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Technical specification for Supply of Balance of System items, Installation and Commissioning of 39MW (AC) Solar Photovoltaic Grid-connected Power plant At Yellandu, Bhadadri Kothagudem Distt, Telangana

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1.0	Introduction
1.1	Overall project outline of 39MW (AC) solar photovoltaic power plant
1.2	Scope of this tender specification
1.3	Enclosures to this tender specification (Tender purpose only)
2.0	Location/ address of power plant:
3.0	Vendor scope of supply, Installation, Commissioning and O&M
4.0	BHEL scope of supplies and works
5.0	Technical specification for supply, installation and commissioning
5.1	Temporary site office for vendor use
5.2	Electrical power / water for construction
5.3	Construction of temporary yards for safe storage of vendor supplied items
5.4	Unloading, safe storage and movement of supply items received at site:
5.5	Series interconnection of SPV modules to form strings
5.6	Routing of 1Cx 10 cable below the SPV modules
5.7	Interconnection of SPV module strings to 1Cx10 cable and Supply of Y and MC4 connectors
5.8	Installation of SMB and Diode boxes including erection of SMB and diode box mounting structures
5.9	Routing of 1Cx10 cable in DWC HDPE pipes underground between the rows of solar array
5.10	Interconnection of Diode box and SMB
5.11	Termination of 1Cx10 cables on input side of SMBs/DIODE BOXES
5.12	Ferruling for 1Cx10 cable
5.13	Underground cable trenches and laying of 1Cx400, RS485 and OFC cables in solar array field
5.14	Laying of 1Cx400/ OFC cables in inverter rooms and terminations at PCU/SCADA
5.15	Termination of 1Cx400 DC power cables and RS 485 cables at SMBs
5.16	Laying and Termination of 1Cx630 LT AC power cables at PCU and Inverter Transformer
5.17	Identification marking of cables using cable tags
5.18	Installation of electrical panels within inverter room and main control room
5.18.a	**Supply and Installation of PCU ducts**
5.19	Supply and Installation of cable trays, cable laying/dressing etc. in inverter room / main control room
5.20	Laying, termination of LT/HT/aux supply cables in inverter/ main control rooms and in associated 33KV transformer yards
5.21	33KV HT cable Laying and termination from Control room to power transformer at 132KV switchyard
5.22	Laying and installation of Control / data / instrumentation / communication cables
5.23	Erection of 33KV Transformer yard
5.24	Supply, erection and commissioning of auxiliary transformer 100kVA, 33kV/415V, Dyn11, Outdoor, ONAN
5.25	Auxiliary AC/DC power supply system
5.26	Supply and installation of security room and Security Cabins-Prefab structures
5.27	Supply and Installation of Weather monitoring system

5.28	Installation and commissioning of SCADA integration systems
5.29	Earthing for solar array structures and SMBs
5.30	Earthing system for inverter rooms, main control room, 33kV transformer yards
5.31	Design, supply and installation of CCTV System
5.32	Design, supply and installation of Plant lighting system
5.33	Firefighting systems
5.34	Identification marking using painting
5.35	Cable markers and cables tags
5.36	Display boards and sign boards
5.37	Electrical insulation mat
5.38	Supply and Installation of Miscellaneous Items
5.39	Tool kits and instruments
5.40	Cable installation Methodology
5.41	Pre-commissioning inspections / checks / tests, MRT tests and coordination / liaison activities with state / central departments / Transco/ DISCOM/ CEIG/ CEA etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant
5.42	Spares required to be supplied along with main consignment:
6.0	General conditions applicable during supply, installation, commissioning and O&M
7.0	Documents to be submitted for BHEL/SECI approval during detailed engineering

1.0 Introduction

1.1 Overall project outline of 39MW (AC) solar photovoltaic power plant

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up 39MW (AC) solar photovoltaic (SPV) power plant for SCCL at Yellandu Village, Bhadadri Kothagudem Distt, Telangana.

Solar PV modules employed at the plant generates DC electricity that in turn shall be inverted to AC at 350V-380V range Output of each solar block (5MW) with independent Inverter/Control room (IR/CR) / transformer yards shall be stepped up to 33kV. Solar plant comprises of 7 no of Inverter room each associated with 5 MW PV array and 1 no. of Main Control Room (MCR/ CR) with associated 5 MW PV array. Output of IR rooms is combined at CR at 33KV level. Combined AC output at CR is stepped up to 132kV.

MMS structures are seasonal type.

The plant is envisaged to have several other infrastructural support systems such as module cleaning system for SPV modules, plant illumination system, fire alarm system, boundary fencing, approach roads, pathways, drainage system etc.

1.2 Scope of this tender specification

Vendor scope includes supply, installation, testing and commissioning of certain identified activities of the solar photovoltaic power plant.

This scope includes activities but not limited to obtaining approval from BHEL/ SCCL/ SECI for the datasheets/ drawings/ MQP, manufacture/ testing/ inspection at manufacturer's works, packing, supply, transportation, transit insurance, delivery to site, unloading, storage, installation and commissioning of certain AC and DC side activities of power plant identified under this specification.

Note: The above is only a broad outline of vendor scope for the sake of introduction. The detailed vendor scope is elaborated under various other sections of this specification.

1.3 Enclosures to this tender specification (Tender purpose only)

1	Tentative AC single line diagram of overall Solar PV power plant
2	Tentative SPV plant layout
3	Tentative layout of main control room
4	Tentative layout of inverter room

2.0 Location/ address of power plant:

39MW (AC) Solar Photovoltaic Power Plant, Yellandu Village, Bhadadri Kothagudem Distt, Telangana.

3.0 Vendor scope of supply, Installation, Commissioning and O&M

The table below indicates the scope of work for the vendor, as briefly outlined. Vendor shall submit the offer as per this list and quantity.

#	Scope of work (as briefly outlined)	Qty
1	**Supply of Items for Control Room (CR) and its associated array** This includes the supply of MC4 connectors, Y-connectors, cable ties, HDPE pipes, 100KVA ONAN auxiliary transformer, Weather monitoring system, cable lugs, glands, cable tray, earth chambers, Air conditioners, Furniture, cable tags, sign boards, danger boards, nuts, bolts, hardwares, termination kits, jointing kits, Outdoor lighting system, CCTV system etc. as per the various clauses of this specification	1 Set
2	**Supply of Items for Inverter room (IR) and its associated array** This includes the supply of MC4 connectors, Y-connectors, cable ties, HDPE pipes, cable lugs, glands, cable tray, earth chambers, cable tags, sign boards, danger boards, nuts, bolts, hardware, termination kits, jointing kits, Outdoor lighting system, CCTV system etc. for Inverter room and its associated solar array as per various clauses of this specification	7 Set
3	**Supply of Duct for 1250kVA PCU**	32 Set
4	**I&C of Items related to Control Room (CR) and its associated array** This includes, installation, testing and commissioning of SMB, PCU, Inverter Transformer, Aux Transformer, ACDB, UPS, FCBC, Battery banks, WMS, SCADA, furniture, earthing, cable tray, cable laying and terminations etc. as per the various clauses of this specification	1 AU
5	**I&C of Items related to Inverter room (IR) and its associated array** This includes, installation, testing and commissioning of SMB, PCU, Inverter transformers, Aux transformer, ACDB, UPS, FCBC, Battery banks, SCADA, earthing, cable tray, cable laying and terminations etc. as per the various clauses of this specification	7 AU
6	**I&C of duct for 1250KW PCU**	32 AU

4.0 BHEL scope of supplies and works

For clarity to the vendor, other items and activities within BHEL scope of solar PV plant end of the project are listed below:

1	Supply of 1C x 10 sqmm Solar Cable	~215 KM
2	Supply of DC cable, 1C x 400 sqmm, Al, XLPE, armoured as per IS: 7098 (from SMB to PCU)	~126 KM
3	Supply of LT cable, 1C x 630 sqmm, Al, XLPE, armoured as per IS: 7098 (from PCUs to Inverter transformers)	~7.5 KM
4	Supply of 33kV cable, 1C x 300, Al, XLPE, armoured as per IS: 7098 (for all 33kV connections within solar plant including Aux transformer HV side)	~48 KM
5	Supply of OFC cables along with termination kits. Also, termination of the cables at both ends (SCADA panels of inverter rooms, SCADA panels of main control room and at SMBs)	As required
6	Supply of power conditioning units (PCUs) of 1250 kW	32 Sets
7	Supply of String Monitoring Box and diode box	224 Sets
8	Supply of inverter transformer 2.5MVA, 33kV/350-350 V, ONAN	16 Nos
9	Supply of 33kV breaker panels	8 Sets

