these units. A leakage current detector as an integral part of the discharge counter shall be provided. The value of the leakage current beyond which the operation is prohibitive shall be clearly indicated in red colour on the detector. The arresters shall be provided with pressure relief diaphragm at both ends.	a) Type	: Gapless metal oxide, Outdoor type	b) Rated Voltage of Arrestor	: 30 kV	c) Nominal system voltage	: 33 kV	d) Nominal discharge current (8/20 micro sec. impulse)	: 10 KAp	e) Maximum residual voltage at lightning impulse of 8/20 micro sec wave	: As per IS 3070	g) Maximum continuous operating voltage	: As per IS 3070	h) Line discharge class	: 3	i) Single impulse energy capability	: As per IS 3070	j) High current short duration test value	: As per IS 3070	k) Pressure relief device	: Class A	
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Corona rings wherever used shall be of non- magnetic materials.

Lightning arresters shall be gapless metal oxide hermetically sealed type, of self-supporting construction and base mounted suitable for mounting on steel structures. They shall have adequate thermal discharge capacity for various types of surges. The lightning arresters shall be capable of withstanding the internal pressures developed during discharges without operation of the pressure relief devices or should safely vent the internal pressures associated with arrester failure without shattering.

Insulator housing shall be porcelain having adequate mechanical strength and integrity. Arrester housing shall withstand short circuit, wind, seismic and other forces during operation.

Arresters shall incorporate anti contamination feature to prevent arrester failure consequent to uneven voltage gradient across the stack in the event of contamination of the porcelain. The arrester shall be protected against the ingress of moisture.

Surge counter should be supplied with the insulating bases for connection. No radio interference shall be caused by the arresters operating at the normal rated voltages.

RECTANGULAR WAVE SHAPE CURRENT

The arrester shall withstand surges of low magnitude rectangular wave shape currents of long duration arising from switching surges or accumulation of static charges from atmosphere.

INSULATING CASING:

The insulating casing shall conform to IEEE No.-A C-76-1-64 with latest amendments. Insulating casing shall be made of wet process, nonporous electrical porcelain, free from imperfection and moisture absorption, vitrified and finished with brown glaze and designed to keep the insulator surface from contamination by natural action of wind and rain. The leakage distance along with external surface shall be large to ensure that the surface contamination likely to deposit in the specified weather conditions shall minimize radio interference.

The complete bushing insulator casing per pole of the arrester shall withstand the following insulator insulation tests:

Insulation class of bushing	: 33 kV
Power frequency withstand	
1 Min. dry	: 70 kV rms.
1 Min. wet	: 70 kV rms.
Lightning impulse voltage withstand	: 170 kV peak

NOTE: The insulator of each unit arrester of which the pole arrester is stacked shall withstand pro rata voltage specified above in proportion with the ratio of the number of elements housed in the unit arrester to the total number of them in each pole arresters.

TYPE OF MOUNTING

Lightning arresters shall be suitable for mounting on steel/concrete support structures/poles to be supplied. The necessary flanges, foundation bolts or clamp, nuts washers etc., for the base of arresters shall be supplied and these shall be hot dip galvanized. Insulating bases required for mounting of the arresters with attachment of surge counters shall be supplied.

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	SUPPORT STRUCTURES / CONCRETE POLES The vendor shall supply along with the LAs all the support structures/ concrete poles and foundation bolts, nuts and washers required. The minimum clearance of live terminal of the equipment to ground shall be 3700 mm. The galvanized steel support structures / concrete poles shall in general conform to the latest edition of IS. FITTINGS AND ACCESSORIES: Arresters shall be complete with insulating base for connection of discharge counter and provision for bolting to the supporting structure (pedestal) Self contained discharge counter, suitably enclosed for outdoor use weather and waterproof and requiring no external supply shall be provided for each 30 kV arrester. The discharge counter shall have a glass window. Suitably sized links of copper to facilitate bypassing of discharge counter shall be provided. The terminal connectors shall have provision for connection of these links. The conductor between lightning arrester earth terminal to the discharge counter terminal shall be insulated for a minimum of 4 kV and required length of insulated conductor shall be supplied along with the arrester. It shall not require sealing ends or plumbed joints at their ends for terminations. Arresters shall be supplied with clamps/connectors on line terminal, earth terminal and the discharge counter terminals along with galvanized steel support structures/concrete poles with bolts, nuts etc., including foundation requirements. Suitable bimetallic type connectors, if any, to receive ACSR Coyote conductor shall be provided and shall be suitable for both horizontal and vertical connections. TESTS The manufacturer shall submit a copy of the type test certificate for the similar type of arresters for the purchaser's reference. If the type test are not conducted, the same shall be conducted free of cost and test reports furnished for the approval of purchaser. The lightning arrester shall comply with the tests prescribed in IS & IEC specifications. The manufacturer shall conduct the following tests on all lightning arrester at their works, in the presence of purchaser's representative, if so desired by the purchaser, as per the latest edition of IS & IEC specifications: Routine tests: All routine tests shall be conducted on the arrestors by the supplier and test certificates furnished. The following Acceptance tests on complete lightning arrester shall be conducted: - Measurement of power frequency reference voltage. - Measurement of lightning impulse residual voltage. - Measurement of partial discharge. - Visual and dimensional checks. - Test on discharge counter. - Switching surge, residual voltage tests. E) Specification for Switchyard structures:	
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	Support structure suitable for 33 KV switchyard equipment shall be fabricated from structural steel confirming to IS 2062(latest). GOS isolators shall be mounted on 2-Pole/4-Pole/6-Pole structures by employing Pre-stressed concrete poles. Adequate height of all the structures must be provided to maintain proper clearances. Additional structures called stools shall be provided between the equipment and its support structures to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the support structures. All fabrication drawings of structures shall be furnished to BHEL for Prior Approval. The scope shall include all types of bolts, nuts, shackles, clamps, step bolts, inserts in concretes, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, angles and bolts. The connection of all structures to their foundations shall be by base plates and embedded anchor/ foundation bolts. All steel structures and anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be as per the standard for anchor/ foundation bolts and for structural members. One additional nut shall be provided below the base plate, which may be used for purpose for leveling. The fabrication drawings to be prepared and furnished by the vendor shall indicate complete details of fabrication splicing details, lacing details, weld sizes and lengths. The fabrication work shall start only after the owner accords final approval to the fabrication drawings. Fabrication of Steel The fabrication and erection works shall be carried out generally in accordance with IS:802 (latest). A reference however may be made to IS:800 (latest) in case of non-stipulation of some particular provision in IS 802 (latest). All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field. ASSEMBLY The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified member, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (Bolts & welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered, drifts shall be used to align the part so that the bolts can be accurately positioned. BOLTING Every bolt shall be provided with a spring washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together. All steels, bolts, nuts and washers shall be hot dip galvanized. 2% extra nuts and bolts shall be supplied for erection. Welding	
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The works shall be done as per approved fabrication drawing which clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld. Symbols for welding on erection and shop drawings shall be according to IS 813. Efforts shall be made to reduce site welding so as to avoid improper welding due to construction difficulties.

Foundation Bolts

Foundation Bolts for equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The vendor shall ensure the proper alignment of these bolts to match the holes in the base plate.

The vendor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.

All foundation bolts for lattice structure, pipes structure are to be supplied by the vendor.

All foundation bolts shall be fully galvanized so as to achieve 80 microns. of Zinc coating as per IS-4759.

Stability of structure

The supplier shall be responsible for the stability of the structure at all the stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

Grouting

The method of grouting the structure column bases shall be subject to approval of owner and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base.

Galvanizing

All structural steel works and single pipe supports shall be galvanized after fabrication as per IS 2629(Latest). Zinc required for galvanizing shall have to be arranged by the manufacturer. Purity of zinc to be used shall be 99.5% as per IS:209 (Latest revision).

F) Specification for ABT meters:

Two numbers of three phase 4 wire energy meters as main & check shall be ABT compliant along with necessary test terminal boards (TTB's) to facilitate CT & PT connections shall be supplied at solar plant end to measure the energy transmitted via the 33 kV line.

Three numbers of three phase 4 wire energy meters as main, check and standby along with necessary test terminal boards (TTB's) to facilitate CT & PT connections shall be supplied at 33KV grid substation end to measure the energy.

The energy meters supplied shall be of microprocessor based trivector meter. The energy meter shall measure, record and display energy related parameters like MW, MVA, MVAR, MWH (Import), MWH (Export), MVARH (while active import) and MVARH (while active export) and Reactive MVARh net for voltage low condition & maximum demand of active import & Active export, reactive lag while active import, apparent while active import & Apparent while active export. In addition,

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	instantaneous phase parameters like voltage, current and power factor are also to be recorded. The accuracy class of energy meter shall be 0.2s. The energy meter shall be suitable for the measurement of alternating current electrical energy of frequency in the range of 47.5 Hz to 52.5 HZ (Nominal frequency 50 Hz) for three phase, 110V System. The limits of errors shall be as per IS 14697. The meter shall be suitable for balanced or unbalanced loads and work at all power factors. The CT and PT ratios shall be programmable. It shall be possible to couple this device to meter testing equipment. Voltage healthiness in all the phases shall be provided suitably on the meter display in the form of phase blinkers. Meters shall have a distinct code which shall be marked permanently on its front, as well as in its memory. The meter shall have an alpha numeric LCD display of minimum 7 digits. The meter shall be capable of storing 15 minutes data (load survey data) for at least 35 days. G) Specification for ACSR conductor: ACSR Coyote conductor for bus bar and intra equipment connection shall be supplied. CODES AND STANDARDS The conductors shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this order shall be constructed to relieve the Vendor of this responsibility. The conductors shall conform to latest relevant specified in the enclosed. In case of conflict between the standards and this offer, this Specification shall govern. MATERIAL Aluminum strands of ACSR conductor shall be hard drawn from 99.5% pure electrolytic Aluminum rods with 60 % TACC conductivity. The vendor shall specify the guaranteed minimum and average values of conductivity. Chemical composition of the material shall comply with the requirements of relevant standards. The surface of conductor shall be clean and dry and free from any excess grease that may be used in its fabrication. The surface strands shall be smooth and free from burrs and other projections which may be cause for increasing corona losses when the conductor is used on extra high voltage lines. GALVANIZING The steel wire strands of ACSR conductor and steel conductor shall be hot dip galvanized. Zinc coating shall be evenly and uniformly coated complying with relevant standards. TESTS All tests required on the required number of samples of raw materials and finished conductor as stipulated in the relevant standards shall be carried out. PACKING Conductor shall be wound on wooden drums made of sufficiently strong wood, and conforming to relevant standards from the conductor to outer edges of the drum shall be provided prior to lagging. All drums shall be painted inside and outside with Aluminum paint. All drums shall	
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	have a layer of water-proof paper around the drum under the conductor and another layer over the conductor and under the lagging. In addition to manufacturer's standard marking on the drums, batch of manufacture shall be clearly marked on each drum. H) Specification for Insulators: The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed. Insulators shall have compression type glaze with a good luster and of uniform brown color. The glaze shall be unaffected by sudden changes in temperature and by atmospheric pollution of Ozone, acids, alkali, dust etc. Under surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical in shape without appreciable warping. Tie wire grooves of pin insulators shall be formed to provide a firm support for the conductor and permit the making of a secure tie. Insulators shall be designed to avoid excessive concentration of electrical stresses in any section or across leakage surfaces. Design features which increase radio influence level shall be avoided. Each insulator shall have the rated strength marked clearly on the metal cap before galvanizing. Each insulator shall also have symbols identifying the manufacturer, month and year of manufacture etc. All metal parts shall be made of good commercial grade malleable iron, or open hearth or electric furnace steel, hot dip galvanized conforming to relevant standards. Castings shall be free from blow holes, cracks and such other defects. Strain and suspension string shall comprise the conventional ball and socket type disc insulators. Individual insulators as well as strings of the same type shall be interchangeable with one another and it shall be possible to form either suspension or strain strings using the same discs. The locking clips shall be made of phosphor bronze and shall provide positive locking of the coupling. The design of insulators shall be such as to avoid the following - Stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. - Stress concentration due to direct engagement with metal fittings - Retention of water in the recesses of metal fittings - Shapes, which do not facilitate easy cleaning by normal methods.	
5.18	Cable trench and laying of power cables (both HT and LT cables) and OFC cables (1) Vendor shall construct underground cable trench for laying HT and LT cables in switchyard and array yards as listed below. Outline of switchyard and overall plant layout is enclosed. Trench shall be constructed: - Between the inverter transformers and 33KV outdoor CT (3 runs of 1CX300 sq-mm cables) – 4 sets (one set each for one transformer). - Between the outgoing isolator in inverter room switchyard and outdoor CT located in control room switchyard (3 runs of 1CX300 sq-mm cables) -1 set. - Between the 100kVA auxiliary transformer located in the switchyard adjacent to control room to the entry point of control room wall bordering the switchyard (3.5Cx95-mm for connecting LV side of transformer to ACDB panel in control room). - Between the outgoing feeder of control room switchyard and the GOS mounted on two pole structure at plant boundary (3 runs of 1Cx300 sq-mm). Cable termination shall be in the scope of vendor. 1.1KV, 3.5 core cables of suitable sizes between the ACDB located at control room and Inverter room DB (IRDB) located at inverter room and from ACDB to security room DB.	