10	Supply of SCADA system including PLC panels, computers, software systems and related peripherals & accessories	8 Sets
11	Supply of ACDB	8 Sets
12	Supply of UPS with battery bank	9 Sets
13	Supply of FCBC and Battery	8 Sets
14	Supply of Dry type aux transformer for Inverter rooms	7 Nos
15	Supply and installation of module cleaning system including borewell construction and RO plant, as required	1 set
16	Supply and Installation of Lightning arrestor	1 set
17	Supply of Auxiliary, Control and communication cables	1 Set
18	Supply and Installation of Fire alarm System	8 Sets
19	Supply of Earthing material for PV array, IR and CR	1 Set
20	Supply and Installation of Module mounting structure including module mounting	~3300 Sets
21	Construction of Inverter and aux transformer foundations including fencing	1 Set
22	Unloading/ storage/ security for BHEL supplied items.	-
23	132 KV switchyard and line works	1 set
24	Construction of RCC inverter rooms, RCC main control room except those vendor scope supply/I&C activities defined under this specification.	1 + 7 rooms
25	Construction of civil works such as approach roads, pathways, drains, overall plant boundary fencing, soak pit, septic tank.	-

5.0 Technical specification for supply, installation and commissioning

#	BHEL specification
5.1	**Temporary site office for vendor use** Vendor shall make necessary office arrangements such as porta cabin, furniture, electrical points/ fittings etc. on their own for their use/ occupation at site during the period of project execution. **Note:** Site offices for BHEL and SCCL/SECI shall be arranged by BHEL.
5.2	**Electrical power / water for construction** Vendor shall organize, on their own, necessary electrical power supply such as DG sets and water supply etc. required for construction activities.
5.3	**Construction of temporary yards for safe storage of vendor supplied items** Vendor shall, at a suitable location at the site, as decided based on discussions with BHEL site engineer, construct temporary yards for safe storage of vendor supplied items.
5.4	**Unloading, safe storage and movement of supply items received at site:** **A. Items supplied by vendor** (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 items (supplied by the vendor) received at site and subsequent movement to storage yards. (2) Similar arrangements shall also be made by vendor for movement of the stored items from storage yards to the exact construction locations within the project site. (3) Vendor shall maintain proper documentation / compilation of all the records related to shipping (invoices, LRs, delivery challans, material receipt certificates etc.) and shall take approval from BHEL site engineer for every consignment. The documents shall be suitably preserved for further handing over to BHEL.

	(4) Registers shall be maintained for the yard to keep track of incoming/outgoing items. (5) Safety of items shall be in vendor scope. Accordingly, suitable watch and ward shall be deployed on round-the-clock basis. **B. All other items (supplies from BHEL and other vendors)** (1) Receipt, unloading, storage, security guards shall be in scope of BHEL/ other vendors. (2) However, movement of these items from their respective storage locations to the points of construction is in scope of vendor (excluding modules and MMS). 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. (3) Vendor shall maintain proper documentation / compilation of all the records related to shipping (invoices, LRs, delivery challans, material receipt certificates etc.) and shall take approval from BHEL site engineer for every consignment. The documents shall be suitably preserved for further handing over to BHEL
5.5	**Series interconnection of SPV modules to form strings** Supply of SPV modules is in BHEL scope. Type of module: L24270 (~330Wp). Total quantity = ~1,32,000 Nos approximately Vendor shall interconnect the SPV modules as follows: (a) Each module is fitted integrally with a junction box having positive and negative polarity cables (4 sq-mm). (b) 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. (c) This way, 20 modules shall be connected in series. Each set of connections is called as a sub string. (d) Each Module mounting structure (MMS) contains 40 nos of SPV modules. Thus from each MMS, two sets of sub strings (top row forms one string and bottom row forms other string) will be formed via **leap-frog method**. These two sub strings will be paralleled at MMS itself using Y-connectors to form a combined output as a string. The combined output of Y connector will be connected to 10 sqmm solar grade cable through MC4 connector. Supply of Y connectors and MC4 connectors is in scope of vendor. This 10 sqmm cable will be terminated at the input side of Diode box/SMB as a single input. After placing the purchase order on vendor, BHEL will provide layout drawings that will describe the exact way in which the strings are formed after placement of purchase order. Vendor shall implement the interconnection as per these drawings.
5.6	**Routing of 1Cx 10 cable below the SPV modules** (1) 1Cx10 sq-mm cables connecting the SPV module strings (output of Y connector) to SMBs/ Diode boxes suitably routed below the SPV modules and along the horizontal C-lip purlin member of MMS structure. These cables shall be dressed properly and fastened to the purlin using UV resistant cable ties of suitable length. (2) Cable ties shall be in vendor scope of supply. (3) Cable ties, nylon polyamide 6.6 UV stabilized black, UL94 flammability rating V2, operating temperature up to 85 deg C, shall be used to arrest any possibility of movement or sagging. Cable ties shall be of make: 3M, Phoenix contact, Weidmuller, Hellermanntyton, Panduit or other reputed equivalent subject to approval of BHEL/SECI/SCCL. Width and Length shall be so appropriate as to ensure that the bunched cables are held firmly to the mounting structure. Spacing between two adjacent cable ties shall be so appropriate as to ensure that there is no loose hanging of cables. During detailed engineering, BHEL/SECI/SCCL approval shall be obtained for the selected brand and sizes of cable tie. (4) Spacing between two adjacent cable ties shall be so appropriate as to ensure that there is no loose hanging of cables.

	(5) Solar cables, wherever exposed to direct sunlight (including gaps between tables) and buried underground, shall be laid through Double Wall Corrugated (DWC) HDPE conduits.
5.7	**Interconnection of SPV module strings to 1Cx10 cable and Supply of Y and MC4 connectors** (1) Vendor shall connect two sub strings (each of 20 SPV modules) to 1Cx10 cable (copper, XLPO insulation cable) using **Y-connector and MC4 connectors**. (2) Vendor shall supply **3300 sets** (1 set = 2 nos) each of Y-connectors and **9900 sets** (1 set = 1 male + 1 Female connector) MC4 connectors. These quantities are excluding spares requirement. (3) Extra quantity shall be procured for any damages / pilferage during the installation by vendor at site. Such additional quantities will not be paid for. Vendor shall ensure that there shall not be any shortage during execution time. (4) Ten sets of tool kits shall be supplied. This shall include crimping plier MC4, open end spanner set MC4, stripping plier MC4, socket wrench insert to tighten, socket wrench insert to secure, inserts for both 4 sq-mm and 10-sqmm (of both pliers). (5) Y-Connectors and MC4 connectors shall have rating of 1000VDC (IEC), rated current of 30A (min), type approved by TUV Rheinland for product safety. (6) Approved make: Multicontact, Bizlink, Sunlont, Elmex or other reputed equivalent subject to BHEL/ SCCL/ SECI approval during detailed engineering. (7) In addition, any other required tools and tackles for crimping of cable etc. shall be arranged by vendor.
5.8	**Installation of SMB and Diode boxes including erection of SMB and diode box mounting structures** (1) Positive cable of each string will be connected to SMBs through diodes for reverse current protection. For the same, Diode boxes (16-input, 16-output, independent of SMBs) shall be supplied. Negative cables will be connected to SMBs directly. All SMB and Diode box cable entries shall be with MC4 connectors. Supply of string monitoring boxes (SMB) and diode boxes with mounting structures, 224 sets, is in BHEL scope. Structure Erection, equipment mounting and installation for SMBs and Diode boxes is in Vendor's scope. SMBs are 16-in/1- out type, Diode boxes are 16-in 16-out type. (2) Vendor shall assemble the structures including erection on foundations, install the SMBs and Diode boxes on SMB/ Diode box foundations. Necessary hardware like nuts, bolts, washers etc. and **canopy of SMB and Diode boxes** shall be in the vendor scope of supply. Details of canopy shall be given by BHEL. (3) Drawings and details of SMBs and the fixtures will be provided to the vendor after placement of purchase order. (4) All necessary labour, tools, machinery etc. for shifting from stores and erection work shall be in vendor scope.
5.9	**Routing of 1Cx10 cable in DWC HDPE pipes underground between the rows of solar array** (1) One SMB is connected to 15 strings. SMBs are located in center of a string block. Where 1Cx10 cables run vertically along MMS leg or between two rows of structure (or) where the cables cross over the pathway separation between two adjacent solar array blocks, HDPE double walled corrugated (DWC) pipe shall be provided to route the cables underground from one row/ block to the other. HDPE DWC pipe together with necessary HDPE couplers/ joints (T-joints, elbows, bends etc.) shall be within scope of vendor supply. Where cables run vertically along MMS leg, HDPE pipes shall be routed properly and tied/ clamped to leg. For this, necessary UV protective cable ties of suitable length or clamps shall be in vendor's scope of supply.

	(2) Specification of HDPE DWC pipe: As per relevant IS; ID shall be selected to accommodate the number of 1Cx10 cables to be guided. A maximum of 7 circuits can be run through single HDPE pipe. Fill ratio will be considered max 50%. However, exact ID shall be selected to ensure that only a maximum of 50% of the ID space is occupied by the cables. Make, part number, sizes/ dimensions shall be submitted for BHEL/SCCL/SECI approval during detailed engineering. (3) Cables with HDPE pipe (and couplers/joints etc.) shall be directly buried underground as per IS: 1255. Continuous trenches shall be excavated on either side of the SMB. In addition, for each SMB, there shall be minimum one pathway crossing, for which trench shall be excavated. a. Trench depth = 400 mm minimum b. Trench width = As per conduit size and number of conduits c. Trench shall, then, be filled with refill soil and compacted. Excavation, laying of pipes, routing of 10 sqmm cables through HDPE pipe, fixing of couplers, sealing end of the HDPE pipes, trench backfilling shall be vendor's scope. Trenches shall be backfilled, compacted and the area shall be neatly levelled. (4) Total length of HDPE DWC pipe and quantity of couplers/joints shall be as required. (5) Bending radii for cables shall be as per IS: 1255. (6) At road crossings, cables shall be routed through Hume pipe of class NP3 of appropriate size that shall be in vendor scope of supply and technical details/ brand etc. shall be submitted for BHEL/ SECI/ SCCL approval during detailed engineering. (7) All cable entry openings of conduit pipes, after laying/ termination of the cables, shall be sealed using appropriate sealant (single component thermoplastic insulating compound) to ensure water proof tightness. The sealant supply will be vendor's scope of supply. (8) Solar cables, wherever exposed to direct sunlight and buried underground, shall be laid through Double Wall Corrugated (DWC) HDPE conduits.
5.10	**Interconnection of Diode box and SMB** 1) 1Cx10 cables of positive polarity originating from SPV module strings shall be terminated at the input side of Diode box using MC4 connector. Output of Diode box shall be connected to SMBs using 10 sqmm cable with MC4 connectors. 2) Vendor scope includes removal of sleeve at the cable end, fixing of MC4 connectors of appropriate type/size and connecting the MC4 connector to the SMB/ Diode box. These cables will be supported suitably and dressed neatly. 3) 10sqmm cables will be supplied by BHEL, MC4 connectors will be supplied by vendor. Quantity for this is already considered under clause 5.7 of this specification. 4) 1Cx10 cables of negative polarities originating from SPV module strings shall be terminated directly at the input side of SMBs using 10 sqmm cable with MC4 connectors. 5) All necessary tools such as pliers, strippers, MC4 crimping tools etc. shall be within vendor scope.
5.11	**Termination of 1Cx10 cables on input side of SMBs/DIODE BOXES** (1) 1Cx10 cables of positive polarity originating from Diode box outputs shall be terminated at the input side of SMBs using 10 sqmm cable with MC4 connectors. 1Cx10 cables of negative polarities originating from SPV module strings shall be terminated directly at the input side of SMBs using 10 sqmm cable with MC4 connectors. MC4 connector are already fixed in cable entry/exit of Diode box input-output and SMBs as part of BHEL scope of supply. However, MC4 connectors required for connecting 10 sqmm cables to strings/SMBs/Diode boxes and Supply of Y connectors shall be done by Vendor. (2) Vendor scope includes removal of sleeve at the cable end, fixing of MC4 connectors of appropriate type/size and connecting the MC4 connector to the SMB/ Diode box. Cables shall be dressed properly using suitable UV protected cable ties at SMB/ Diode box ends. Supply of cable ties is in vendor's scope.

	(3) Any other hardware, if necessary for fulfilling the connection, such as bolts, nuts, screws, washers etc. shall be in vendor scope of supply. All hardware shall be of SS304. (4) All necessary tools such as pliers, strippers, MC4 crimping tools etc. shall be within vendor scope.
5.12	**Ferruling for 1Cx10 cable** 1) For 1Cx10 sqmm DC solar array cable, vendor shall supply and provide UV resistant ferrules printed with source/destination identification of cable. Printing details shall be given by BHEL after placement of order. Printing shall be of appropriate size to ensure readability. 2) Supply of ferrule shall be in vendor scope. 3) Ferrules shall be provided on all termination ends: module end, Diode box end and SMB ends for all 10 sqmm cables.
5.13	**Underground cable trenches and laying of 1Cx400, RS485 and OFC cables in solar array field** (1) DC power cable 1Cx400 sqmm, Al conductor, XLPE, armoured (from SMB to PCU), data cable RS485 (for looping between SMBs to SMBs) and OFC cable (from SMBs to SCADA) shall be laid underground by way of direct burying as per IS:1255. Supply of above the cables shall be in BHEL scope. Cable laying shall be carried out as per **"Cable installation methodology"** defined in this specification. (2) Typical trench details/dimensions are below only for tender purpose. (a) Total trench depth = 850 mm minimum (b) Trench width = As per number of cables laid. (c) Trench shall have layers one over the other as below (from bottom to top): 1. Bottom layer shall be sand of IS: 383 with 75mm minimum thickness 2. 1Cx400 cable shall be laid over the sand layer 3. Another layer of sand of 75 mm minimum thickness. 4. Single layer of brick as protective cover covering all cables 5. Then, 300mm backfilled with soil. 6. RS485/OFC cables shall be laid in HDPE pipe. 7. Trench shall, then, be filled with refill soil and compacted (3) Data communication (RS 485) cables shall be laid between SMBs to form daisy chain loop (Not more than 7 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. These cables shall be laid underground through HDPE pipe at a min depth of 400 mm with clearance of 300 mm min from adjacent running power cables. HDPE pipe for OFC and RS485 cables will be supplied by BHEL. UV resistant ferrules shall be supplied and fixed for identification of cables by vendor. (4) Bending radii for cables shall be as per IS:1255. At road crossings, cables shall be routed through Hume pipe (Class NP3, 150 dia minimum) of appropriate size that shall be in vendor scope of supply. At Nallah crossings, cables shall be routed through Covered cable trays/ structures. Hume pipe and cable trays/ structures of appropriate size shall be in vendor scope of supply, fabrication, grouting and erection. (5) Vendor shall take utmost care in laying the cables in order to prevent wastages and damages on outer sheath and inner insulation. Cable shall be drawn with rollers only to ensure no damage to cable during laying. In case cables found to be damaged/ cut after the laying in trenches, vendor shall implement suitable corrective action such as cable jointing, or re-lay a new cable in consultation with BHEL.
5.14	**Laying of 1Cx400/ OFC cables in inverter rooms and terminations at PCU/SCADA** (1) 1Cx400 cables (Al conductor, XLPE insulation, armoured: BHEL scope of supply) and OFC (unarmoured, BHEL scope of supply) running from SMBs (through outdoor cable trenches) shall be routed into the inverter/ control rooms and laid on the cable trays therein. Supply and laying of cable trays within the rooms shall be in vendor scope. Vendor shall

	route, lay and dress the cables neatly on the trays. Cable ties shall be in vendor scope of supply. OFC Cable shall be laid inside the HDPE pipe. Cables shall enter in control/inverter rooms through PVC pipe (dia 150mm min.) provided in entry points. (2) Vendor shall carry out drilling of holes in cable gland plates of the PCUs for the 7 positive and 7 negative DC inputs of 1Cx400 cable. Similarly, holes for entry of OFC cables into SCADA panels. Gas cutting method is strictly not allowed. Vendor shall organize hole-saw cutters of appropriate size for this purpose. All necessary drilling machines / tools etc. shall be made available at site. (3) Prior to termination, each cable shall be checked for continuity and megger. In case any cable found defective, vendor shall implement suitable corrective action such as cable jointing, replacement/re-laying of cable etc. as applicable. (4) Vendor shall carry out glanding of the cables following which the glands shall be fitted to the respective holes of gland plates. . Holes shall be drilled in the gland plate by vendor. (5) Vendor shall carry out the 1Cx400 cable terminations for the 7 positive and 7 negative inputs that include tasks such as unsleeving, crimping, connecting to the tinned copper bus bars, tightening using torque wrench etc. Bimetallic Lugs and metallic double compression glands for power cable termination at PCU is in vendor scope of supply. Total lugs requirement- 448 **nos** approx. Make shall be Dowell, or equivalent subject to approval of BHEL/SECI/SCCL Lug shall match the cable conductor material /size and also the tin plated copper bus bar of SMB. Total Glands requirement- **448 nos** approx. Make shall be COMET or equivalent make subject to approval of BHEL/SECI/SCCL. (6) Quantity of lug, glands and hardware shall also include contingency requirements arising out of shortage due to various reasons (damage, theft etc) during installation. (6) Cable glands (metallic, single compression) for OFC cable termination is in vendor scope of supply. (7) Vendor shall arrange torque wrench of appropriate range. Torque setting shall be as per the bolt size and property class. For the setting, approval shall be obtained from BHEL site engineer. (8) All tools/accessories such as crimping tools etc. required to carry out the termination shall be within scope of vendor.
5.15	**Termination of 1Cx400 DC power cables and RS 485 cables at SMBs** (1) Cables of 1Cx400 (Al conductor, XLPE insulation, armoured) shall be terminated at the output side of SMBs (positive, negative terminals). Supply of this cable is in BHEL scope. (2) 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 tinned copper bus bar within the SMB. Cables shall enter the SMB through the metallic cable glands that are also supplied by BHEL along with SMBs. (3) Bimetallic lug shall be in vendor scope of supply. Total requirement- **448 nos** approx. Make shall be Dowell, or equivalent subject to approval of BHEL/SECI/SCCL Lug shall match the cable conductor material /size and also the tin plated copper bus bar of SMB. (4) Quantity of lug and hardware shall also include contingency requirements arising out of shortage due to various reasons (damage, theft etc) during installation. (5) All necessary tools such as pliers, strippers, crimping tool etc shall be within vendor scope. (6) Similarly, vendor shall carry out RS485 cable terminations at SMBs. Supply of Cable glands is in BHEL scope as part of SMBs. Cable lugs shall be in vendor scope of supply for which details of make, part number, size etc. shall be submitted for BHEL/SECI/SCCL approval during detailed engineering. Shield of the RS485 cables shall be suitably earthed at SMB end.