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	(2) Vendor shall construct underground cable trench for laying 2 runs of OFC cables from inverter room to Control room for communication between SCADA panels. The distance between HT cable trench and OFC cable trench shall be maintained as per relevant standards. Each run of OFC cables shall be laid in separate HDPE DWC pipe of min. ID 25mm which is to be supplied by vendor. Supply and termination of OFC cable shall be in the scope of BHEL. Laying of OFC cables shall be in the scope of vendor. (3) Supply of following cables shall be within vendor scope of supply. Specification of cables is as follows: (a) LT Cable, 3.5Cx95 sq-mm, 1.1KV, Al conductor, PVC insulation, armoured, PVC sheath as per IS: 1554 (latest edition) part-1. (b) LT cable of suitable size 3.5C, 1.1KV, Al conductor, PVC insulation, armoured, PVC sheath as per IS: 1554 (latest edition) part-1 from ACDB to IRDB and ACDB to security room DB. (4) LT Power Cable shall be 1100V, grade, single / multicore, stranded aluminum conductor, XLPE, insulated with PVC inner sheath and outer sheath made on FRLS PVC compound. The armouring will be of Aluminum / galvanized steel round wire/ flat strip as per IS. (5) Vendor shall lay these cables layer wise providing adequate separation as per the relevant IS standards. Vendor shall indicate the IS standards employed. (6) Half-cut RCC hume pipes shall be provided over HT cables in switchyard. (7) Trench layout and trench drawings shall be submitted to BHEL for approval.	
5.19	Power cable terminations on AC HT side (33KV) (1) Vendor shall carry out HT power cable terminations on HV side (33KV) of 2700 kVA transformers (4 sets) and outdoor CTs/Isolators using 3 runs of 1Cx 300 sq-mm cables as indicated in SLD. Cable lugs, HT termination kits and all necessary hardware, all of which shall be within vendor scope of supply. HT termination kits shall be indoor / outdoor type suitable for 33KV, 1CX300 cable. Make: Raychem, 3M or reputed equivalent as shall be approved by BHEL. (2) Quantity of termination kits = 4 sets of indoor type for 33KV 1Cx300 sq-mm cable, 8 sets of outdoor type for 33KV 1Cx300 sq-mm cable. In addition, vendor shall supply 1 set of indoor and 2 sets of outdoor type termination kits as spare. 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) Cable lugs and hardware shall be of dowell's / 3M or reputed equivalent as shall be approved by BHEL. (4) All tools and accessories required to carry out the termination shall be within the scope of vendor. (5) 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. (6) Vendor shall provide support mechanism using clamps and GI pipes for HT cables wherever required so that the connecting terminals are not damaged due to mechanical load of cable.	
5.20	Supply and installation of FCBC, Battery banks (2 sets- one each at inverter room and control room) One double float cum boost charger and one set of battery bank (Lead acid tubular type) are to be supplied and installed at each of inverter room and control room by the vendor. Battery bank shall be of 110 V rated at 10 hours discharge rate to be installed in a separate room constructed by BHEL. Vendor shall submit sizing calculations for battery, charger, GA and GTP of battery and charger for approval	

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	considering design margin, temperature correction factors and safety margins for approval. The vendor shall take the prior approval for all design, sizing and make of the batteries and FCBC. DC system will be used for electrical control of equipment and indications on the control panel, protection system, communication system and DC lighting. The battery shall be sized considering the following: 1. Momentary load for 1 minute 2. Emergency load for 2 hours 3. Continuous load for 3 hours Under normal conditions, the battery shall be on float charger. The float charger will be connected to a distribution board and meets the requirements of DC load. In case of additional demand of load on AC supply failure, the battery shall meet the requirement of DC loads. The boost charger shall charge the fully discharged battery in 12 hours before bringing it back on float charge. 110V with suitable AH ratings with double float cum boost chargers each with inbuilt switch board shall meet the DC loads. The batteries shall be Lead Acid tubular type. The chargers with modern version of Thyristor controls shall be provided. The batteries provided shall be suitable for the control and protection, emergency lighting, operation of breakers, indications etc. and shall meet all the requirements of the plant wherever DC supply is required.	
5.21	Supply and installation of ACDB Panels (1 No.), IRDB panels (1 No.) and security room DBs (1 No.) The ACDB, IRDB, security room DBs are to be supplied by the vendor and is to be installed in the control room, inverter room and security rooms respectively. Vendor shall submit the single line diagram, GA drawing showing the details of feeders for internal lighting, module cleaning pumps, FCBC, Air conditioners, periphery lighting and other loads in the plant. Vendor shall ensure equal loading in all the three phases. The number of feeders and their capacity shall be decided in consultation with KPCL during detailed Engineering stage. AC distribution panels shall be made of sheet steel panel complete with all the equipments specified herein with 3-phase insulation aluminum busbar and neutral system self-supporting, free standing, steel doors at the front and rear, painted as per requirement, completely wired and provided with 16A, 3 pin power plug and sockets industrial type as required, cubicle heating by space heaters with thermostat and panel lighting. CONSTRUCTION FEATURES: The panels shall be of best quality CRCA sheet steel of 2mm SWG enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP-20 for indoor DBs as per IS-2147/8623. Distribution boards shall be provided with hinged doors with handle and locking facility for switch on interlock of doors. Doors shall be gasketed all round with Neoprene gaskets. All accessible live connections / metals shall be shrouded and it shall be possible to change/replace individual MCB/Fuse units from the front of the board without danger of coming into contact with live parts space and suitable removable type cable entry plates shall be provided for top/bottom entry of cable through gland as specified. The DB shall have two earthing terminals each to suit the purchaser's earthing. These boards shall have space heaters, name plate, danger boards etc. The required cable glands for the cables shall also be supplied with DBs. The incoming MCCBS shall be hand operated, air break, quick make and quick break type with short	

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	circuit breaking capacity of not less than 50kA. The HRC fuses (provided as back up) shall also have the breaking capacity of not less then 50kA. Anodised aluminum plate engraved with finalized single line diagram shall be fixed on the doors of the distribution boards. The Outgoing MCBs shall conform to IS-8828 (latest edition) and shall have a minimum interrupting rating of 10 kA. The ACDB and IRDB shall be provided with of 3phase, 4 wire 0.5 class Multi-Function Meter (MFMs) for measuring auxiliary power consumption. The MFMs shall have a RS-485 Modbus communication port to communicate with the central PC system (SCADA).	
5.22	Supply and installation of UPS for PCUs, SCADA and emergency lighting Vendor shall supply and install 1No. 5KVA UPS in each of the control room and inverter room for auxiliary supply to PCUs, SCADA panels 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.	
5.23	Supply, installation and commissioning of weather monitoring station Vendor shall supply and install Weather monitoring Station (WMS) on an independent structure on ground at a location near 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.), Ambient temperature sensor (1 No.), Room temperature sensors (2 Nos.). 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 civil foundation 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: 1. Spectral Response- 300 to 2800 nano meters. 2. Sensitivity- 8 to 20 $\mu\text{V/W/m}^2$ 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.	

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	TEMPERATURE SENSORS: PT100 sensors mounted inside a radiation shield, communication cable of adequate length, temperature range: -40 to +60 deg C with accuracy of +/- 0.2degC.	
5.24	Supply and Installation of auxiliary transformer: Vendor shall supply and install 1 No. auxiliary transformer for catering to the internal auxiliary loads of solar plant. Auxiliary transformer shall be located at switchyard near control room. The supplied auxiliary transformer shall conform to the following technical specifications: (1) Outdoor, Oil immersion type, ONAN, 3-phase, Dyn11, 100kVA, 33KV/ 433V (+/- 10%), 50Hz +/- 3% transformer, Class A insulation, minimum percent impedance 4.5%, off-circuit tap changer with 5 taps from -5% to + 5% in steps of 2.5%, bushing on HV side and cable box LV side, as per IS: 2026 for auxiliary power consumption to internal utilities of the power plant. (2) Electrical interconnections up to the transformer bushings on HV side shall be made using ACSR conductor. Termination kits shall be supplied by the vendor. (3) On LV side, suitable supporting arrangement shall be provided to route the cable, 3.5C X 95 sq-mm, Al conductor, armoured, 1100V, PVC insulation, PVC sheath cable as per IS: 1554 (part-1). The arrangement shall provide for suitable clips, clamps etc to ensure neat dressing of the cable. (4) Transformer shall be mounted on a suitable RCC foundation which is in the scope of vendor. The mounting arrangement and foundation details shall be submitted by the vendor for approval by BHEL. 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. (5) Height of foundation shall be as per KPCL/KPTCL/CEIG requirements. Approved makes: Schneider/ PETE/ Kamat/ Universal /Esennar or reputed equivalent, as approved by BHEL. Transformer includes all the mountings, fittings and accessories specifically described under this section and necessary spares as indicated. The Transformer shall be complete in all respects and include all components and accessories even though not specifically mentioned in the specification but which are essential for the satisfactory performance of the Transformer in accordance with the technical specification. The transformer shall be designed to facilitate operation, inspection, maintenance and repairs. All apparatus shall be designed to ensure satisfactory operation under such sudden variations of frequency, load and voltage as may be met with under working conditions, on the system including those due to short circuits. VIBRATION & NOISE The Noise level at rated voltage and frequency shall not be more than the specified level as per NEMA publication. SUPPRESSION OF HARMONICS The Transformer shall be designed with particular attention for the suppression of harmonic voltages.	



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FREQUENCY & VOLTAGE VARIATION

The Transformer shall be suitable for continuous operation with the frequency variation of +3% or -5% from normal 50Hz without exceeding the specified temperature rise. Further, the Transformer shall be capable of operating without injurious heating at rated KVA on any particular tapping provided that the voltage does not vary by more than +/-10% of the voltage corresponding to the tapping.

GENERAL DESIGN AND OPERATING CONSIDERATIONS

Duty under Fault Conditions

Transformer shall be capable of withstanding short circuit currents without damage according to IS: 2026. Unbalanced loading from the transformers is anticipated and the transformers shall be designed for operation at unbalanced loading conditions. Transformers shall be free from partial discharges over the range of operating voltages.

Over Fluxing

The transformers shall be suitable for over fluxing up to 10% without injurious heating. The maximum flux density in any part of the core and yoke of the transformers at normal voltage and frequency shall be such that the flux density under the over voltage conditions of 110% continuously of the rated voltage of any tapping shall not exceed 1.9 Tesla.

CONSTRUCTION AND MATERIALS

Core

The core shall be constructed from high-grade, cold rolled, non-ageing, low loss and high permeability grain oriented silicon steel laminations. The material shall conform to the latest edition of relevant IEC / IS.

The core laminations shall be annealed after removing all sharp projections and each lamination shall be coated with durable baked enamel / glass insulation. The complete core shall be coated with special resin as a protection against corrosion.

The core shall be rigidly clamped and bolted to ensure adequate mechanical strength and to prevent vibration/noise during operation. The bolts used in the assembly of the core shall be so constructed that eddy current flow is minimum.

The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and the production of the flux components at right angles to the plane of the laminations which may cause local heating.

The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2kV rms for one minute.

The core shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformers.

Windings

All windings shall be fully insulated. Neutral points shall be insulated for voltages specified in IS: 2026. The windings shall be designed to reduce the out-of balance forces to minimum in the transformer at all voltage ratios.



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The insulation at transformer windings and connections shall be free from insulating composition liable to soften, core out, shrink or collapse. The stacks and winding shall receive adequate shrinkage treatment before final assembly.

The high and low voltage windings shall be of copper conductors. The entire coil shall be epoxy resin encapsulated, cast under vacuum. The insulation system shall be of uniform glass-fibre epoxy laminated of highest electrical and mechanical quality into which the windings are voidlessly embedded. Both the HV & LV windings of one phase shall be separately cast as one rigid tubular coil having no link between their coaxial arrangement i.e. no creepage path can be formed even under dusty and corroding ambient conditions. The insulation laminates shall correspond to class B as per IS: 2026. Precautions shall be taken that the thermal stresses do not prove detrimental to the insulation of winding.

The winding shall not absorb any moisture and shall be suitable for tropical climate and 95% air humidity. The coils shall be hardly inflammable and shall be self-extinguishing in case of transformer catching fire.

The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. The assembled core shall be vacuum dried.

Terminal Connections

The HV terminals (Bushing) shall be connected to the 33 kV Bus. Removable links shall be provided.

Cable box suitable for PVC / XLPE cables of adequate size shall be provided on LV side.

LV neutral bushing shall be provided for neutral earthing at transformer end.

Earthing Terminals

Two earthing terminals each capable of carrying short circuit current of the transformers for two seconds shall be provided at bottom at two corners of the transformer enclosure. The earthing terminals shall be suitable for bolted connections to the grounding.

Bushings

The bushings used in the transformers shall comply with latest edition of IS: 2099, IS: 3347, IEC 60237 or any other equivalent International Standard. The bushing shall be of solid porcelain / epoxy case resin type. The bushing shall have high factor of safety against leakage to ground and shall be located so as to provide adequate electrical clearance between bushings and between bushing and ground parts. Bushings of identical voltage shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size and all external current carrying contact surfaces shall be properly surface treated.

Tappings

Tappings will be provided for voltage adjustment on the HV winding with adjustment of high voltage of + 5% to – 5% in steps of 2.5% for all the transformers.

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	Off circuit tap changer shall have bolted link type arrangement and the links shall be completely shrouded and no live parts shall be exposed. Cooling: All transformers shall be suitable for working outdoor and shall conform to IS: 11171 with ONAN cooling type. Painting The internal and external surfaces of enclosure and structural steel work to be painted shall be shot or sand blasted type to remove all rust, scale, foreign adhering matters, etc. All steel surfaces exposed to weather shall be given a primary coat of zinc chromate, second coat of weather resistant varnish of a color distinct from primary and final two coats of weather resisting color paint to be finalized during detailed engineering. Galvanizing All galvanizing shall be done after fabrication by the hot dip method. Marking of Parts Each part of the equipment shall be properly marked to ensure easy identification and to facilitate correct assembly and erection in the field. FITTINGS AND ACCESSORIES General The following fittings and accessories shall be provided on each transformer together with such other fittings and accessories which are necessary for satisfactory installation, operation and maintenance of the transformers. The fittings and accessories shall conform to relevant IS/IEC wherever exists. - Rating plates bearing data such as Type, applicable standard, Manufacturer's serial number, Year of manufacture, No. of phases, Rated power, Rated frequency, Rated voltage, Rated current, Percentage impedance voltage at rated current at principal & extreme taps, Type of cooling, Connection diagram, Total weight and dimensions, core + coil weight, Temperature class of insulation, etc. - A diagram plate showing the internal connections and also the vector relationship of the windings in accordance with requirements of standards and in addition to the plan view of the transformers, giving the correct principal relationship of transformer. - Suitable HV & LV terminals to suit the terminal arrangements. - Under carriage with four nos. plain bi-directional rollers with locking and bolting devices. - Jacking lugs. - Transformer clamping / fixing devices against earthquakes. 2 Nos. earthing terminals. - Enclosure lifting eyes, transformer-lifting lugs, core and winding lifting lugs, skids and pulling eye on both sides. - Any other accessories or appliances recommended by the manufacturer for the satisfactory operation of the transformer together with their prices shall be supplied. - Off circuit tap changing equipment	
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TESTS

The following tests will be carried out on the transformers as per IS/IEC

Routine Tests

- a) The following shall constitute the routine tests:
- b) Measurement of winding resistance at all taps.
- c) Measurement of voltage ratio at all taps and check of voltage vector relationship and polarity.
- d) Measurement of insulation resistance.
- e) Induced over voltage withstand test.
- f) Separate source voltage withstand test.
- g) Measurement of impedance voltage/short circuit impedance and load losses at principal and extreme tap.
- h) Measurement of no load losses and current at 90%, 100% & 110% rated voltage.
- i) Core isolation test.
- j) Capacitance and Tan delta measurement test.
- k) Repeat measurement of no load loss & current after dielectric test.
- l) No load current at 415V.
- m) Magnetic balance test.
- n) Partial discharge test.

Field Tests

The scope of tests during and after erection includes:

- a) Checking of correctness and completeness
- b) Checking of quality of porcelain parts, seals and external surfaces
- c) Checking of connections with earthing system
- d) Checking of bolt connections with a spanner
- e) Checking of correctness of phase alteration
- f) Checking of correctness of tap changer
- g) Measurement of insulation resistance
- h) Testing of insulation of all LV circuits

EFFICIENCY

The transformer shall be so designed that the efficiency load characteristics shall be as flat as possible between 50% and 100% rated capacity. The efficiency figures shall be guaranteed as per IS: 2026 but without tolerances allowed therein.

GUARANTEE FOR LOSSES

The no-load loss in Kilowatts, the load loss in Kilowatts at rated output, rated voltage, rated frequency and at 75°C temperature shall be specified and guaranteed without any tolerance.