5.16	**Laying and Termination of 1Cx630 LT AC power cables at PCU and Inverter Transformer** (1) LT Cables 3 runs of 1C x 630 sqmm Al conductor, XLPE, unarmoured per phase shall be laid between AC side of the PCU and the LT side of the Inverter transformer in RCC trench. Supply of this cable is in BHEL scope. Cables shall be laid in trefoil arrangement. Trefoil clamps supply and fixing in in vendor's scope. (2) Vendor scope includes removal of sleeve at the cable end, crimping with suitable Bimetallic Lug. Cables shall enter the PCU and Transformer through the metallic cable glands. Supply of Lugs and Glands required for PCU side and Inverter Transformer side termination shall be in vendor's scope. Required qty- **576 nos of lugs, 576 Nos of glands** approx. (3) Cable lug make shall be Dowell, or equivalent subject to approval of BHEL/SECI. (4) Cable gland metallic type shall be of COMET make or equivalent subject to approval of BHEL/SECI/SCCL. (5) Quantity of lug and hardware shall also include contingency requirements arising out of shortage due to various reasons (damage, theft etc.) during installation. (6) All necessary tools such as pliers, strippers, crimping tool etc. shall be within vendor scope.
5.17	**Identification marking of cables using cable tags** 1) Cable tags shall be provided on all power cables at both ends just before entering the equipment enclosure and every 20 m on cable tray or trench run. 2) Cable tags shall be of rectangular shape. 3) Cable tag shall be of 2mm thick aluminum with number punched (embossed) on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. 4) ID numbering scheme shall be provided to vendor after Purchase order placement. Vendor shall submit the technical details of cable tags for BHEL/SECI/SCCL approval during detailed engineering.
5.18	**Installation of electrical panels within inverter rooms and main control room** **Panel installation within each inverter room:** Vendor shall organize necessary resources such as labour, cranes, hydra, forklifts, transportation trucks / trolleys and other accessories for movements and positioning of the panels as below (Quantities mentioned are per inverter room): (a) 1250 kW PCU panels: 4 sets (including PCU assembly- DC, AC & PCS cabins) (b) 33kV VCB panels: 1 set (2 incomers + 1 outgoer. This includes assembly of panels together as well) (c) Indoor Dry type Aux Transformer – 1 No (d) Distribution boards: ACDB, UPSDB, AC, DCDB and any extra boards as required (e) SCADA panel: 1 No (f) UPS with battery bank: 1 No (g) FCBC battery charger with Battery bank– 1 No **Panel installation within main control room:** (a) 1250 kW PCU panels: 4 sets (including PCU assembly- DC, AC & PCS cabins) (b) 33kV VCB panels: 1 Set (9 incomers + 1 outgoer + 1 Aux TRF outgoer + 1 Bus PT. This includes assembly of panels together as well) (c) ACDB main panel: 1 set (d) Distribution boards (wall mounted): DCDB, UPS DB, CR DB (room utilities), LDB (plant illumination), PDB (power DB): 1 No each + any extra boards as required (e) SCADA panel: 2 Nos (f) HMI SCADA control desk with PCs and accessories: 1 set

	(g) UPS with battery bank – 2 Nos (h) FCBC battery charger with battery bank – 1 No (1) Panels shall be moved to the respective positions and placed over the cable trenches in control room, in the exact sequence and locations as per drawings. Drawing shall be provided after placement of purchase order. (2) PCUs, VCB panels shall be placed on cable trench of inverter / main control rooms, with cable entry openings to match cable trench on bottom side. (3) Panels shall be suitably grouted using welding/ bolting methods as per relevant standards and recommendation of OEMs. BHEL approval shall be obtained for the grouting arrangement. All necessary hardware for the same shall be within vendor scope of supply.
5.18. a	**Supply and Installation of PCU ducts** Scope shall include supply, fabrication and installation of ducts for PCUs. Total no of PCUs-32 nos. Duct drawing shall be provided by BHEL after placement of PO. All fixing brackets, support arrangement for duct on room ceiling (hang support), other support structures, hardware etc required for fixing the ducts shall be in scope of vendor. BHEL will provide the cut-outs in the room walls for fixing of ducts/ exhaust fans.
5.19	**Supply and Installation of cable trays, cable laying/dressing etc. in inverter rooms / main control room** **A. Installation of cable trays** (1) Vendor shall supply and install cable trays, fittings and accessories within control room for laying 33kV HT, DC/AC LT, control, communication cables etc. Cables trays shall be ladder type with horizontal corner bend pieces and shall have 750mm minimum width, 3mm minimum thickness and 100mm minimum height. Drawings/ make/ part number of these shall be submitted for BHEL/SECI/SCCL approval. (2) Cable trays shall be installed by vendor on MS support angles provided in cable trench by BHEL. (3) Cable trays shall be in three vertical layer arrangements: bottom for 33kV cables, middle for LTAC/DC cables and top for control/data/ communication cables. (4) Suitable cut outs, wherever applicable, shall be made in the cable trays to provide path for the cable to reach the panel. (5) Adjacent cable trays shall be interconnected using suitable hardware items that shall be in vendor scope of supply. (6) Cable trays shall be double earthed to the earth mat grid of the room. **B. Cable routing, laying, dressing** (1) All Cables entering into the inverter/ main control rooms from outside (solar array/ transformer yards) shall be bunched appropriately LT/HT/control category wise. The multiple bunches shall be routed through PVC conduit pipes already provided in the building below the plinth beam of room. (2) Cables (HT, LT, communication, control etc.) shall be laid on cable trays in separate tiers with appropriate spacing as per IS: 1255. (3) Control/ data/ instrumentation cables that run from inverter rooms to marshalling box of inverter transformers shall be routed through HDPE DWC conduit pipes of appropriate size. (4) Cables shall be dressed using appropriate cable ties at appropriate intervals to ensure firmness of their position over the trays. (5) Trefoil clamps shall be used wherever single core cables are used for three phase system. These clamps shall be at appropriate intervals to ensure firmness of bunching of cables. (6) All cable entry openings of conduit pipes, after laying/ termination of the cables, shall be sealed using appropriate sealant to ensure water proof tightness.

	(7) All cable accessories such as cable conduits/pipes, ties, trefoil clamps, sealants etc for the above purpose shall be in vendor scope of supply. (8) All the supply and installation works as mentioned above shall be as per "**Cable installation methodology**" section of this specification and as per drawings. Drawings shall be provided after placement of purchase order.
5.20	**Laying, termination of LT/HT/aux supply cables in inverter/ main control rooms and in associated transformer yards** (1) For all electrical panels viz. PCUs/ VCB panels/ ACDB panel/ UPS/ FCBC battery charger/ battery bank /DB boards/ aux transformer and inverter transformers of the inverter rooms, laying and termination of LT/HT/Aux power cables shall be in vendor scope. (2) For all electrical panels viz. PCUs/ VCB panels/ ACDB panel/ UPS/ FCBC battery charger/ Battery bank / DB boards / aux transformers/ inverter transformers/ Power Transformer (33KV side) of the control room, laying and termination of LT/HT/Aux power cables etc shall be in vendor scope. (3) 630sqmm AC cables in transformer yards in inverter room and control room yard shall be routed through RCC trenches. Construction of RCC cable trench shall be BHEL scope. (4) Cable glands, cable lugs, 33kV HT cable termination kits (indoor/ outdoor types as applicable), Cable jointing kits, lugs, bolts, nuts, washers etc. shall be in vendor scope of supply. (5) It is the responsibility of the vendor to assess the actual length requirements duly considering all applicable clearances as per relevant standards, Indian electricity rules, CEA/CEIG requirements etc. For this purpose, tentative (indicative) locations of inverter/Control rooms, internal layouts of inverter/Control rooms are enclosed along with tender. (6) For marshalling box of transformer/ UPS/ SCADA/ DB boards, single compression nickel plated brass glands shall be provided by vendor. Make shall be COMET or reputed equivalent subject to approval of BHEL/SECI/SCCL. (7) HT termination kits (indoor/ outdoor as applicable) shall be of Raychem make as shall be approved by BHEL/SECI/SCCL. HT termination shall be carried out by certified jointers. Credentials / certification of experience from Raychem for the proposed jointers shall be submitted for BHEL/SECI/SCCL approval during detailed engineering. (8) Quantity of 33KV End termination and straight through jointing kits shall be supplied by vendor as follow (for solar plant connections only, termination kits for transmission line and substation purpose will be additional as per design): a. Indoor 33KV End termination kit for 1Cx300 sqmm (E) cable = **153 Nos** b. Outdoor 33KV End termination kit for 1Cx300 sqmm (E) cable = **9 Nos** c. 33KV, 1C, 300 sqmm (E) Straight through jointing kits = **36 Nos** These quantities are excluding spares requirement. (9) The scope of HT cable laying and termination at Control room incomer panels for the cables coming from Inverter rooms shall be in the scope of the vendor. (10) **The scope of HT cable laying and termination (three runs per phase) from Control room outgoer panel to 33/132KV Power transformer shall be in the scope of the vendor including cable trench, cable support structure work.** (11) Suitable arrangements will be made for connecting 33KV cable to Power transformer LV outdoor bushings. (12) All trench excavations, cable laying, sand and brick layer, backfilling etc as per IS 1255 shall be in vendor's scope.

(13) Vendor shall make appropriate holes in the gland plates of PCUs, HT VCB panels, ACDBs, SCADA panels, Inverter transformers, Marshaling boxes, Auxiliary transformer, Battery chargers, Distribution boards etc. for fixing the cable glands. Gas cutting is strictly prohibited. Hole-saw cutters of appropriate sizes with suitable drilling machines shall be made available at site for this purpose.

(14) Bimetallic lugs shall be used for connecting Cu bus bar and Al cables or vice-versa wherever applicable.

(15) Terminations with M10 and above shall be tightened using torque wrench. Torque setting shall be as per size, property class of bolt. BHEL approval shall be obtained for the settings prior to tightening.

(16) Approximate (indicative) specifications of certain power cables are as follows. Exact specification shall be based on design calculations that shall be submitted for BHEL/SECI/SCCL approval during detailed engineering. Quantity shall be appropriately selected.

(a) PCU to 2.5MVA transformers: **Cable supply in BHEL scope**
3-phase 3-wire system, 3Rx1Cx630 sqmm per phase (with R, Y, B colour coding), 1.1kV grade, aluminium conductor, XLPE insulation, unarmoured, PVC sheathed as per IS: 7098. (Note: cables from inverter/CMCS room shall be laid in RCC trench in trefoil arrangement).

(b) HV (33kV) side connections in VCB panels (incomers, outgoers), 2.5MVA transformer, control room auxiliary transformer: **Cable supply in BHEL scope**
3-phase 3-wire system, 1Rx1Cx300 sqmm per phase, 33kV, aluminium conductor, XLPE insulation, armoured, PVC sheathed as per IS: 7098.

(c) HV (33kV) side connections from Outgoer VCB panel in control room to 33/132KV Power transformer: **Cable supply in BHEL scope**
3-phase 3-wire system, 3Rx1Cx300 sqmm per phase, 33kV, aluminium conductor, XLPE insulation, armoured, PVC sheathed as per IS: 7098.

(d) PCU to dry type auxiliary transformer in inverter room: **Cable supply in BHEL scope**

(e) Dry/ONAN Auxiliary transformers to ACDB panel in each inverter/ Control rooms: **Cable supply in BHEL scope**

(f) LT AC aux power supply cables from ACDB panels in Inverter/control room to the related utility loads such as battery charger, UPS, MCB DB boxes for room appliances, PCU, transformers aux supply, SCADA, VCB panels aux supply, fire alarm system, panel illumination lamps, space heaters of VCB panels etc. **Cable supply in BHEL scope**

(g) LT DC aux power supply cables from DCDB panels in inverter/Control rooms to the utility loads such as DCDB panels, VCB panel tripping/closing circuits, SCADA, VCB panel spring charge motors etc. **Cable supply in BHEL scope**

(17) Supply of all cable accessories (for the above requirements) such as cable trays, cable glands, cable lugs, ferrules, nuts/bolts/washers, cable dressing ties etc shall be in vendor scope.

(18) Laying of above cables, fixing of cable glands, cable termination at the respective terminal bus bars shall be in the scope of vendor

(19) All resources such as labour, machinery, tools and accessories to carry out the above electrical works shall be in vendor scope.

(20) All applicable/relevant clauses under "**General specification of LT cables**" and "**Cable installation methodology**" sections of this specification shall be adopted for all aspects of these cables.

5.21	**33KV HT cable Laying and termination from Control room to power transformer at 132KV switchyard** The 33KV KV HT cable laying and termination work between Control room VCB outgoer and 33/132KV power transformer shall be in the scope of the vendor. 3Rx1Cx300 sqmm/ph shall be laid and terminated at both ends. Suitable arrangements will be made for connecting 33KV cable to Power transformer LV outdoor bushings. Note: **These cables shall be laid on the cable trays from Control room to Power transformers.** For this vendor to provide the necessary cable support structure, insulators. Supply of cable tray, support structure, insulators and necessary hardware is in vendor's scope of supply and installation.
5.22	**Laying and installation of Control / data / instrumentation / Communication cables** (1) BHEL shall supply all the control/ data/ instrumentation / communication cables. (2) All the cable installation accessories such as cable trays, cable conduits, cable glands, cable lugs, ferrules, cable ties, bolts, nuts, washers etc. shall be in vendor scope of supply. Cable laying and cable terminations shall be in vendor scope. All necessary resources such as labour, tools and accessories required to carry out laying and termination works etc. shall be in vendor scope. (3) **OFC cable** termination kits shall be in BHEL scope of supply. Vendor scope includes laying of the OFC cable underground in the conduit from SMBs to SCADA panel and from inverter room SCADA panels to main control room SCADA panel. Termination of the OFC cables at both the ends shall be in BHEL scope. (4) Vendor shall lay and terminate the **RS485 cables** to SCADA from all plant equipment e.g. HT panels, ACDBs, transformers, FCBC, UPS etc. These cables shall be laid between the panels of respective inverter/ main control rooms. (5) Vendor shall lay and terminate the Ethernet cables to SCADA from (a) PCUs, (b) numerical relays of VCB panels. These cables shall be laid between the panels of respective inverter/ main control rooms. (6) Vendor shall lay and terminate control and instrumentation cables from inverter transformers to SCADA and from HT breakers to SCADA. (7) Electrical Interconnections of HT breaker panels e.g. outgoer, incomers, Bus PT panels for inverter room and control room HT breakers. (8) Suitable size ferrules with details shall be provided on either side on either side of each control/ data/ instrumentation cable. (9) BHEL will provide cable schedules during execution. (10)All applicable/relevant clauses under "**Cable installation methodology**" sections of this specification shall be adopted for all aspects of these cables.
5.23	**Erection of 33KV Transformer yard** (1) Inverter room is attached to two transformer yards each having one inverter transformer. (2) Control room is attached to one transformer yard having two inverter transformers and one Aux transformer 100kVA, 33kV/415V. (3) Construction of transformer RCC foundations, fencing and gates for transformer yard in control room and inverter room is in BHEL scope. Levelling, stone jelly, cable support structures fabrication & foundation works, all earthing related works-excavation etc shall be in vendor's scope. **TRANSFORMER ERECTION-** (1) Vendor shall erect the inverter and auxiliary transformers on RCC foundation as per transformer GA details. Vendor scope of I&C of transformers shall include:

a) Movement of transformers and its accessory parts such as radiators, cable boxes, hardware etc from storage yard and placement on foundation pedestal.
b) Assembly of transformer parts.
c) Cable laying and terminations at LV/HV/Marshalling boxes of transformers.
d) All activities applicable to oil filling and filtration including measurement of oil BDV and PPM. Particularly for inverter transformers, filtration of oil shall be carried out to such an extent as to obtain the desired BDV (>60 kV) and PPM (< 15ppm) values.
e) Testing of transformers as per "**pre-commissioning checks**" section of this section.

(2) After installation of transformers at the transformer yards of each inverter/ main control room, vendor shall level/ compact the ground with an appropriate magnitude and direction of slope to facilitate draining of rain water away from transformer yard. Accordingly, to prevent stagnation of water within transformer yard, vendor shall implement suitable civil works in and around the transformer yard. This shall include filling up the land (wherever necessary) with suitable soil and compact the filled-up portions either manually or with rollers, as applicable, as per site conditions, to achieve required compaction/slope.

General Notes-

Vendor shall provide the 100 mm layer of stone gravels in transformer yards as per relevant IS standards / CBIP/ CEIG requirements etc.

Vendor shall provide applicable earthing connections to transformers, fencing / gates etc. in the yard as per relevant clauses under the "**Earthing system**" section of this specification.

All other items (if any, other than the above) that are required to meet the technical requirements of transformer yard as per applicable standards / electricity rules shall be incorporated by the vendor.

5.24 Supply, erection and commissioning of auxiliary transformer 100kVA, 33kV/415V, Dyn11, Outdoor, ONAN

QTY REQUIRED- 1 NO

Type test reports from NABL accredited lab will be submitted for Auxiliary transformer for approval of manufacturer. Vendor will be approved based on type test report and credential.