SPARES

List of mandatory spares to be supplied are as follows:

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	1. HV bushing complete with gaskets, etc. :1 set (3 Nos per set) 2. LV bushing complete with gaskets, etc. :1 set (3 Nos per set) 3. Neutral bushing complete with gaskets, etc. : 1 No.	
5.25	Power cable terminations at 100kVA transformer and ACDB panel: (1) Vendor shall carry out termination on HT side of 100 kVA auxiliary transformer using ACSR conductor. Supply of ACSR conductor, lugs and hardware shall be in the scope of vendor. (2) Vendor shall carry out termination on LT side of 100kVA auxiliary transformer (33KV /433V) using 3.5Cx 95 sq-mm, Al conductor, armoured, 1100V, XLPE insulation, PVC sheath cable as per IS: 1554 (part-1), Cable glands, cable lugs, bolts, nuts, plain washers and spring washers. All these items including cable shall be within vendor scope of supply. (3) Similar terminations shall be carried out on the other end of cable that gets terminated at ACDB panel kept within control room. Vendor shall supply the necessary cable glands, cable lugs and hardware for ACDB end as well. (4) Quantity of 3.5CX95 sqmm cable ~ 50m. (5) All tools and accessories required to carry out the termination shall be within the scope of vendor.	
5.26	Erection of switchyard fencing with gate. Vendor shall provide all around chain-link fencing to the switchyard with gate at four different locations as indicated in the layout. i. Gates shall be with following details: - MS gates - 4 Nos each of 1.5m width. - Other necessary details such as hinges, padlocks, wheels etc shall be considered. - Gate shall be finished with red oxide (one coat) and paint of approved colour and type. - Frame of 50x50mm MS pipes with 4mm thick - Vertical grills of 16mm square bar at 120mm c/c ii. Vendor shall submit drawing of the fencing with gate for BHEL approval. iii. Height of fencing shall be as per relevant CEA regulations/standards. iv. Civil works for fencing, supply and erection of fencing shall be in vendor's scope.	
5.27	Switchyard leveling, jelly spreading (1) After installation of switchyard equipment such as transformers, PCVCB, CT, PT, GOS, RSJ poles, 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.	
5.28	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.	

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	(c) Power conditioning units: DC input /AC output parameters of inverters, grid data, fault status and events logged, etc (d) 33KV switchyards: status of breakers, status of protection relays of transformers, oil/winding temperatures, energy export to the grid from ABT meters etc. (2) Vendor shall provide support and assistance to BHEL in following activities: (a) Formation of underground cable trenches and cable laying and termination for data communication cables from SMBs to SMBs (daisy chain) and OFC cable from SMBs to SCADA, from transformers/ VCB panels / C&R panels to SCADA, OFC cable from inverter room to control room. (b) Data cable laying from PCUs, VCBs, ACDB, IRDB panels to SCADA. (c) Data cable terminations at PCUs, ACDB panels, transformers and VCB panels. (d) Laying and termination of Optical fiber cables including splicing in SCADA panels at inverter room and Control room and at SMBs.	
5.29	Cable trenches for laying data communication cables (RS485) and Optical Fiber Cables (OFC) from SMBs to inverter room / control room. (1) Data communication (RS 485) cables shall be laid between SMBs to form daisy chain loop (Not more than 10 SMBs in one loop) and from the end SMB of each loop, optical fiber cable shall be laid to the SCADA panel in the inverter room/ control room. Communication and OFC Cables shall be laid in HDPE DWC pipes of minimum ID 25mm. (2) Supply of communication and OFC cables shall be in BHEL scope. Supply of DWC pipes shall be in vendor's scope. (3) These data / OFC 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.	
5.30	Cable trench and laying of data communication cables in switchyard (1) Following are the data cables in switchyard (a) Transformers C&R panels (b) C&R panels to VCB panels (c) VCB panels (or C&R panels to SCADA (d) Transformers to SCADA (2) These data cables (details under following section), which are within the vendor scope of supply, shall be laid underground as follows: (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 (burnt clay type), 75mm thick, shall be laid	

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	over the sand. (g) Trench, then, shall be filled up with refill soil and suitably compacted.	
5.31	Data & Control cable terminations in control room and switchyard (1) Vendor shall carry out following data cable terminations at 2700 kVA transformers, VCB panels, C&R panels, ACDB panels and PCUs. (2) Terminations at marshalling box of 4 sets of 2700kVA transformers and VCB panels/ C&R panels (Buchholz relay, pressure release valve, low oil level, WTI, OTI etc). RS485 cable for MFM and numerical relay to SCADA shall be supplied by BHEL. (3) Terminations at VCB panels/ C&R panels (Buchholz relay, pressure release valve, low oil level, WTI, OC/EF relay, OV/UV relay, MFM etc) for SCADA. (4) Terminations at 8 PCUs of 1250kW for RS485 MODBUS communication over TCP/IP cable connections using LAN cables. Supply of LAN cable is in BHEL scope. (5) Terminations at ACDB and IRDB panels. (6) 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. (7) 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. (8) Supply and termination of control cables from VCB panels/ C&R panels to transformer: 12core X 2.5 sq-mm ~200m. (9) Vendor has to lay the control cable from each transformer to VCB panel / C&R panels 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. (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, VCB panels and C&R panel 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/IRDB panel (for AC).	
5.32	Earthing of solar array structures (1) Vendor shall interconnect solar array structures using welding of min. 25x3 mm GI strips. (2) Every row of such interconnected structures shall be terminated in a chemical 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	

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	manufacturer's datasheet/ installation instructions. (5) Earth chambers of brick masonry shall be constructed as per BHEL drawing enclosed. 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.	
5.33	Earthing lines for control room and inverter room panels – PCUs, Battery banks, FCBC charger, ACDB, IRDB, 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 and inverter room panels such as PCUs, 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 and inverter room panels 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 and inverter 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) 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. (10) Expansion bolts, cable lugs and all hardware required for this activity shall be within vendor scope of supply.	

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5.34	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 – 4x 2 Nos each = 8 Nos. (2) PCVCB, CT and PT structure earth– 2 Nos. each (3) 4P/2P/6P structure body earth – 2 Nos each (4) Lightning arrestors– 2 Nos each (5) Aux transformer, body earth –2Nos. (6) Aux transformer, neutral earth –2Nos. (7) Switchyard fencing – Quantity as required 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 with chemicals, GI strips, all hardware required for making the connections shall be within vendor scope of supply. Vendor shall carry out all the necessary GI strip laying and interconnections to form earth mat under the ground at a depth of ~ 500 mm. Vendor shall carry out measurement of earth resistance in all the cases that shall be witnessed, verified and certified by BHEL site engineer. Suitable size MS flats shall be laid according to the excavated ground profile for a grid of 2 x 2 Mtrs or higher as required and the main and cross conductors shall be welded together at the cross junctions by using 8 SWG low hydrogen welding electrodes conforming to AWS-7106 OR 7108 class to the full thickness to form fillet welds on either side of the MS flats. The Ms flats shall be surrounded by bentonite clay proportionately with water while applying for the entire ground mat grid. The design and drawings shall be got approved prior to commencement of the works. The welded surface of the ground mat joints and cross connections of the earth mat grid shall and two coats of red oxide paint and one coat of coal tar paint shall be applied after allowing each coat to dry sufficiently. In addition, CI pipe rods shall be driven alround the switchyard periphery at an interval of 6 mtrs. The rods shall be driven directly to the ground and filled with bentonite clay and connected to the ground mat. Chemical electrodes with proper treatment by using chemicals can also be used for reliable operation instead of CI pipe rods. The vendor shall carry out the study of soil resistivity after completion of erection and in case the soil resistivity is found to be high, then additional mat shall be laid and connected to the existing ground mat in the switchyard mat to bring down the resistance value below 0.5 Ohms.	
5.35	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 (3) Lightning arrestors shall be mounted on top of a mast of height 5m minimum above ground level using MS pipe of 100 mm minimum average diameter with painted finish; Each mast shall be secured by three steel stay wires that are	

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	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 chemical 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.	
5.36	Yard lights for switchyard, approach roads, pathways and compound wall (periphery lighting): (1) Vendor shall supply and install required number of lights in switchyards, approach road, pathways and pre-cast type 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 (IP65), Dust & vermin Proof and shall have suitable brass or copper made connector terminal., MCB (1A, single pole) of Schneider or reputed make, 3 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.	
5.37	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	

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	(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.	
5.38	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) 2-core/4-core, Cu/Al, armoured, PVC cable (size of cable shall be finalized based on cable sizing calculation to be submitted by vendor) (b) 2Cx 1.5 sq-mm Cu/Al, unarmoured, PVC cable from JB to light fitting (3) Vendor shall supply following 1-inch CPVC pipes of required length:	
5.39	Construction of bore wells for water supply for O&M including water analysis, electrical cabling and plumbing works. (1) Vendor shall construct a minimum of two bore wells and pump the water from bore wells to water storage tanks to be located on the control room and inverter room buildings. (2) Water analysis shall be carried out and reports shall be submitted to BHEL. (3) Pressure pump of required capacity (3 phase) with all necessary electrical cabling up to the ACDB's located in control room/ nearest IR shall be provided. Vendor shall submit the calculations for deciding pump rating and cable size. (4) Casing as required shall be provided for the pump. (5) 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. (6) Pump make: CGL, Suguna, Kirloskar , or other make for which BHEL approval shall be taken. (7) Vendor shall supply and install of PVC water storage tanks of 5000 liters capacity each on control room (2 Nos.) and inverter room (2 Nos.).	
5.40	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) Two numbers of suitable centrifugal 3-phase booster pumps of required capacity shall be supplied and installed one each at control room and inverter 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. One spare pump shall also be supplied.	

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	(3) Starter and DP switch (2 set-1 set for each pump) shall be supplied and installed in control room and inverter 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 and inverter 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.	
5.41	Identification markings using 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 switchyard equipment such as transformers, VCB panels, C&R 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.	
5.42	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: - For 300 sq-mm cable from string monitoring boxes to respective inverter rooms - For data communication cables from string monitoring boxes to control room - For cables of yard lights of solar array field, compound wall/chain-link fencing and switchyard fencing - For electrical cables of bore well connections - For HT (33KV) cables within switchyard - For aux transformer to ACDB panel - For CPVC water pipelines (2) Cable markers shall be suitably grouted with concrete foundation depth of	

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	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.		
5.43	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 with black colour for background. Letters shall be written with white colour. (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 1.5m above the ground level. (6) Vendor shall submit the drawing of hoarding arrangement to BHEL for approval.		
5.44	Display boards and sign boards		
	1	Board displaying instruction chart for restoration of person from Electric Shock	2 Nos
	2	Board displaying instruction chart for artificial respiration	2 Nos
	3	Board displaying dos and don'ts.	2 Nos
	4	Board displaying fire extinguishers details and operations	2 Nos
	5	"No smoking" board	10 Nos
	6	Board showing list of O&M staff with name, qualification and work responsibility	1 Nos
	7	Board showing list of contact details of BHEL, O&M team, O&M security, police station, fire service, hospital, medical store etc with names, address, mobile numbers etc	1 Nos
	8	Danger boards with details such as value of voltage etc for string monitoring boxes, PCUs, LT panels, Transformers, HT panels, Four pole / two 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 SI 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 Kannada and English language.		
5.45	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) As per IS: 15652:2006		

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	(c) Class B (d) Thickness 2.5 mm minimum (e) Size = 2m x 1m minimum (f) Colour: Black. (g) Max use voltage = 1.1 KV/ 33KV depending on location (h) Marking of IS standard on the mat (2) Test certificate shall be provided by vendor (3) Vendor shall lay the mats in front of electrical panels (PCUs, LT, HT, FCBC, ACDB panels) in control and inverter rooms, switchyard.																																														
5.46	Checkered plate for closing the cable trenches (a) behind the panels such as PCUs, LT panels, VCB panels , ACDB panels etc in inverter and 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.																																														
5.47	Air conditioner and pedestal fans Vendor shall supply and install 2 Nos. Split air conditioners of 1.5T capacity (min BEE 3 star rating) each with stabilizers in SCADA room. Make: LG, Videocon, Bluestar or reputed equivalent that shall be approved by BHEL. Construction of SCADA room and partitioning is in the scope of BHEL. Pedestal fans: 2 nos pedestal fan shall also be provided for SCADA room. Make shall be approved by BHEL.																																														
5.48	Tool kits and instruments Vendor shall supply the following tool kits and instruments: A. Measuring instruments <table><tr><td>1</td><td>Digital Earth Resistance Tester</td><td>Cambridge Instruments/equivalent</td><td>DET-2000</td><td>1 Nos</td></tr><tr><td>2</td><td>Digital multimeter</td><td>Reputed make</td><td></td><td>2 Nos</td></tr><tr><td>3</td><td>AC-DC Clamp Meter</td><td>Lutron/equivalent</td><td>DM-6506</td><td>2 Nos</td></tr><tr><td>5</td><td>Digital thermometer (wall hanging)</td><td>Reputed Make</td><td></td><td>2 Nos</td></tr><tr><td>6</td><td>Megger – 5KV</td><td>Shanti Electric Instruments, Nippen/equivalent</td><td></td><td>1 Nos</td></tr><tr><td>7</td><td>Electrical Tester</td><td>Reputed Make</td><td></td><td>4 Nos</td></tr></table> Note: Make / model number etc shall be approved by BHEL prior to procurement. B. Tool kits <table><tr><td>1</td><td>Double ended spanner Set of sizes 10-11, 12-13, 14-15, 16-17, 17-18</td><td>4 Nos each</td></tr><tr><td>2</td><td>Screwdriver Set</td><td>2 Set</td></tr><tr><td>3</td><td>Crimping tool with Dye range 50-400sq-mm cable, mechanical gear power, hand operated</td><td>1 Set</td></tr><tr><td>4</td><td>Crimping tool up to 6 sq-mm cable</td><td>2 set</td></tr><tr><td>5</td><td>Drilling machine AC, hand operated, with bit size up to 20 mm</td><td>1 set</td></tr></table>	1	Digital Earth Resistance Tester	Cambridge Instruments/equivalent	DET-2000	1 Nos	2	Digital multimeter	Reputed make		2 Nos	3	AC-DC Clamp Meter	Lutron/equivalent	DM-6506	2 Nos	5	Digital thermometer (wall hanging)	Reputed Make		2 Nos	6	Megger – 5KV	Shanti Electric Instruments, Nippen/equivalent		1 Nos	7	Electrical Tester	Reputed Make		4 Nos	1	Double ended spanner Set of sizes 10-11, 12-13, 14-15, 16-17, 17-18	4 Nos each	2	Screwdriver Set	2 Set	3	Crimping tool with Dye range 50-400sq-mm cable, mechanical gear power, hand operated	1 Set	4	Crimping tool up to 6 sq-mm cable	2 set	5	Drilling machine AC, hand operated, with bit size up to 20 mm	1 set	
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	<table> <tr><td>6</td><td>Measuring Tape, 5m</td><td>4 Nos</td></tr> <tr><td>7</td><td>Measuring Tape, 50 m</td><td>2 Nos</td></tr> <tr><td>8</td><td>Allen Key set</td><td>2 Set</td></tr> <tr><td>9</td><td>Adjustable spanner 2-inch size</td><td>2 No</td></tr> <tr><td>10</td><td>Hammer</td><td>4 Nos</td></tr> <tr><td>11</td><td>Rough file kit</td><td>2 Set</td></tr> <tr><td>12</td><td>Platform balance, 50Kg range, 100g accuracy</td><td>1 No</td></tr> <tr><td>13</td><td>Cutting Pliers</td><td>4 Nos</td></tr> <tr><td>14</td><td>Nose Pliers</td><td>4 Nos</td></tr> <tr><td>15</td><td>Vacuum cleaner, of industrial type, for control room sweeping / cleaning.</td><td>1 No.</td></tr> <tr><td>16</td><td>Blowers for cleaning the panels</td><td>1 No.</td></tr> </table> Note: Prior to procurement, vendor shall obtain approval from BHEL for the make and specification of the items.	6	Measuring Tape, 5m	4 Nos	7	Measuring Tape, 50 m	2 Nos	8	Allen Key set	2 Set	9	Adjustable spanner 2-inch size	2 No	10	Hammer	4 Nos	11	Rough file kit	2 Set	12	Platform balance, 50Kg range, 100g accuracy	1 No	13	Cutting Pliers	4 Nos	14	Nose Pliers	4 Nos	15	Vacuum cleaner, of industrial type, for control room sweeping / cleaning.	1 No.	16	Blowers for cleaning the panels	1 No.	
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5.49	Office furniture Vendor shall supply and install the following: <table> <tr><td>1</td><td>Executive table, wooden type, complete with draws and side racks</td><td>1 sets</td></tr> <tr><td>2</td><td>Chairs, swivel type, with arm rest</td><td>8 Nos</td></tr> <tr><td>4</td><td>PC table with chair</td><td>2 sets</td></tr> <tr><td>5</td><td>Storage almirahs</td><td>1 Nos</td></tr> <tr><td>6</td><td>Filing cabinets</td><td>1 Nos</td></tr> <tr><td>7</td><td>Aqua Guard or approved make water purifiers</td><td>1 Nos.</td></tr> </table> 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.	1	Executive table, wooden type, complete with draws and side racks	1 sets	2	Chairs, swivel type, with arm rest	8 Nos	4	PC table with chair	2 sets	5	Storage almirahs	1 Nos	6	Filing cabinets	1 Nos	7	Aqua Guard or approved make water purifiers	1 Nos.																
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5.50	Fire alarm system for control room and inverter 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 with casing / tubing of type and size, of required length, as																																		