1.0 Technical parameters and specifications:

#	Technical parameter	Specification
1	Transformer type	Outdoor, oil-immersion type
2	IP class	Transformer, including cable box and marshalling box shall be of IP55
3	Type of cooling	ONAN
4	Governing Standard	IS: 2026
5	Rating in KVA	100 kVA
6	No. of phases	3
7	Frequency	50 Hz, +/- 3%
8	HV winding	33kV, 3-Ph, with **Delta** connection
9	LV windings	415V, 3-Ph, with **Star** connection
10	Winding material	Electrolytic grade copper for both HV and LV windings
11	Winding Insulation	Class A

12	Neutral on LV side	Neutral terminal shall be brought out separately to facilitate earthing connections.
13	Vector Group	Dyn11
14	Short circuit withstand time (thermal)	2 sec.
15	% Impedance	As per IS: 2026
16	Termination HV/LV/Orientation	Air insulated cable box with disconnecting chamber, for both HV and LV sides. Cable box / Cable box / 180^0.
17	Cable entry on HV side	Bottom entry of cables.
18	Cable entry on LV side	Bottom entry of cables.
19	Cables and accessories	HV & LV Cables, termination kits (for HV), cable lugs (Dowell make), (Comet make) and connecting hardware shall be in vendor scope of supply. Vendor shall provide hole on the bottom-side gland-plate of HV & LV side cable box for cable entry as per the final outer diameter of cable provided by BHEL during detailed Engg.
20	Tapping on HV winding	Off circuit tap changer (OCTC) switch with five tap positions: +5%, +2.5%, 0, -2.5%, -5%.
21	Loading Capability	Continuous operation at rated KVA on any tap with voltage variation of +/-10%. Transformer shall be capable of being loaded in accordance with IS: 6600 / IEC 60076-7.
22	Ambient temperature	Max 50 deg C
23	Temperature rise	For top oil: Max. 50 deg C by thermometer method For winding: Max. 55 deg C by resistance method Both rises shall be over an ambient temperature of 50 deg C irrespective of tap position.
24	Flux density	Not to exceed 1.9 Wb/sq.m at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over-fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating b) 125% for at least one minute c) 140% for at least five seconds Vendor shall furnish over-fluxing characteristics up to 150%
25	Air Clearance	As per CBIP
26	Load loss principal tap at 75^0C, with IS tolerance	This shall be provided by vendor.
27	No Load loss at rated voltage on principal tapping and	This shall be provided by vendor.

		at rated frequency, with IS tolerance	
	28	No load current at rated voltage and rated frequency	This shall be provided by vendor. To be indicated as percentage.
	29	Efficiency at 75^{0}C, UPF	As per IS 1180 and CBIP
	30	Regulation at full load, 75 ^{o}C	< 2 % for UPF For 0.8 PF lagging, to be indicated by vendor.
	31	Harmonics	Shall be designed to suppress harmonics especially 3rd& 5th.
	32	Vibration & noise	Noise level shall be according to NEMA TR-1 standard
	33	Highest system voltage	LV side: 1.1kV HV side: 36 kV
	34	Insulation levels as per IS:2026 Rated Lightning Impulse withstand voltage / Short duration power frequency withstand voltage	LV side: -- kVp / 3 kV rms HV side: 170kVp / 70kV rms
	35	Overall dimensions in mm Length x Breadth x Height	This shall be provided by vendor.
	36	Oil capacity (in Litres)	This shall be provided by vendor.
	37	Weight of transformer in Kg	This shall be provided by vendor.
	38	Constructional features	As per relevant clause of this specification
	39	Fittings and accessories	As per relevant clause of this specification
	40	Painting	RAL 7032

2.0 Tests on auxiliary transformer will be witnessed by BHEL/SECI/SCCL prior to dispatch clearance.

5.25 **Auxiliary AC/DC power supply system**

Supply of ACDB at control room and inverter room is in BHEL scope. Installation, testing and commissioning is in vendor's scope.

Following DB boards for application in main control room shall be in vendor scope of supply, installation and commissioning:

Control Room UPS DB for 230V AC UPS supply to SCADA, weather monitoring system, fire alarm system, emergency loads, CCTV system along with fixing arrangement/ structure- 2 Nos

	Following DB boards for inverter rooms shall be in vendor scope of supply, installation and commissioning: Inverter Room UPS DB 230V UPS supply for PCUs (control circuits), fire alarm system panel, emergency loads, CCTV system etc – 1 No for each Inverter room i. SLD will be shared after PO placement. ii. Above DBs shall be of reputed make such as Legrand, Siemens, Schneider or any other reputed make as approved by BHEL/SECI/SCCL. iii. Installation of all the above items including all necessary cable terminations/ installation shall be in vendor scope.
5.26	**Supply and installation of security room and Security Cabins-Prefab structures** i. Vendor shall provide **5 Nos. of security cabins** at strategic locations & at corners of the plot and **1 nos. security room** at Main entry gate. ii. The Security room shall be of min. size 4m x 4m x 2.75m height The Security cabin shall be of min. size 1.2 x 1.8m x 2.5m height. iii. Security room/ cabin shall be a pre-engineered & pre-fabricated structure. The walls and roof of the building shall be fabricated with double skin insulated sandwiched Al-Zn alloy coated high tensile steel metal panels (BMT- 0.5mm, Al-Zn alloy coating -150 GSM total on both sides). The insulation shall be of PUF with min. density 40 kg/ cum and adequate thickness. Roof shall be provided with suitable slope, not less than 100 to the horizontal (approx. 1V:6H) for proper drainage of rain water and shall project 300mm beyond the walls. The make and (color) shade of precoated metal panels shall be subject to approval by the Engineer. Min. thickness of color coating shall be 20 micron (DFT) excluding prime coat 5 micron (DFT). The coating system shall confirm to IS; 15965. iv. The Main security room shall be provided with one Aluminum (AL) glazed door (0.75m wide x 2.1m height) on one face and AL glazed sliding windows (1.2m width x 1.0 m height) with AL grill on remaining three sides. Security cabin shall have one AL glazed door (0.75m widex2.1m height) and 1 no. AL sliding window (0.8m width x 1.0 m height) with AL (anodized) grill on one side. All glazing shall be of clear float glass with thickness of 4mm for window and 6 mm for door panel. v. The door and windows shall be provided with all necessary fitting and fixtures like handles, tower bolts, mortise lock for door, stays, door stopper etc. All AL sections for doors and windows shall be anodized (min. average thickness 25 microns) or polyester powder coated (min. DFT 50 microns) with approved color shade for protection against weather. vi. Specially coated/ SS self-drilling screws/ fasteners conforming to class 3 as per ASTM: 3566.1 and 3566.2 shall only be used for all connections. vii. Anchor/ foundation bolts shall be supplied by vendor and shall conform to IS: 5624 and IS 800. viii. The Security Room shall be supported on RCC pedestal & foundations. **RCC foundation shall be constructed by BHEL. Supply of foundation / anchor bolts shall be in vendor scope.** ix. The Design and drawings of pre-fab structure and RCC foundations shall be submitted for approval prior to fabrication and installation. x. Supply and installation of Electrical fittings (lights & fans) in security room and security cabins shall be in vendor scope. Vendor shall submit drawing for approval. xi. Cable laying from room to Security room/ security cabin including cable trenches is in vendor's scope.

5.27 Supply and Installation of Weather monitoring system

As part of weather monitoring system (WMS), vendor shall supply, install and commission Pyranometers, Anemometer, Temperature sensors and data logger with all necessary software and hardware such as power supply/ control/ data/ communication cables, support structures etc. required to integrate with SCADA.

Scope of vendor shall also include supply and erection of all the mounting arrangements including all necessary civil works/ foundations, clamps arrangement etc. as recommended by manufacturer and required at site. Communication cables shall be laid and terminated at both SCADA station at main control room and data logger at weather monitoring station end. Similarly, power supply cables shall be laid between WMS and DB boards in main control room.

Exact location of the weather monitoring station shall be decided during detailed engineering.
Detailed specification of WMS items is as below-

Pyranometer (2 Nos)
Vendor shall supply and erect 2 Nos pyranometers secondary standard pyranometers (ISO 9060 classification) for measuring the incidental solar radiation at horizontal and inclined plane of array. One shall be mounted horizontally and one shall be mounted in tilt position on MMS.
Specification of the pyranometer shall be as follows-

Parameter	Specification
Spectral Response	0.31 to 2.8 micron
Time response (95%)	Maximum 15s
Nonlinearity	±0.5%
Temperature Response	±2%
Tilt error	<±0.5%
Zero offset thermal radiation	±7 W/m^2
Zero offset temperature change	±2 W/m^2
Operating temperature range	0°C to +80°C
Non-stability	Maximum ±0.8%
Resolution	Minimum +/- 1W/m^2
Output	Analog output: 4 – 20 mA, Serial output: RS485

Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the equipment. The signal cable length shall not exceed 20m. The Contractor shall provide instrument manual in hard and soft form.

Temperature Sensors
Vendor shall supply and install two thermometers (one for ambient temperature measurement with shielding case and other for module temperature measurement). The thermometers shall be RTD/ semiconductor type measuring instrument with measurement range of 0°C to 80°C. The instrument shall have valid calibration certificate.