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	approved by BHEL. (7) Spares: Smoke detectors – 2 No, Manual call point – 2 No, Hooter – 1 No. (8) 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. (9) Vendor shall submit fire alarm layout/scheme along with the detailed BOM to BHEL for approval. (10) Fire alarm control panels shall have provision for RS-485 Modbus output so that status can be monitored in plant SCADA system.																																				
5.51	Other safety related items (1) Safety gadgets: <table><tr><td>1</td><td>Gas Mask</td><td>4 Nos</td></tr><tr><td>2</td><td>First Aid Box with essential medicines and bandage cotton, antibiotic cream, Dettol, etc.</td><td>4 set</td></tr><tr><td>3</td><td>Hand Gloves 33 KV for GOS operation</td><td>4 sets</td></tr><tr><td>4</td><td>Hand Gloves 1KV for Maintenance of SMB</td><td>4 sets</td></tr><tr><td>5</td><td>Discharge rod</td><td>4 Nos</td></tr><tr><td>6</td><td>Safety Helmet</td><td>10 Nos</td></tr><tr><td>7</td><td>Rain Coat</td><td>4 Nos</td></tr></table> (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. <table><tr><td>1</td><td>Dry powder fire extinguisher (stored pressure type)</td><td>Capacity: 10 Kg IS: 2171, IS:10658 CM/L-7759096 Suitability for Class A, B & C fire, related to solid combustibles, flammable liquid and gases.</td><td>10 Nos</td></tr><tr><td>2</td><td>Carbon di-oxide (CO2) type fire extinguisher with trolley</td><td>Capacity: 9 Kg IS: 2878 Suitability for Class B&C fires Involving flammable liquids & gases, electronic equipment.</td><td>10 Nos</td></tr><tr><td>2</td><td>Sand buckets</td><td>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.</td><td>8 sets</td></tr></table>			1	Gas Mask	4 Nos	2	First Aid Box with essential medicines and bandage cotton, antibiotic cream, Dettol, etc.	4 set	3	Hand Gloves 33 KV for GOS operation	4 sets	4	Hand Gloves 1KV for Maintenance of SMB	4 sets	5	Discharge rod	4 Nos	6	Safety Helmet	10 Nos	7	Rain Coat	4 Nos	1	Dry powder fire extinguisher (stored pressure type)	Capacity: 10 Kg IS: 2171, IS:10658 CM/L-7759096 Suitability for Class A, B & C fire, related to solid combustibles, flammable liquid and gases.	10 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.	10 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.	8 sets	
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5.52	Pre-commissioning inspections / checks / tests and coordination with state departments for necessary approvals and clearances for commissioning.																																				

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	synchronization with grid and post-commissioning operation of the plant: (A) Vendor shall carry out following minimum pre-commissioning checks: (1) Verification of firmness of terminations in all electrical equipment: SMBs, PCUs, LT/VCB panels, transformers, 4P/2P/6P 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, inverter 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, C&R 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 and C&R 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/C&R panels to operations from C&R panels/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. (B) 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/CEIG/SECI etc., requirements. (a) Transformers: IR tests, ratio tests, excitation current measurement, magnetic balance test on HV, short circuit test, excitation test LV side, vector group test. (b) 33KV vacuum circuit breaker panels and C&R 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) Auxiliary transformers: IR tests, ratio tests. (d) Relays in C&R panels: open/close, tripping, primary injection tests. (e) Lightning arrestors: IR tests (f) GOS switches: IR and contact resistance tests.	
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	(2) Appropriate testing agency shall be arranged for the tests. (3) Vendor shall coordinate / liaison with concerned STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/MRT departments to fix up test schedules and witness by their representatives. (4) Vendor shall prepare and submit the reports to STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/MRT/CEIG/SECI and obtain their approval through necessary liaison activities. (C) Vendor shall coordinate and liaison with STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS/CEIG etc., prepare and submit the applications with necessary enclosures on behalf of BHEL and obtain their approval: (a) Approval for BHEL drawings (b) Approval for synchronization of plant with grid. (c) CEIG inspection of power plant (d) Provisional CEIG clearance to proceed with commissioning (D) Vendor shall take approval of BHEL for appointing Electrical consultant for the entire SPV plant and switch yard to comply with CEIG norms and getting approvals. (E) Vendor shall implement corrective steps on the observations of CEIG, follow-up with them and obtain final clearance for licensed operation of the plant on a continuous basis. Note: Scope of coordinating with state departments such as STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS, CEIG to get the clearances / approvals for licensed / statutory operation of the power plant on a continuous basis includes all transactions required for successful liaison and clearances. Application fees and renewal fees (say, in the form of DD) to be enclosed with application / renewal documents and all other expenses in the above process shall be in the scope of vendor.	
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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) HDPE DWC pipe 2) Pre-stressed concrete (PSC)/ RSJ poles for 2P/4P/6P structure 3) Gang operated switch 33KV with/ without earth switch 4) Lightning arrestors 30kV, 10kA 5) Auxiliary transformer 100kVA, 33KV / 433V, ONAN 6) Disc insulators and other 2P/4P/6P structure accessories 7) ACSR conductor 8) All cables under vendor scope (LT, data, control, OFC and communication cables) 9) Earthing electrodes & earth strip 10) Lightning arrestor (ESE) 11) Submersible pump 12) Centrifugal Booster pump 13) Ball valves 14) CPVC pipes 15) Air conditioner 16) Fire alarm system 17) Fire extinguishers 18) Electrical insulation mat 19) 33kV termination kits (indoor, outdoor)	
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20) ACDB, IRDB, Security room DB 21) FCBC, Battery bank 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.	
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7.0 General conditions applicable during installation and commissioning phase

7.1	As already mentioned in previous clauses, vendor shall organize power supply on their own. Accordingly, DG sets of suitable capacity shall be deployed by the vendor for construction works.	
7.2	Water required for construction works shall be organized by vendor. Bore wells, which are deliverables of vendor as part of this contract, shall be laid in the beginning stages so that bore well water can be used for the construction purposes. Alternatively, vendor shall make their own alternate arrangements (tankers etc).	
7.3	All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement of materials shall be organized by the vendor.	
7.4	All necessary tools and tackles such as crimping tool (including heavy duty tools for crimping copper cables up to 300 sq-mm), 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.	
7.5	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.	
7.6	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.	
7.7	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.	
7.8	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.	
7.9	Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site.	
7.10	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.	
7.11	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.	
7.12	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.	
7.13	Any damages on the building, structures etc attributable to the acts of labour /	

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	employees of vendor shall be rectified and made good by the vendor at their own cost.	
7.14	No child labour shall be employed for execution of the present contract.	
7.15	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.	
7.16	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.	
7.17	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.	
7.18	Any deviations shall be discussed with BHEL site engineers and implementation shall be taken up only after approval from BHEL.	
7.19	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.	
7.20	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.	
7.21	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.	
7.22	All cable terminations shall be done in such a way that bending radius of the cable is strictly as per IS: 1255	
7.23	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	
7.24	Vendor has to pay the plant electricity consumption charges, internet & telephone charges etc during the O&M period.	
7.25	Vendor shall prepare and submit as-built drawings after execution of works.	

8.0 Operations and Maintenance

8.1	Date of commencement of operations and maintenance : Zero date for O&M shall be the actual date on which the complete 10 MW capacity is commissioned with synchronization / export of power to 33kV grid and completion of all the works in the scope of the vendor.	
8.2	Period for O&M: Vendor shall operate and maintain the power plant for a period of FIVE years (60 months) from the zero date as above.	
8.3	O&M personnel 1. Vendor shall deploy following minimum personnel:	

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	(a) Technical / administrative / office personnel (i) One technical-cum-administrative in-charge having diploma in electrical / electronics engineering and experience in electrical plants with overall responsibility for complete plant operations. The in-charge shall have competence to handle technical and operational / crisis problems. (ii) Three working level staff with ITI / diploma level qualifications in engineering with competence for operating electrical / electronics / mechanical equipment, taking measurements, data logging / maintaining registers, preparation of reports in computer. (iii) Six unskilled persons for regular house-keeping (cleaning / mopping etc) and water cleaning of SPV modules. (iv) Note: At least one among the technical personnel shall essentially be a certified / licensed person for HT operations (33KV minimum). This is a mandatory requirement. (b) Security personnel (i) Minimum Five security guards with competence to handle tough situations and safeguard the plant from miscreants. Among these, three shall be deployed during night time and two during day time. Three security persons during night are considered for patrolling and stationed security. Wireless communication (walkie-talkie etc) shall be provided for the security personnel. (c) In case, any of the above O&M personnel is on leave, reliever shall be arranged by the vendor so that there is no effect on O&M activity. 2. Similarly, O&M personnel shall be provided with raincoats, toolsets, earthing rods, safety gloves, safety goggles, gumboots, helmets and all other personal protective equipment (PPE) that will be relevant to ensure human safety. 3. Names, qualification, work responsibility of personnel shall be listed on a display board within control room. 4. Attendance register shall be maintained for both the teams. 5. Vendor shall ensure statutory requirements such as ESI, PF and labour license for their O&M personnel posted at site. 6. BHEL shall have right to disallow any O&M employee, if found unfit to perform. BHEL instructions issued in writing shall be binding on vendor who shall replace the person. 7. O&M personnel at site shall conform to general regulations in force at site and to any special instructions from local administration/KPCL. 8. O&M personnel at site shall be deemed to be aware of damages and risks incidental to conditions of BHEL land and works from time to time and BHEL shall not be responsible for any injury to personnel arising there from. 9. Training to O&M personnel It is the absolute responsibility of vendor to ensure imparting of necessary training to their O&M personnel to get them acquainted with the operations of various electrical and mechanical equipment of the power plant. For this purpose, vendor shall identify the O&M personnel well in advance and involve them during installation and commissioning stages so that they become well versed with various functional aspects of the power plant. 10. Availability of O&M personnel at power plant (a) Vendor shall ensure that operating staff are present in the power plant during plant operation (6:00 AM – 6:30 PM) every day. (b) Vendor shall ensure that certain minimum operating staffs are present at the power plant even on festivals, public holidays and any other unique occasions so that the plant is run under competent supervision on all days.	
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	(c) Security guards shall be available at the power plant on round the clock basis and on all the days. In case of any break in duty of security guard(s), replacement with alternate guard(s) shall be ensured during the break time. 11. O&M personnel shall, strictly, not use any part of the power plant for their personal / residential purposes. Their presence at the plant shall, strictly, be meant only for the purpose of operation and maintenance of plant.	
8.4	O&M operations – daily basis (1) Water cleaning of SPV modules (cycle to be completed in maximum 15 days and repeated again) (2) Control room and inverter room cleaning – dry sweeping, wet mopping (3) Water wash cleaning of toilets, urinals. (4) Logging of DC, AC, grid parameters (current, voltage, power, energy) at PCUs & VCB/ C&R panels, transformer temperatures, equipment tripping/ breakdown, grid outage etc as per BHEL formats. (5) SCADA data station / PC operations for daily monitoring of weather parameters, trend graphs and urgent reporting to BHEL in case of any problems / anomalies observed with any of the parameters. (6) Drinking water to be arranged for O&M personnel at site.	
8.5	O&M activities – weekly basis (1) Removal of garbage from solar array field, switchyard, roads, drains, pathways, sand buckets; logging in registers with signatures of operating persons and in-charge. (2) Monitoring and logging of fire extinguisher levels / pressures as per BHEL formats	
8.6	O&M activities – monthly basis (1) Inspection of fire extinguishers (weight, pressure indication, physical status etc) followed by refilling actions, if necessary, based on indications. Report to be submitted as per BHEL approved recording formats. (2) Earthing resistance measurements for solar array structures, control room equipment, switchyard equipment, lightning arrestors (ESE): measured values shall be recorded in registers and reported to BHEL as per BHEL approved recording formats. (3) Submission of values / status of plant parameters and events for the corresponding month, as below, as per BHEL approved formats: - Daily values of solar array strings (SMB parameters) - Daily values of weather parameters (solar energy, wind speed, ambient temperature) - Daily energy generation - Events (with date, time) of faults / tripping / breakdown of equipment - Events (with date, time) of grid outage - Events (with date, time) of equipment damages, accidents and thefts - Activities of module cleaning (4) Monthly reports shall be submitted to BHEL for all the above data. (5) Energy generation / meter reading report to be prepared and submitted to the concerned department (STATE ELECTRICITY SUPPLY & TRANSMISSION BOARDS etc). Signatures from BHEL's customer and substation representatives shall be obtained wherever required.	
8.7	O&M activities - quarterly basis (1) Cleaning of PCUs, VCB panels, C&R panels, ACBD, IRDB, FCBC, battery banks etc to remove accumulated dust. (2) Monitoring and status review, followed by rectification / calibration / replenishment / replacement actions as necessary and applicable for	

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	following: (a) Spare items of all electrical equipment (b) First aid box items - medicines and accessories (c) Safety gadgets (d) Tool kits and measuring instruments (e) Yard lights (f) Pumps, starters (g) Control room appliances: air conditioners, lights, fans, exhaust fans, switch boards etc (3) Pest control for control room (rats, snakes etc) – sprays, chemicals, medicines etc to be applied wherever required. (4) Submission of quarterly report on above activities to BHEL. (5) Cleaning of water storage tanks	
8.8	O&M activities – yearly basis (1) BDV measurements for oil samples from all the transformers and submission of report to BHEL. (2) Filtration of oil to be arranged, if required, based on BDV measurement report. (3) Lubrication of moving contacts (VCBs, GOS switches, Earth switches etc) with appropriate grease etc (4) Cleaning of sewerage lines, septic tanks (if found necessary) (5) Painting of switchyard gate / fencing, earthing chambers, other steel structures within control room and switchyard if required based on conditions of rusting etc. (6) Checking tightness of hardware in solar array structures and tightening wherever required. (7) Checking tightness of power cable terminations in SPV modules (MC4), SMBs, electrical panels of control room and switchyard.	
8.9	O&M activities - as and when required (contextual basis) (1) Monitoring and operation of plant electrical equipment as and when required: (a) GOS Air break switches (b) VCB on/off: local operations from outdoor HT panel and remote operations from indoor remote annunciation panel (c) Settings of numerical relays in HT panels: review and revision in consultation with BHEL. (d) ACB on/off operations on LT side. (e) PCU operations: emergency close, LCD displays (selection of settings, monitoring the DC/AC/event/fault status parameters), operation of duct fans. (f) Battery and battery charger operations (g) Bore well pump operations to fill the storage tanks. (2) Coordinating, on behalf of BHEL, and obtaining renewal of statutory licenses, clearances and approvals from state departments such as KPCL / KPTCL/ CEIG/etc. (3) Repair and replacement of vendor supplied items, by vendor, with urgent action plans and implementation, when the items are found non-working / damaged. The same shall be reported to BHEL within 12 hours from time of observation. (4) Reporting, on an immediate basis (within max 2 hours) of functional problems / damages in BHEL supplied items to facilitate repair / replacement by BHEL. Further, vendor shall correspond / coordinate with respective equipment vendors / service centers, on behalf of BHEL, for getting the service engineers to the site. Later, coordinating with the service engineers during their visit to site, and assisting them in the trouble shooting process until the problem is	

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	resolved. Vendor shall report to BHEL (within max 2 hours) immediately after the problem is resolved. (5) Vendor shall keep updating the spares inventory at the site every time there is consumption of spare items towards replacement. In case of shortage of spares, the same shall be reported on an urgent basis (with max 2 hours) to BHEL. (6) Coordinating with sub-station upon grid failures, line problems etc and implementing the needful steps to restore the plant to normal operation. (7) The electrical charges for the auxiliary consumption and broadband internet, telephone charges, if any, of the SPV plant during the entire period will be in scope of the vendor (8) Theft incidents: immediate reporting to BHEL, filing FIRs with police stations on behalf of BHEL, coordination for site inspection by insurance companies and clearance of insurance claims, logging of events (date, time) and maintaining records. (9) Accidents: immediate reporting to BHEL, coordinating with hospitals, logging of events (data, time) and maintaining records. (10) Procurement of all O&M consumables for fulfilling the activities detailed above will be in the scope of vendor. (11) Grass cutting – quarterly once or if when the height of grass is more than 2 feet from ground lever whichever is earlier.	
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9.0 Documents to be submitted for BHEL approval after receipt of purchase order

9.1	BHEL approval shall be obtained for the following technical documents, which shall be submitted to BHEL in phased manner based on priority sequence of activities. However, it shall be ensured that all documents are submitted within 14 days from date of purchase order.	
9.2	Vendor, make, model number / part number, specification / sizes / dimensions / drawings / datasheets of all the vendor supplied items.	
9.3	General arrangement drawings / schemes / layouts etc with bill of materials / quantities shall be submitted for the following (list is indicative and not limited to): (1) SMB Mounting structure (2) Transformer foundation pedestal (3) Cable support structure for 1Cx300 sq-mm cables between inverter room and transformers (4) Cable trench layout in array yard, switchyard (5) Foundations for Switchyard equipment (6) GTP and drawings of Switchyard equipment – GOS, LA, ACSR, insulators (7) Details of power, control, communication and OFC cable (8) ESE Lightning arrester arrangement with foundation details (9) Yard lights –switchyard, compound wall/chain link fencing, approach road. (10) Water pipeline layout from bore wells to storage tank (11) Water pipeline layout from storage tank to solar array field for module cleaning system with pressure calculations (12) Fire alarm system scheme / layout (13) Cable support structures and cable ladders within control room and inverter rooms	
9.4	Quality assurance plans for items listed under clause 7.0	
9.5	Detailed activity-time chart for project implementation.	

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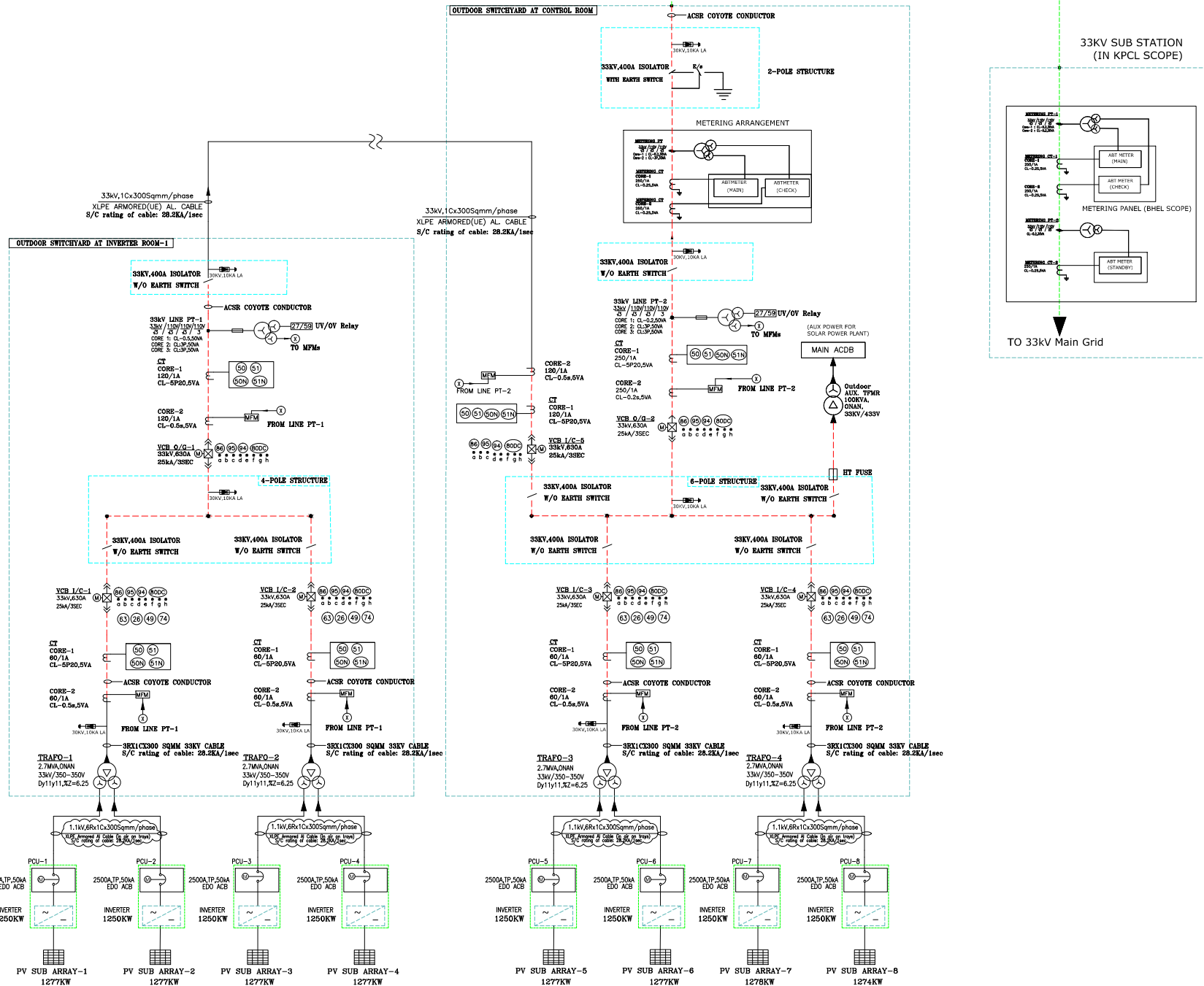
9.6	Detailed manpower deployment schedule.	
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10.0 Codes and Standards:

IS:7098 (Part -I)	Specification for XLPE insulated PVC sheathed cables. Part-I: For working voltages upto 3.3 KV
IS:1554 (Part-I)	Specification for PVC insulated cables for working voltages up to 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:2026	Power Transformers
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 KV rating

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

33KV TRANSMISSION LINE (IN KPCL SCOPE)



NOTE:
AT 33KV SUBSTATION, VENDOR SCOPE IS LIMITED TO SUPPLY OF 33KV METERING CT, METERING PT AND METERING PANELS WITH ABT METERS (MAIN, CHECK & STANDBY).

LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1		TRANSFORMER 2.7MVA,0.000N 33kV/350-350V Dy11y11,Z=6.25
2		Outdoor POCYB 33kV,630A 25kV/3SEC
3		DC FAILURE INDICATION
4		MASTER TRIP RELAY
5		TRIP CIRCUIT SUPERVISION RELAY
6		ANTI PUMPING RELAY
7		BUCHHOLZ RELAY
8		MAGNETIC OIL LEVEL GAUGE
9		WINDING TEMP INDICATOR AND OIL TEMP INDICATOR
10		PRESSURE RELIEF DEVICE
11		VCB ON
12		VCB OFF
13		SPRING CHARGE
14		AUTO TRIP
15		TRIP CIRCUIT HEALTHY
16		SERVICE POSITION
17		TEST POSITION
18		DC FAILURE
19		INST OVER CURRENT RELAY
20		IDMT OVER CURRENT RELAY
21		NEUTRAL INSTANTANEOUS OVER CURRENT RELAY
22		IDMT EARTH FAULT RELAY
23		MULTI FUNCTION METER
24		CURRENT TRANSFORMER
25		UNDER VOLTAGE RELAY
26		OVER VOLTAGE RELAY
27		POTENTIAL TRANSFORMER
28		FUSE
29		LIGHTNING ARRESTOR
30		TARIFF ENERGY METER
31		INVERTER, 1250KW
32		2500A,TP,50kA ACB

PROJECT : 10MW SOLAR POWER PLANT AT CHANDAPURA, HAVERI DT. CUSTOMER : KPCL

BHARAT HEAVY ELECTRICALS LIMITED.

ELECTRONICS DIVISION, BANGALORE

SINGLE LINE DIAGRAM-AC

SL. NO. DATE

REV. 01

REV. 02

REV. 03

REV. 04

REV. 05

REV. 06

REV. 07

REV. 08

REV. 09

REV. 10

REV. 11

REV. 12

REV. 13

REV. 14

REV. 15

REV. 16

REV. 17

REV. 18

REV. 19

REV. 20

REV. 21

REV. 22

REV. 23

REV. 24

REV. 25

REV. 26

REV. 27

REV. 28

REV. 29

REV. 30

REV. 31

REV. 32

REV. 33

REV. 34

REV. 35

REV. 36

REV. 37

REV. 38

REV. 39

REV. 40

REV. 41

REV. 42

REV. 43

REV. 44

REV. 45

REV. 46

REV. 47

REV. 48

REV. 49

REV. 50

REV. 51

REV. 52

REV. 53

REV. 54

REV. 55

REV. 56

REV. 57

REV. 58

REV. 59

REV. 60

REV. 61

REV. 62

REV. 63

REV. 64

REV. 65

REV. 66

REV. 67

REV. 68

REV. 69

REV. 70

REV. 71

REV. 72

REV. 73

REV. 74

REV. 75

REV. 76

REV. 77

REV. 78

REV. 79

REV. 80

REV. 81

REV. 82

REV. 83

REV. 84

REV. 85

REV. 86

REV. 87

REV. 88

REV. 89

REV. 90

REV. 91

REV. 92

REV. 93

REV. 94

REV. 95

REV. 96

REV. 97

REV. 98

REV. 99

REV. 100

REV. 101

REV. 102

REV. 103

REV. 104

REV. 105

REV. 106

REV. 107

REV. 108

REV. 109

REV. 110

REV. 111

REV. 112

REV. 113

REV. 114

REV. 115

REV. 116

REV. 117

REV. 118

REV. 119

REV. 120

REV. 121

REV. 122

REV. 123

REV. 124

REV. 125

REV. 126

REV. 127

REV. 128

REV. 129

REV. 130

REV. 131

REV. 132

REV. 133

REV. 134

REV. 135

REV. 136

REV. 137

REV. 138

REV. 139

REV. 140

REV. 141

REV. 142

REV. 143

REV. 144

REV. 145

REV. 146

REV. 147

REV. 148

REV. 149

REV. 150

REV. 151

REV. 152

REV. 153

REV. 154

REV. 155

REV. 156

REV. 157

REV. 158

REV. 159

REV. 160

REV. 161

REV. 162

REV. 163

REV. 164

REV. 165

REV. 166

REV. 167

REV. 168

REV. 169

REV. 170

REV. 171

REV. 172

REV. 173

REV. 174

REV. 175

REV. 176

REV. 177

REV. 178

REV. 179

REV. 180

REV. 181

REV. 182

REV. 183

REV. 184

REV. 185

REV. 186

REV. 187

REV. 188

REV. 189

REV. 190

REV. 191

REV. 192

REV. 193

REV. 194

REV. 195

REV. 196

REV. 197

REV. 198

REV. 199

REV. 200

REV. 201

REV. 202

REV. 203

REV. 204

REV. 205

REV. 206

REV. 207

REV. 208

REV. 209

REV. 210

REV. 211

REV. 212

REV. 213

REV. 214

REV. 215

REV. 216

REV. 217

REV. 218

REV. 219

REV. 220

REV. 221

REV. 222

REV. 223

REV. 224

REV. 225

REV. 226

REV. 227

REV. 228

REV. 229

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REF. DRG. No.

SIGN. & DATE

INVENTORY No.

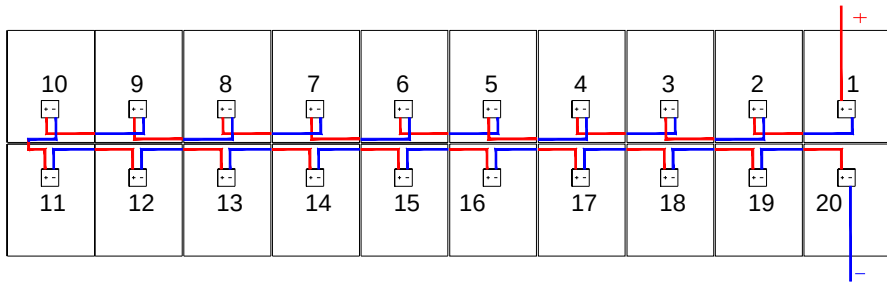
BH-KP0H-005

DRG. No.

DETAILS

Module Type	Poly Crystalline
BHEL Model	L24270P
No. of modules in one string	20
Total No. of Strings	1648
Total No. of Moduels	32960
String Monitoring Box (SMB)	24 Positive & 24 Negative input 1 Positive & 1 Ngative output
No. of SMBs per Inverter	9
Total No. of Inverters	8
Rating of Inverter	1250 KW @ 50 degC
Cable Size-String to SMB	1Cx6 mm Copper Cable
Cable Size-SMB to Inverter	1Cx300 sq mm Al armored cable

Typical Connection Diagram of a PV String



DISTRIBUTION OF PV MODULES :

Inverter No.	No. of SMBs per inverter	No. of strings per inverter	No. of modules per inverter	PV Module rating	DC capacity connected to inverter
1 to 6	9	206	4120	310	1277 KWp
7	9	203	4060	315	1278 KWp
8	9	209	4180	305	1274 KWp

TECHNICAL PARAMETERS OF PV MODULES :

MODULE RATING	305 W	310 W	315 W
OPEN CIRCUIT VOLTAGE (V _{oc})	45 V	45 V	45 V
SHORT CIRCUIT CURRENT (I _{sc})	8.8 A	8.8 A	8.9 A
VOLTAGE AT PEAK POWER POINT (V _{mp})	36 V	36 V	36 V
CURRENT AT PEAK POWER POINT (I _{mp})	8.47 A	8.61 A	8.75 A
MODULE POWER RATING (P _{max})	305 W	310 W	315 W
MODULE EFFICIENCY	15.73%	15.99%	16.25%
CELL EFFICIENCY (at module level)	17.41%	17.69%	17.97%
FILL FACTOR	≥ 0.70	≥ 0.70	≥ 0.70

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

PROJECT : 10MW Solar Photovoltaic Power Plant, Chandapura, Haveri
CUSTOMER: KPCL

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

SINGLE LINE DIAGRAM-DC

No. OF SHEETS
SHEET No.