Ultrasonic Anemometer and wind vane (wind speed and direction)
Vendor shall supply and install one no. ultrasonic wind sensor (no moving parts) for wind speed and direction monitoring.

Specification of the Anemometer shall be as follows-

Parameter	Specification
Velocity range with accuracy limit	0-60m/s with +/-2% accuracy @12 m/s; Resolution: 0.01m/s
Wind direction range with accuracy limit	0 to 360° (No dead band) with +/-2° accuracy @12 m/s; Resolution: 1°
Mounting Bracket	Anodized Aluminium bracket to reduce corrosion, all mounting bolts of SS
Protection Class	IP66
Output	RS232 and RS485

Data logger and Data Acquisition System

Vendor shall supply and install data logger for weather monitoring system. Data logger for the weather monitoring station should have the following features:
Provision for analog, digital and counter type inputs for interfacing with various type of sensors
(i) Analog Input
- Adequate nos. for all analog sensors with redundancy
- Provision for operation in different current and voltage ranges as per connected sensors
- Accuracy of +/-0.1% of FS

(ii) Digital Inputs
- Adequate no. of Digital inputs and outputs for the application

(iii) Provision for RS232 and RS485 serial outputs
(iv) Built-in battery backup
(v) Connectivity and Data transmission:
- Built-in GSM/ GPRS modem for wireless data transmission to SCADA/ cloud server (procurement of GPRS enabled SIM Card and connection subscription to be the responsibility of Contractor). It should be possible to remotely communicate with the device for configuration settings.
- RS485 MODBUS interface for data collection and storage on SCADA
- Web interface with provision for user login to enable viewing and downloading of weather data in XLS/ CSV format
- Communication protocol should support fast data transmission rates, enable operation in different Frequency bands and have an encryption-based data security layer for secure data transmission

(vi) Display Settings: Graphic LCD screen which should be easily accessible and should display relevant details like all sensor values, battery strength, network strength etc.
(vii) Provision of Time synchronization from telecom time or server time
(viii) Data Storage: Provision for at least 2 MB internal Flash Memory and at least 8 GB Micro SD card (expandable)
(ix) Protection level: IP65 or better

	Support structure for weather monitoring device- (a) POA Pyranometer will be mounted on MMS table structure. Suitable arrangement for the same shall be made at site by Vendor. (b) Module temperature sensor will be fixed on back sheet of nearby module. (c) Other WMS items including datalogger will be fixed on an independent pole in the vicinity. Minimum 3m height of Anemometer shall be considered above GL. (d) Weather monitoring device shall be mounted on tubular steel pole of required height. The pole shall conform to IS: 2713. (e) The pole shall be secured to an independent RCC foundation structure through Base plate and Anchor bolt assembly. (f) 200 long 20 dia. rods shall be welded to the pole at 300 mm C/c for access to the device for maintenance purpose. **(g)** The support structure shall be hot dip galvanized.
5.28	**Installation and commissioning of SCADA integration systems** **(1)** SCADA system, supply of which shall be in BHEL scope, comprises of data station panels and PC based control desks with software to collect, store, process and report the data parameters of power plant and also to control the operations of the power plant by integrating the various equipment at the segments as follows: (a) String monitoring boxes (168 Nos) in solar array field (b) Weather monitoring equipment: Pyranometers for solar irradiation (2 Nos), thermometer for ambient temperature (1 No), thermometer for module surface temperature (1 No), anemometer for wind speed and direction with datalogger. (c) Power conditioning units (24 Nos): DC input / AC output parameters of inverters, grid data, fault status and events logged, etc. (d) Inverter transformers (12 Nos): Alarm/Trip signals, WTI/OTI temperature values. (e) 33kV VCB breaker panels (as per SLD): status of VCB breakers, status of protection relays of transformers, oil / winding temperatures, AC parameters at every 5MW level of the plant. (f) 132KV switchyard equipments and associated panels (g) ACDB multifunction meters (6 Nos): AC auxiliary utility consumption parameters (h) Fire alarm system (all inverter/ main control rooms): status signals (i) CCTV system **(2) BHEL scope of SCADA:** (a) Supply of Data station panels with necessary data loggers / PLCs and other accessories such as power supply etc to integrate the data signals as listed below. This includes main panel at main control room and intermediate (linking) panels at inverter room. (b) Supply of Desktop PCs (HMI control desks) provided with necessary software packages and remote monitoring features. (c) Supply of OFC, RS 485 and LAN cables for SCADA. (d) Termination of OFC cable at SCADA panels. **(3) Vendor scope of supply and installation of SCADA system:** (a) Vendor shall install the BHEL supplied SCADA system in the SCADA room in main control room. Vendor shall also install SCADA panels in the inverter rooms.

	(b) Cable laying/ terminations of all SCADA cables at respective rooms/ panels / equipments including cable trench works shall be in vendor scope. BHEL will provide the necessary cabling schedule during detailed engineering. (c) INTERNET CONNECTION: (Internet/Intranet at Plant with Static IP: Public or private network access shall be provided at the plant through any broadband/VSAT connectivity of 2Mbps or higher bandwidth. In case no broadband/VSAT connectivity can be provided at the plant, a 3G/4G data card from any Internet Service Provider (ISP) may be provided. SCADA system shall be capable of sending all plant data in real time to the Remote Server.) All required hardware items such as Modem / Router / Wifi facility etc. shall be in vendor scope.
5.29	**Earthing for solar array structures and SMBs** Vendor shall install the earthing system for solar array, MMS structures, SMBs and various other electrical equipments in line with IS 3043 latest amendment. Earth electrode shall be of 17mm dia, 3 m length. Electrode connection shall be brought out upto ground level. The Material for earthing like, Earth electrode with back fill compound, GI strips etc. will be part of BHEL scope of supply. Earthing cables, 50X6 mm copper strips (for transformer shield and neutral connections), all necessary hardwares like nut, bolts, bimetallic lugs etc. shall be in vendor's scope of supply. BHEL will provide the earthing drawing during detailed engineering. Vendor has to supply and fix the earth chamber precast/prefab type for each earth electrode with following details. (a) Minimum Inner diameter shall be 300mm. Exact size shall be chosen to ensure ease of maintenance operation using spanners etc. (b) Projection of chamber above FGL = 150mm minimum (c) Cover plate with suitable lifting hooks and padlocking arrangement. Supply and installation of all materials related to Earth chambers shall be in vendor scope. **Array Earth mat grid shall have following dimensions:** (1) Earth mat grid (25X6 mm GI flat) shall be buried 600mm minimum below ground level. Where it crosses trenches, pipes, ducts, channels etc, it shall be at least 300mm below them. Back filling soil to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm. Backfilled surface shall be well compacted. (2) Inner branches (along the solar array rows) shall be with GI flat 25x6mm (Supply of GI strip by BHEL). Inner branches shall be connected to outer grid. All excavations related to earthing in each row shall be in scope of vendor. **Earthing of PV Modules shall be as follows:** (1) Each PV Module frame shall be earthed using copper wire of 2.5 sqmm XLPO. The copper wire shall be connected to the earth hole provided in the module frame using suitable arrangement. The earthing arrangement shall use stainless washers to prevent galvanic corrosion between aluminium frame and copper wire. In order to achieve effective earthing, serrated washers shall be employed to penetrate the anodization layer of the module frame. Supply of copper cable, hardware for module earthing is in scope of vendor. (2) Continuous copper earthing wire shall be run to connect a group of modules and both ends of the loop shall be bolted to the DC earth grid/ MMS leg using bimetallic lugs and stainless-steel fasteners. The copper earthing wire shall be routed in such a way to avoid physical contact with the module aluminium frame.

	Earthing of MMS structures shall be as follows: (1) Solar array MMS structure shall be connected to earth mat using GI flat 25x6 mm minimum; Bolting on structure (M10 minimum), Welding on earth mat end. (2) Adjacent structures shall be connected to one another using GI flat 25x3 mm minimum. Both ends shall be bolted (M10 minimum). (3) Wherever the clear distance between the adjacent structure is 2m, 25x6 GI strip shall be laid below the ground at a depth of 600mm from GL. (4) Earth strips shall be bend properly and taken along the support structure. **Earthing of SMBs and Diode boxes shall be as follows:** (1) SPD earth point shall be earthed using 1Cx16 flexible copper (unarmoured) green cable from SPD to SMB structure. Both ends of cable shall be suitably lugged and connected using matching hardware. (2) Data card of the SMB shall be earthed using 1Cx2.5 flexible copper (unarmoured) green cable from Data card to SMB structure. Both ends of cable shall be suitably lugged and connected using matching hardware. (3) Lugs for these earthing cable shall be in vendor's scope of supply. (4) SMB structure shall be connected from structure legs (2 independent connections) to MMS leg using 25X6 GI strip for earth continuity. Earth strips shall be bend properly and taken along the support structure. (5) Earth bus bar in Diode box shall be earthed using 1Cx16 sqmm flexible copper (unarmoured) green cable to Diode box structure. Both ends of cable shall be suitably lugged and connected using matching hardware. (6) Diode box structure shall be connected from structure legs (2 independent connections) to MMS leg using 25X6 GI strip for earth continuity. Earth strips shall be bend properly and taken along the support structure. **General points:** (a) **Stainless steel**, nuts, plain washers shall be used. Spring washers shall be zinc/epoxy coated. (b) All connections to equipments and earth electrodes shall be bolted connections. (c) Weldings ahall be allowed only in case of inner earth grid to outer earth grid connections. Welding for GI flats shall be using electric arc welding. Both the flats shall be overlapped for the full width where they are in perpendicular direction in same plane. Where the connection is along same line, both flats shall be overlapped for a minimum of 50mm. L-bend with weld length of 50mm minimum shall be adopted wherever overlap length to be ensured. (d) Resistance of welded joint shall not be more than that of GI flat. (e) All Welds shall be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection. (f) Bimettalic lugs/ washers shall be used wherever copper to GI earthing is made. Supply of bimetallic lug/ washer is in vendor's scope. (g) While laying earthing electrodes, adding/mixing of chemical compound and water around the electrode in the dug hole shall be as per instructions of OEM. (h) In compliance to Rule 11 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode.
5.30	**Earthing system for inverter rooms, main control room and 33kV transformer yards** (1) Vendor shall install and commission earthing system for protection against faults as guided by IEC 60364 for the inverter rooms, main control room and 33kV transformer yards.