4

1

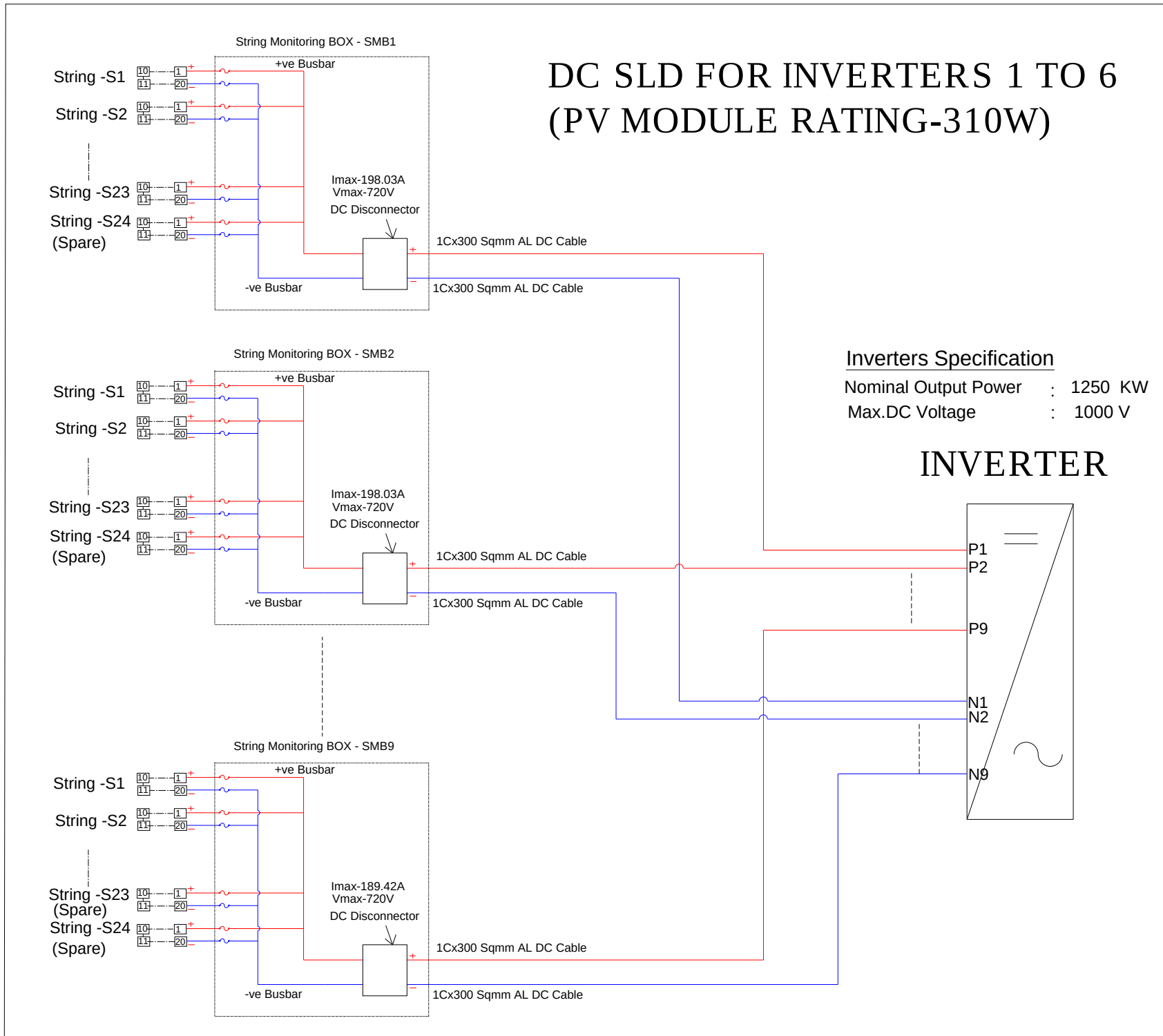
REV

02

TITLE:			
WBS. No.		DRG. No.	BH-KP10H-005

BH-KP0H-005

DRG. No.



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

Note:

1. This scheme is applicable to Inverter Nos. 1 to 6.
2. All SMBs shall have provision for 24 strings. However, 8 SMBs shall be connected with 23 strings (1 string will be spare) and 1 SMBs shall be connected with 22 strings (2 strings will be spare) - Total 206 strings per inverter.

PROJECT : 10MW Solar Photovoltaic Power Plant, Chandapura, Haveri
CUSTOMER: KPCL

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

REV.	DATE	ALTERED	LNK	REV.	DATE	ALTERED	LNK		NAME	SIGN	DATE
02	24.01.17	CHECKED	SLR	01	30.12.16	CHECKED	SLR				
		APPROVED	NHK			APPROVED	NHK				
Revised with three ratings of PV Modules				Revised as per KPCL comments dated 24.12.16				DRAWN	LNK		22.11.16
								CHECKED	SLR		22.11.16
								APPROVED	NHK		22.11.16

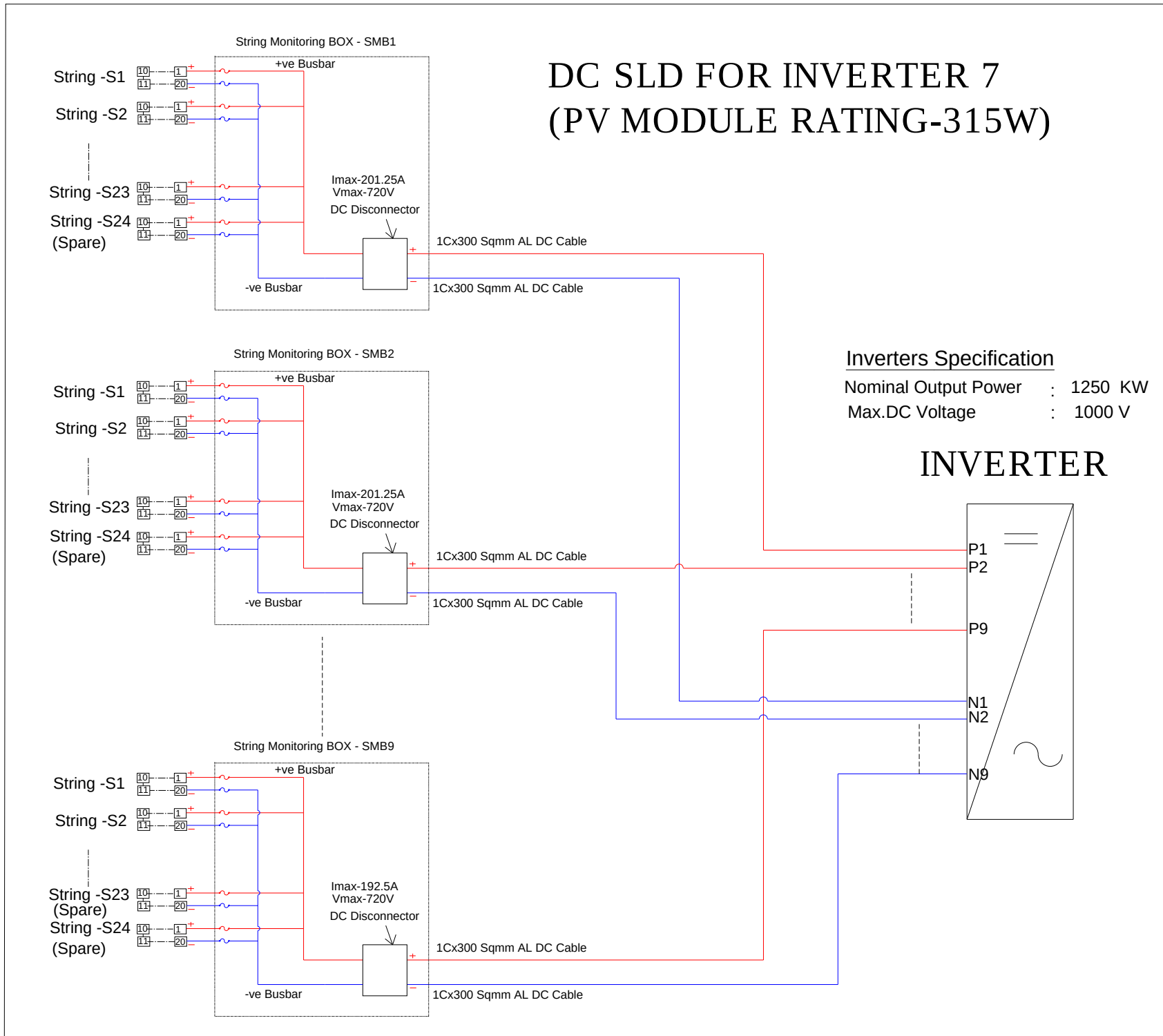


DEPT.	CODE
SC&PV	439

TITLE:		No. OF SHEETS	4
SINGLE LINE DIAGRAM-DC		SHEET No.	2
WBS. No.		DRG. No.	BH-KP10H-005
		REV	02

BH-KP0H-005

DRG. No.



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

Note:

1. This scheme is applicable to Inverter No. 7.
2. All SMBs shall have provision for 24 strings. However, 5 SMBs shall be connected with 23 strings (1 string will be spare) and 4 SMBs shall be connected with 22 strings (2 strings will be spare) - Total 203 strings per inverter.

PROJECT : 10MW Solar Photovoltaic Power Plant, Chandapura, Haveri
CUSTOMER: KPCL

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

REV.	DATE	ALTERED	LNK	REV.	DATE	ALTERED	LNK		NAME	SIGN	DATE
02	24.01.17	CHECKED	SLR	01	30.12.16	CHECKED	SLR				
		APPROVED	NHK			APPROVED	NHK				
Revised with three ratings of PV Modules				Revised as per KPCL comments dated 24.12.16				DRAWN	LNK		22.11.16
								CHECKED	SLR		22.11.16
								APPROVED	NHK		22.11.16

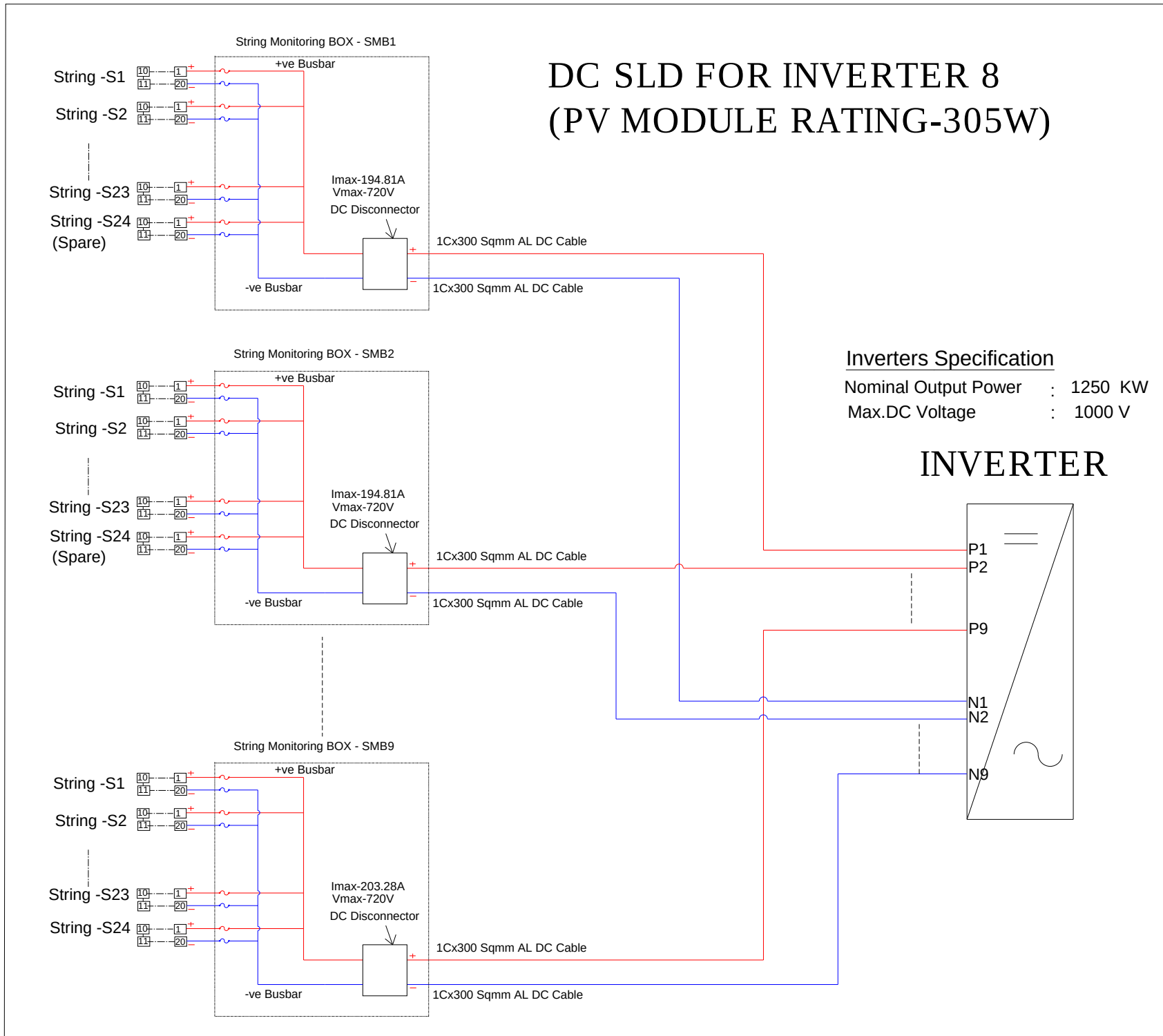


DEPT.	CODE
SC&PV	439

TITLE:		No. OF SHEETS	4
SINGLE LINE DIAGRAM-DC		SHEET No.	3
WBS. No.		DRG. No.	BH-KP10H-005
		REV	02

BH-KP0H-005

DRG. No.



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

Note:

1. This scheme is applicable to Inverter No. 8.
2. All SMBs shall have provision for 24 strings. However, 7 SMBs shall be connected with 23 strings (1 string will be spare) and 2 SMBs shall be connected with 24 strings - Total 209 strings per inverter.

PROJECT : 10MW Solar Photovoltaic Power Plant, Chandapura, Haveri
CUSTOMER: KPCL

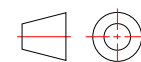
BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

SINGLE LINE DIAGRAM-DC

REV.	DATE	ALTERED	LNK	REV.	DATE	ALTERED	LNK		NAME	SIGN	DATE
02	24.01.17	CHECKED	SLR	01	30.12.16	CHECKED	SLR				
		APPROVED	NHK			APPROVED	NHK				
Revised with three ratings of PV Modules				Revised as per KPCL comments dated 24.12.16				DRAWN	LNK		22.11.16
								CHECKED	SLR		22.11.16
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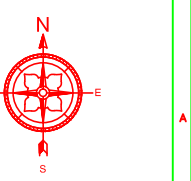


DEPT. CODE
SC&PV 439



TITLE:		No. OF SHEETS	4
		SHEET No.	4
WBS. No.		DRG. No.	BH-KP10H-005
		REV	02

N



PV ARRAY CAPACITY	: 10.21MWp
PV MODULES(L24270)	: 32960 nos
RATING OF MODULE	: 305/310/315Wp
NO. OF MODULE/STRING	: 20 nos
TOTAL NO OF STRINGS	: 1648 nos
TOTAL NO OF STRUCTURES	: 1648 nos
TOTAL NO OF SMBs	: 72 nos
NO. OF INVERTER 1250KVA	: 8 nos
NO OF STRINGS/INVERTER	: 203/206/209
NO OF SBMs/INVERTER	: 9 nos

20 module structure 1648 nos

0x3.714m

8x13m

11x22

Inverter room

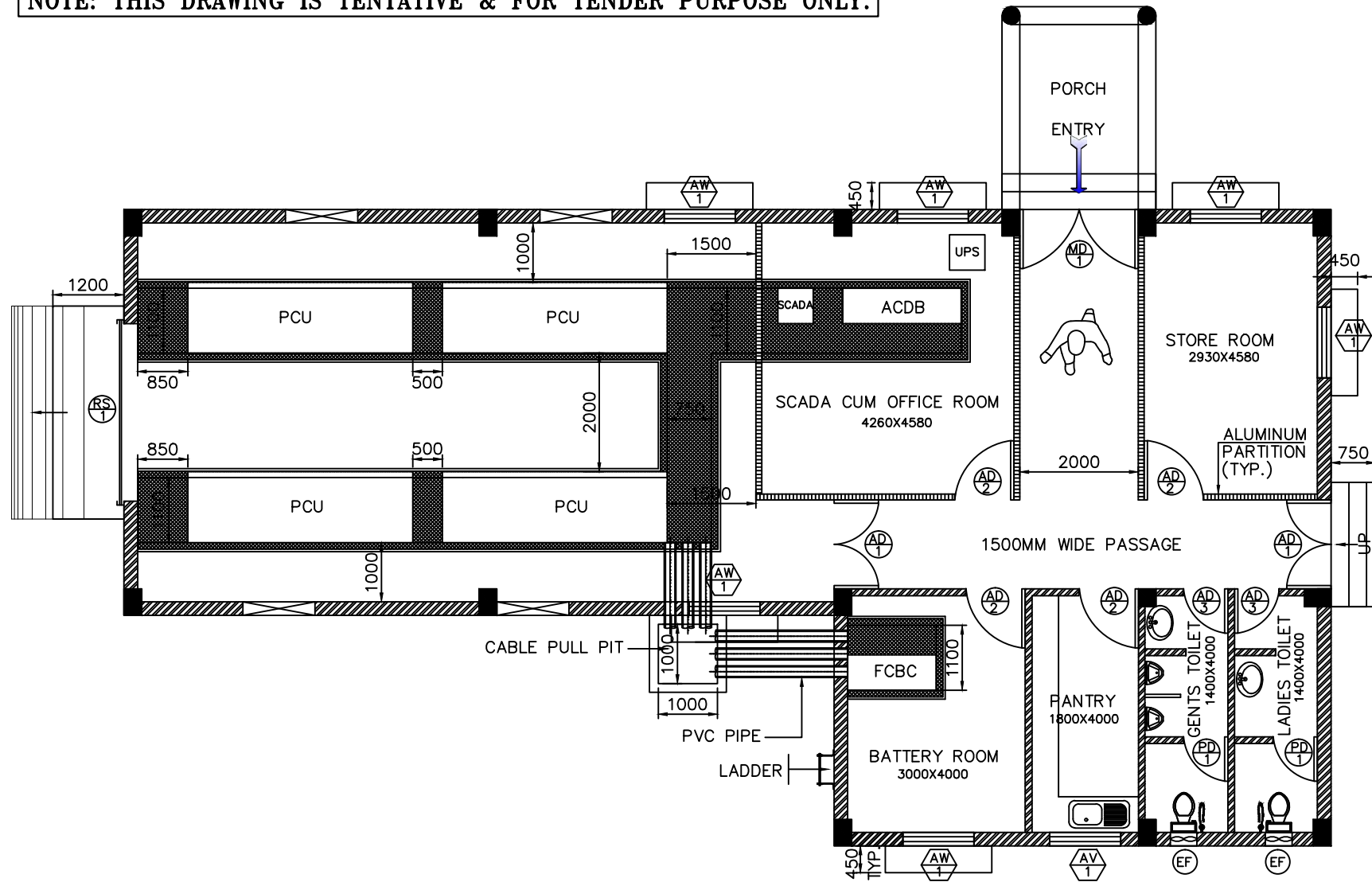
Control room with Inverter room

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



NAME OF CUSTOMER/PROJECT				CUSTOMER : KPCL, HAVERI				
				PROJECT: 10 MWp SPV POWER PLANT				
 BHARAT HEAVY ELECTRICALS LIMITED. ELECTRONICS DIVISION, BANGALORE				DRN	NAME	SIGN.	DATE	
				CKD				
				APPD				
DEPT. SCPV	FOR UNSPECIFIED- TOLERANCES REFER EIR 0230499		SCALE NTS	WEIGHT(Kg)	REF. TO ASSY. DRG.	ITEM NO.	NO.OF ITEM	NO.OF ITEM
CODE 439								
TITLE				DRAWING NO.			REV.	
10MW PV ARRAY LAYOUT				BH-KP10-012			00	
				SHEET NO. 01		NO. OF SHEETS		

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

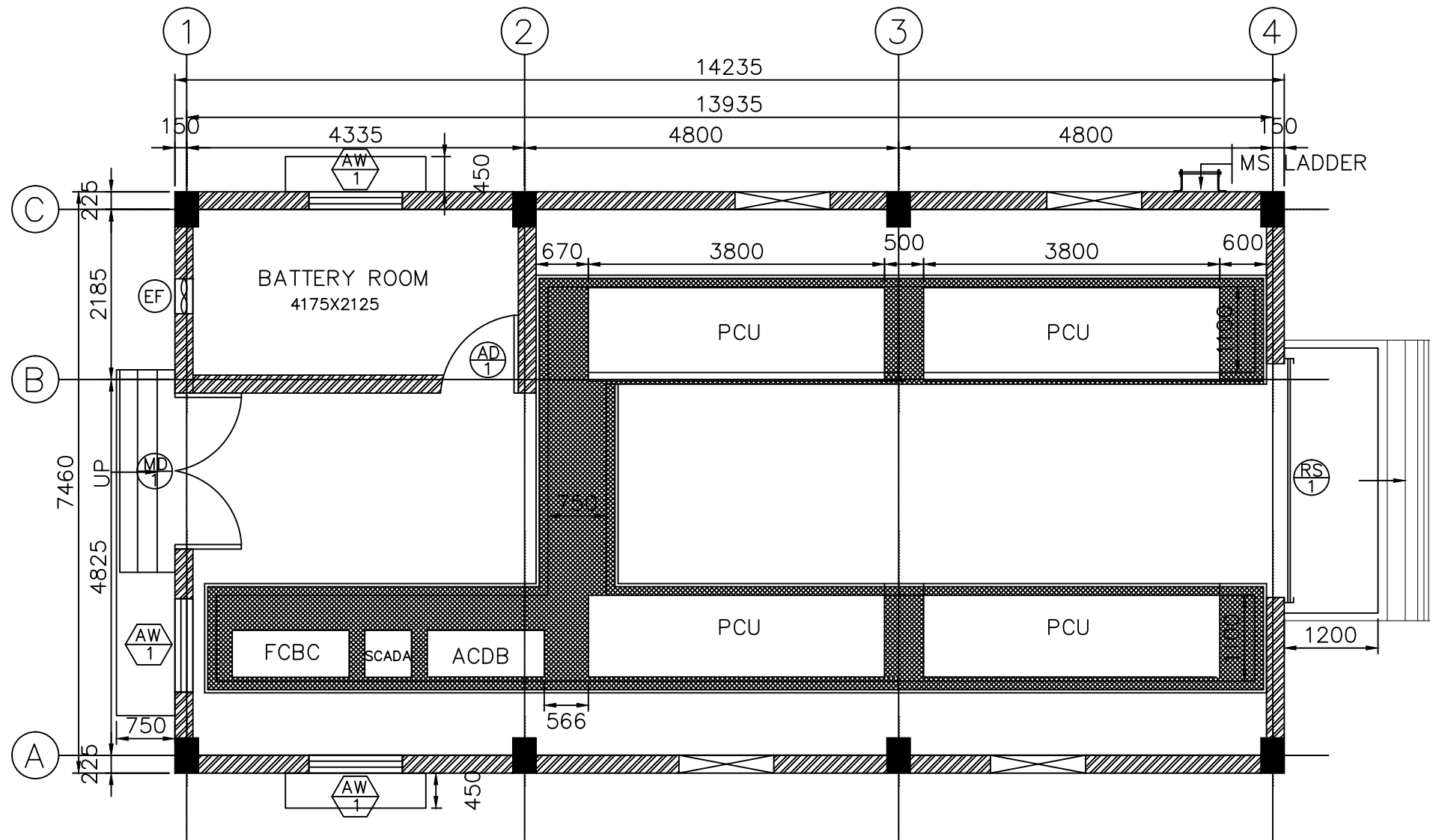


GROUND FLOOR PLAN
(SCALE 1: 75)

REV	DATE	BY	CHK	APP	REV	DATE	BY	CHK	APP	REV	DATE	BY	CHK	APP	REV	DATE	BY	CHK	APP

DEPT.	SC&PV
STATUS	CONTRACT
DISTRIBUTION	
KPCIL 10MWp SOLAR POWER PLANT AT CHANDAPUR VILLAGE, SHIGGON TALUK, HAVERI DIST	
BHARAT HEAVY ELECTRICALS LTD ELECTRONICS DIVISION, BANGALORE	
TITLE INVERTER ROOM LAYOUT	
SCALE	DRAWING NO. HE-37403-010

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



GROUND FLOOR PLAN
(SCALE 1: 75)

REV. DATE. ALD. DES. APPR. REV. DATE. ALD. DES. APPR. REV. DATE. ALD. DES. APPR. REV. DATE. ALD. DES. APPR. REV. DATE. ALD. DES. APPR.											
REVISIONS FOR APPROVAL											
DEPT. SC&PV STATUS CONTRACT DISTRIBUTION											
KPCIL 10MWp SOLAR POWER PLANT AT CHANDAPUR VILLAGE, SHIGGON TALUK, HAVERI DIST											
BHARAT HEAVY ELECTRICALS LTD ELECTRONICS DIVISION, BANGALORE											
TITLE INVERTER ROOM LAYOUT											
SCALE 1:100 DRAWING NO. INV-EPD05-000											
SHEET 1 OF 1											

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REF. DRG. No.

SIGN. & DATE

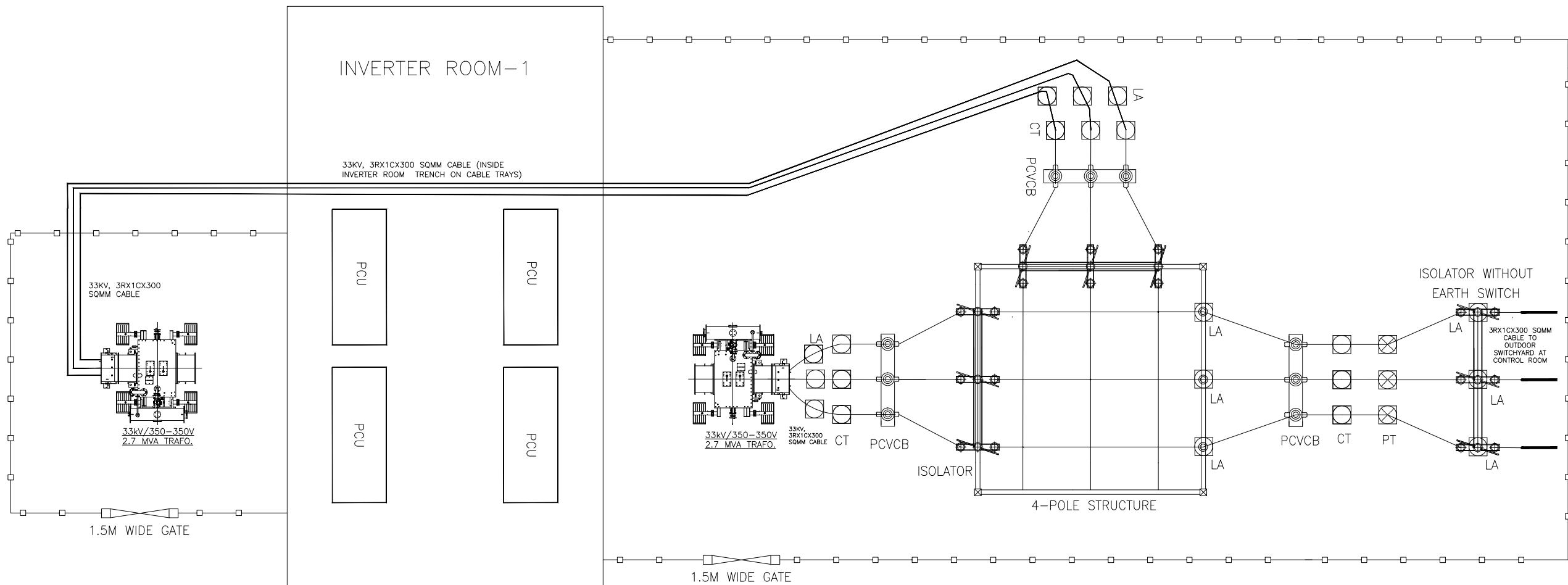
INVENTORY No.

BH-KP0H-006

DRG. No.

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

33KV OUTDOOR SWITCHYARD AT INVERTER ROOM



PLAN

CLEARANCES BETWEEN EQUIPMENT SHALL BE AS PER CEIG REGULATION & ELECTRICAL RULES.

PRODUCT : 10MW Solar Photovoltaic Power Plant
CUSTOMER: KPCL, Chandapur Village, Haveri Dist

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

33KV OUTDOOR SWITCHYARD LAYOUT

No. OF SHEETS
02

SHEET No.
01

REV
00

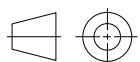
DRG. No.
BH-KP10H-006

WBS. No.

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		APPROVED			APPROVED				
						DRAWN			
						CHECKED			
						APPROVED			



DEPT. CODE



BH-KP0H-006

DRG. No.

2

3

4

5

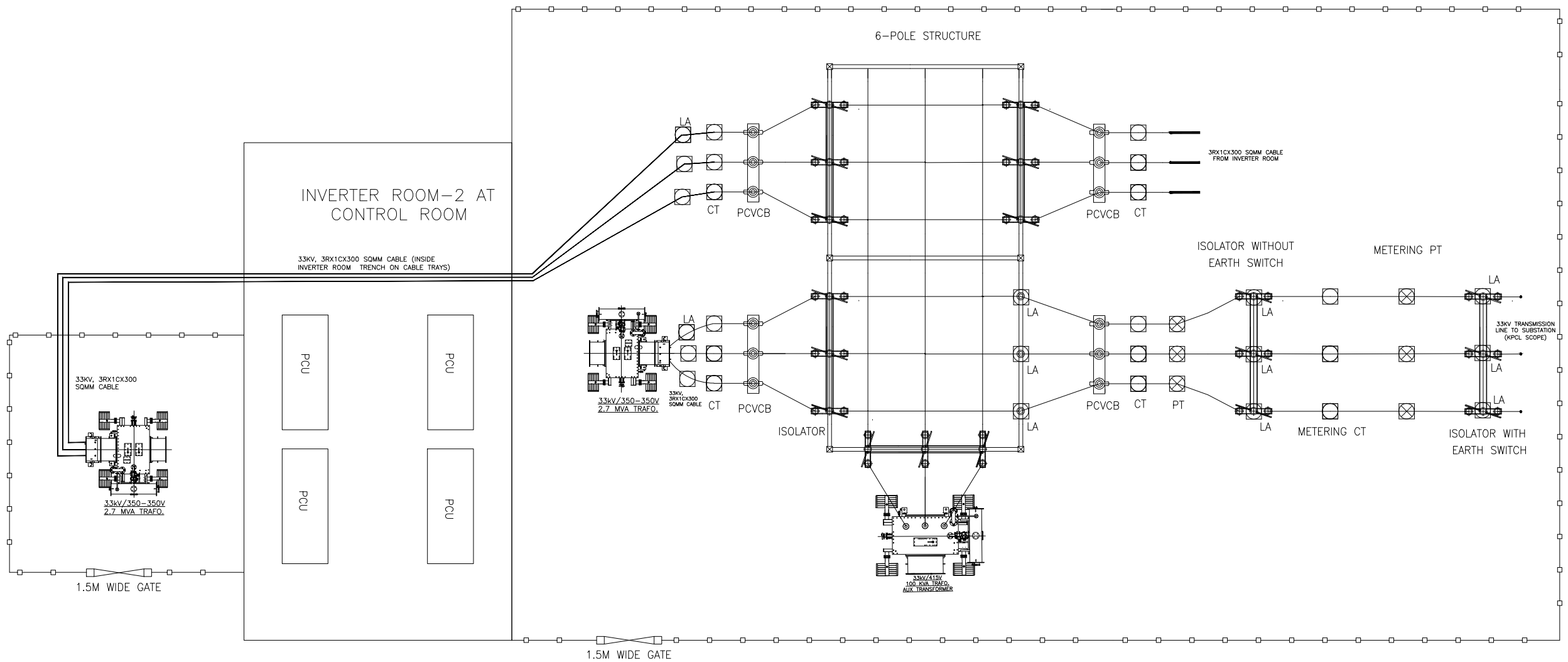
6

7

8

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

33KV OUTDOOR SWITCHYARD AT CONTROL ROOM



PLAN

CLEARANCES BETWEEN EQUIPMENT SHALL BE AS PER CEIG REGULATION & ELECTRICAL RULES.

PRODUCT : 10MW Solar Photovoltaic Power Plant
CUSTOMER: KPCL, Chandapur Village, Haveri Dist

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

33KV OUTDOOR SWITCHYARD LAYOUT

No. OF SHEETS
02

SHEET No.
02

REV
00

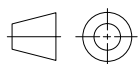
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BH-KP10H-006

WBS. No.

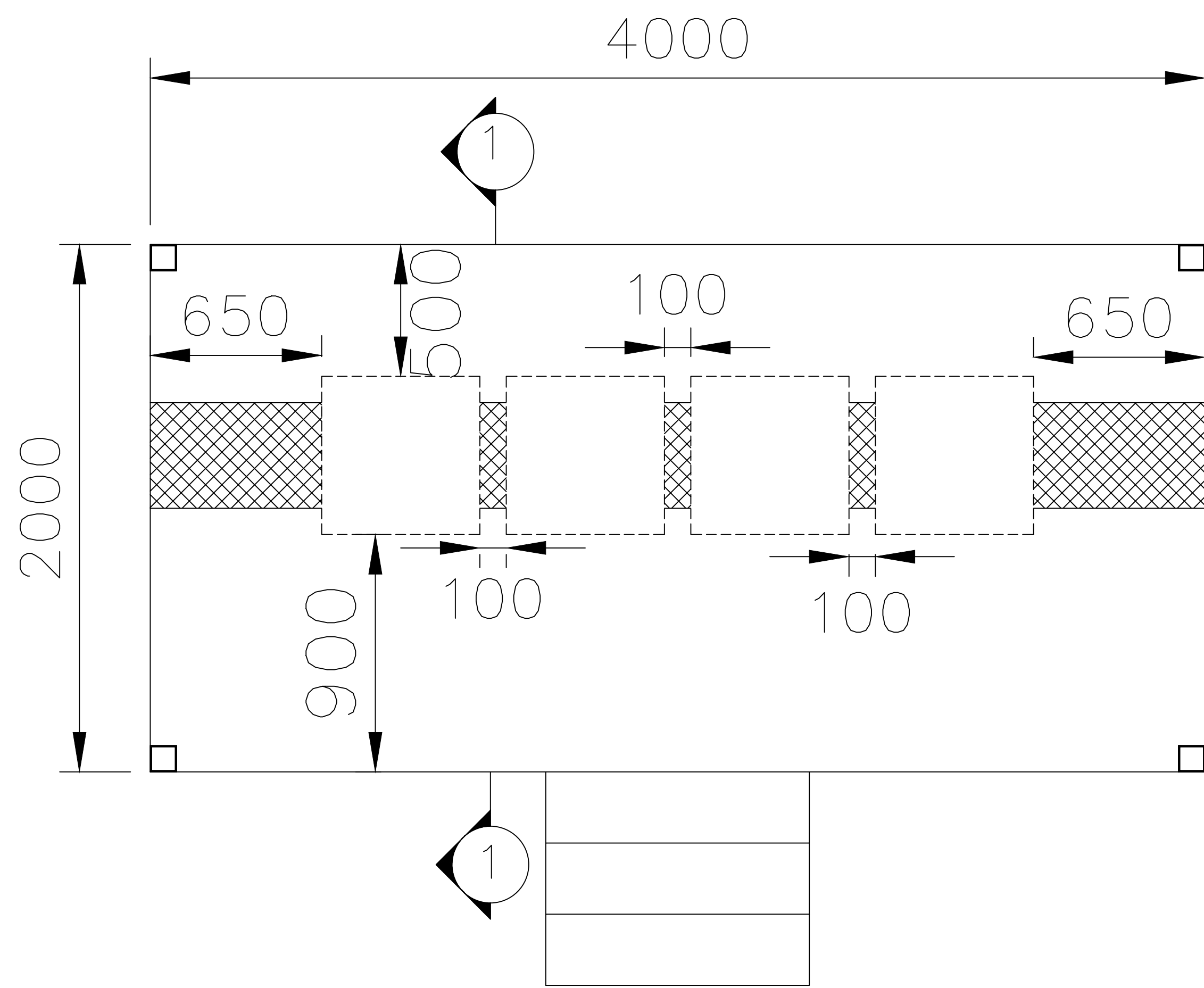
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		APPROVED			APPROVED				
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						CHECKED			
						APPROVED			



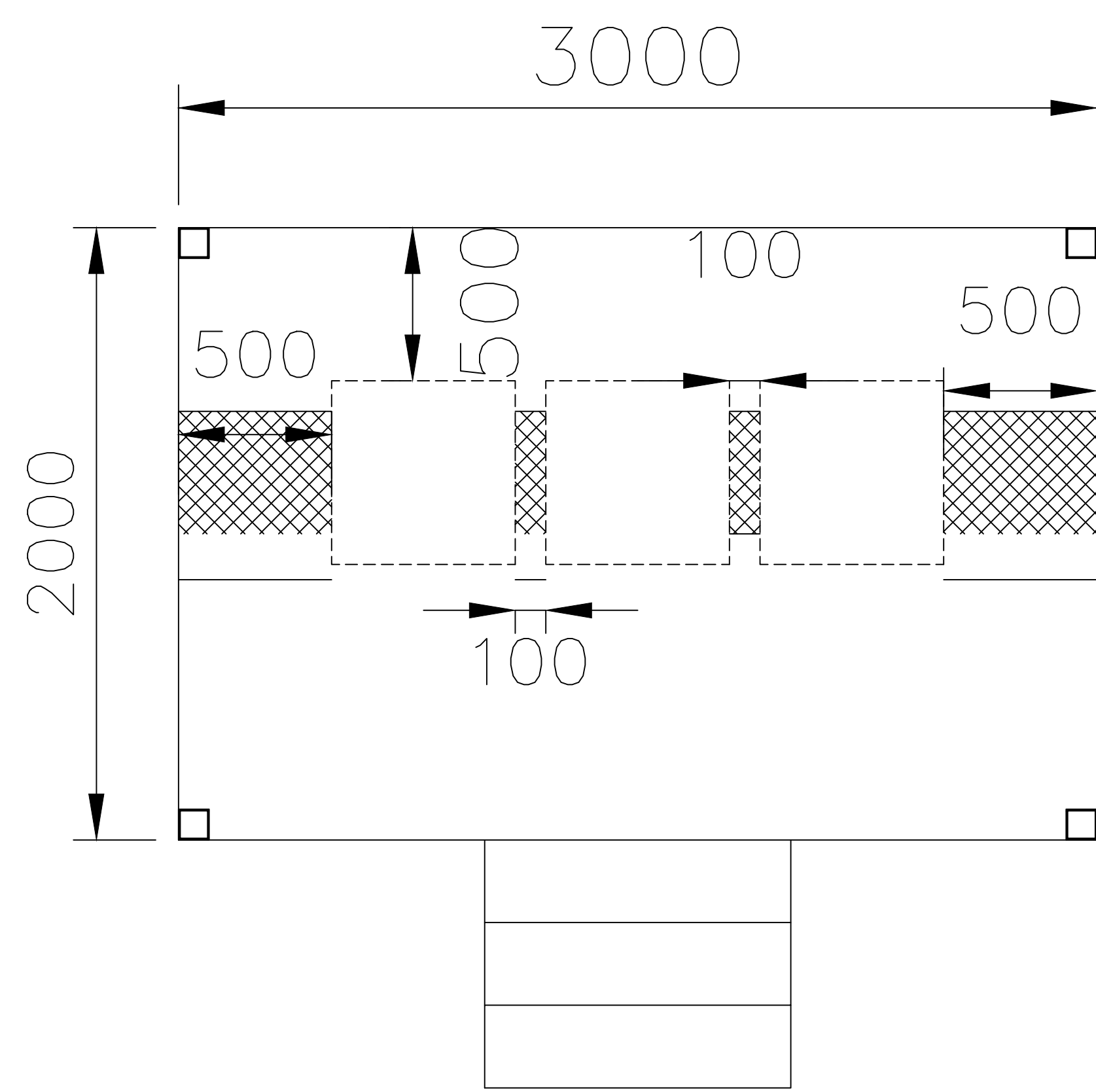
DEPT. CODE



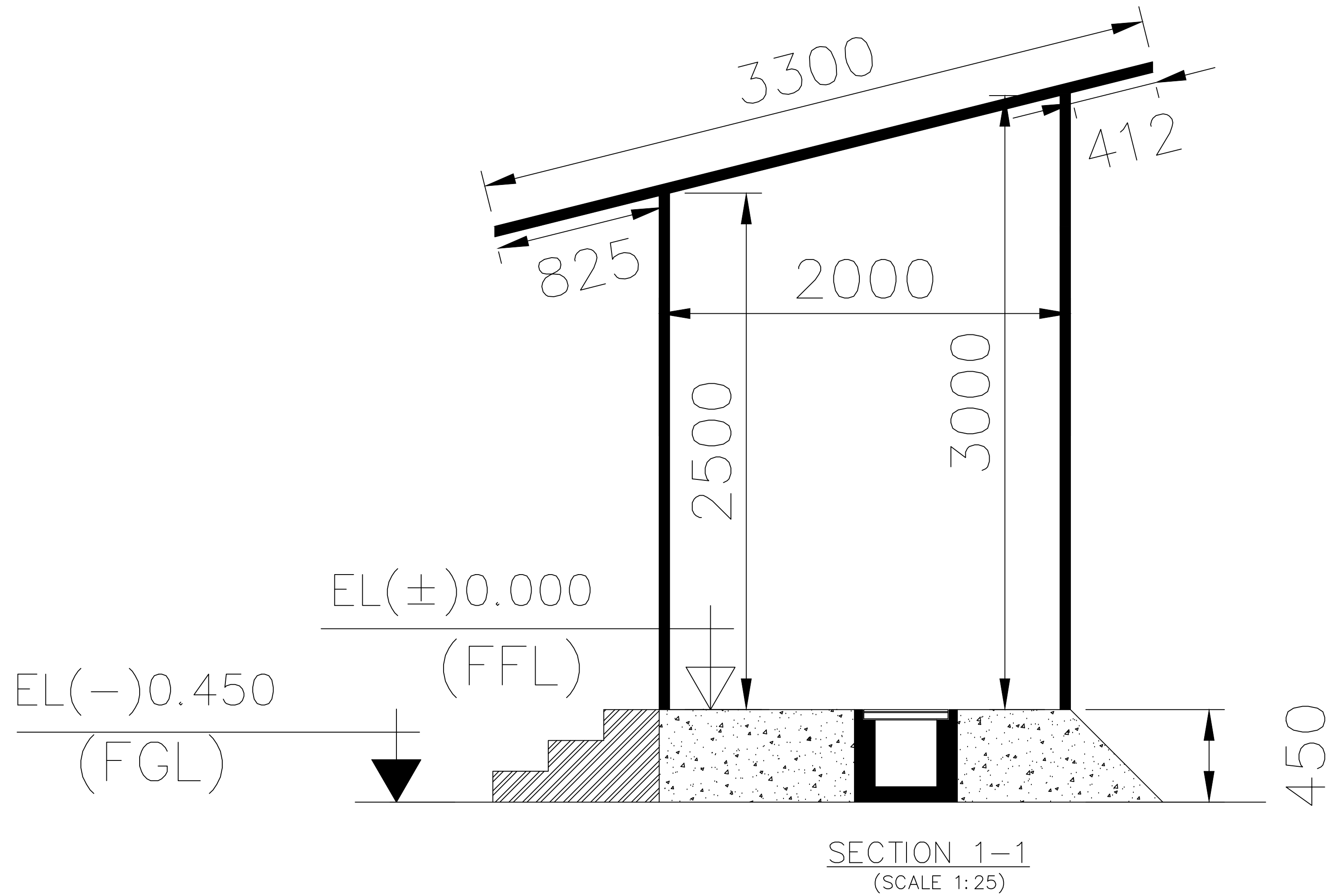
THIS DRAWING IS TENTATIVE AND
FOR TENDER PURPOSE ONLY



TYPICAL PLAN FOR PANELS
IN SWITCHYARD AT CONTROL ROOM
(SCALE 1:25)



TYPICAL PLAN FOR PANELS
IN SWITCHYARD AT INVERTER ROOM
(SCALE 1:25)



REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

DEPT.	SC&PV
STATUS	CONTRACT
DISTRIBUTION	



KPCL 10MWp SOLAR POWER PLANT AT CHANDAPUR
VILLAGE, SHIGGON TALUK, HAVERI DIST



BHARAT HEAVY ELECTRICALS LTD
ELECTRONICS DIVISION, BANGALORE

TITLE	PLAN FOR C&R PANELS AT CONTROL & INVERTER ROOM SWITCHYARDS
SCALE	1:100
DRAWING NO.	BH-KP10H-CIV-CR-PN-01
SHEET	1 OF 1
REV.	00