(2) Earthing system Layout for Inverter rooms, Control Room and Transformer yards will be provided by the BHEL during detailed Engg.

(3) Earthing electrodes of 3m minimum long, 17.2 mm minimum diameter, copper bonded MS, chemical compound filled will be supplied by BHEL. Electrode connection shall be brought out upto ground level.

(4) Bore holes of appropriate diameter shall be made by vendor on the earth for insertion of such chemical earthing electrodes with filling of mix of chemical compound and water around. Inverter rooms and main control room shall be provided with separate earth grids.

(5) Earthing connections to electrical panels within the inverter rooms/ main control room: Flats GI 65x8 (BHEL scope of supply) shall be provided for double earthing of 33kV VCB panels, UPS/ FCBC/ Battery banks, C&R panel, cable trays. The earthing for PCU shall be done through 1Cx 70 flexible copper cable and for SCADA through 1Cx 16 sqmm copper cable. Supply of 1CX70 sqmm cable, 1CX16 sqmm cable, cable lugs and hardware is in scope of BHEL.

(6) Earthing of inverter transformers in the transformer yards of inverter/control rooms, Aux transformer:

(a) Flats GI 65x8 minimum shall be provided for interconnecting various parts of the inverter transformer (for body earthing) viz tank, conservator, disconnecting chambers, cable boxes, marshaling box, radiators etc.

(b) Such interconnected local grid shall be double earthed to the main earth mat grid running underground through GI flats 65x8 outside 2 m from yard fence.

(c) Flats shall be bolted on transformer side and overlap welded to earth mat grid. Two earth pits shall be located close to each transformer for body earthing.

(d) Shield earthing of inverter transformers shall be separate and connected to two earth pits (connected together, isolated from earth grid) using copper flat 50x6mm.

(e) Neutral of aux transformer shall be connected to two earth pits (connected together, isolated from earth grid) using copper flat 50X6 mm.

(7) Transformer yard fencing shall be earthed at every alternate post using GI flats 25x6 mm minimum to the earth grid. Gate shall be looped to the fencing mesh by way of GI wire of suitable size.

(8) The metallic frame work of all transformer yard equipment, cable trays and support structures shall be connected to the earth grid by means of two separate and distinct connections

(9) Earth grid shall be buried underground up to a depth of 600mm minimum from NGL. Back filling soil to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm. Backfilled surface shall be well compacted.

(10) Vendor has to provide the earth chamber precast/prefab type for each earth electrode with following details

a) Minimum Inner diameter shall be 300mm. Exact size shall be chosen to ensure ease of maintenance operation using spanners etc.

b) Projection of chamber above FGL = 150mm minimum

c) Cover plate with suitable lifting hooks and padlocking arrangement.

(11) Supply and installation of all materials related to Earth chambers shall be in vendor scope. Earth electrodes will be supplied by BHEL.

(12) Earth electrode shall be bolted to a horizontal GI flat 65x8 minimum that in turn bolted (M10 minimum) to two GI flat 65x8 minimum raisers on either side of horizontal flat. Raisers shall be connected to earth mat grid by way of overlap welding.

General points:

(a) All earthing electrodes, GI flats is in BHEL scope of supply

	(b) All earthing cables, 50X6 mm copper strip, lugs, hardware etc shall be in vendor scope of supply. (c) **Stainless steel** bolts, nuts, plain washers shall be used. Spring washers shall be zinc/epoxy coated. (d) Welding for GI flats shall be using electric arc welding. Both the flats shall be overlapped for the full width where they are in perpendicular direction in same plane. Where the connection is along same line, both flats shall be overlapped for a minimum of 50mm. L-bend with weld length of 50mm minimum shall be adopted wherever overlap length to be ensured. (e) Resistance of welded joint shall not be more than that of GI flat. (f) Welds shall be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection. (g) While laying earthing electrodes, adding/mixing of chemical compound and water around the electrode in the dug hole shall be as per instructions of OEM.
5.31	**Design, supply and installation of CCTV System** The scope includes Design, engineering, supply, transport, store, install, cabling and commissioning of complete CCTV system. The vendor shall provide IP Based CCTV Camera for the Monitoring of Control Room, Inverter Rooms, Entry & Exit Gates, Switchyards complete in all respect including necessary Camera, Network Video Recorder (NVR), Network Switch, cables, Active & Passive Components, mounting structure, Software, minimum 40” LED monitor etc. Vendor has to design the CCTV system considering the locations, distance and relevant standards applicable. OFC and auxiliary power cable of CCTV system shall be laid in underground trenches through HDPE pipe as per standard practice. 1. CCTV Cameras along with monitoring stations (sufficient numbers) and all other accessories required for its proper operation must be installed to have complete coverage of following areas for 24 hours. (i) Main plant entries (3 entry gates): Covering all the entry/exit gates (ii) PTZ camera along the Plant Perimeter (Boundary length 6.5km approx): Covering complete perimeter of Plant Area to capture all possible intrusion (iii) Control/Inverter Rooms (1 no control room, 7 nos Inverter rooms): Covering Entry/Exit in the room and Dome camera for activities within equipment area in Control/Inverter Rooms and lobby area in control room (iv) WMS system (v) Storage area (vi) The Vendor has to propose the locations and number of cameras required for the Plant during detailed engineering. However approver’s decision on number of cameras shall be final. 2. Monitoring stations of the CCTV Network shall be installed in Main Control Room. 3. The CCTV system shall be designed as a standalone IP based network architecture. System shall use video signals from different cameras at defined locations, process the video signals for viewing on monitors at control room and simultaneously record all video streams using latest compression techniques. 4. Camera shall be colour, suitable for day and night surveillance (even under complete darkness) and network compatible. 5. It shall be possible to control all cameras i.e., PTZ auto/ manual focus, selection of presets, video tour selection etc. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitor for live video. 6. The system shall support video analytics in respect of the following: (i) Video motion detection (ii) Object tracking (iii) Object classification

(iv) Camera server shall be provided with sufficient storage space to storage recordings of all cameras at HD mode for a period of 15 days. All recordings shall have camera ID, location, date and time of recording.

7. CCTV supply scope will include cameras with night vision, mounting poles, Power supply units, Chasis based, layer-3, redundant power supply, Ethernet network solution with single IP management, LIU, Server with VMS software, recording software and license for all cameras and clients, 40-inch LED industrial monitor, PC, Keyboard, joy-stick, Field network switches with minimum layer-2 functionality, fibre optic / SFP/ RJ-45 ports with surge protective devices, 42U panels, network switches, OFC cable, Cat-6 cable, power supply cable, Passive fibre optic components & termination kit consisting of fibre panel, information outlet, cabinets, face plates, SC coupler, Fibre optic drawer with pig-tail, UTP cat-6 patch cords, various connectors, cable ties, multi-stranded copper wire for equipment ground, PVC conduit with couplers and any other supply items not covered in above required for completion of the CCTV system.

All related supplies, installation including trench work, civil works etc for CCTV system shall be in scope of vendor. All necessary labour, machinery, tools, instruments shall be in vendor scope

Camera Specification (Outdoor Bullet Type):

1/3" CMOS HD sensor, Out Door Bullet H.264 Compression, 2 mega Pixels CMOS, 3DNR, The highest resolution can be up to 1920 × 1080 Low Lux, DWDR, Support Voice talk, 1CH Audio in/1CH Audio Out, Mobile P2P Viewing, Support Protocol: TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS, ARP, ICMP, POP3, NTP and RTSP, Support ONVIF 2.0, Lens : 2.8-12mm Megapixel lens (4-9mm lens optional), IR Distance: 50m, POE (802.3af). Support ROI function, Built-in Micro SD/SDHC/SDXC card slot, Ingress Protection level: IP66, Video Bit Rate 32 Kbps –8 Mbps, Audio Compression G.711/G.722.1/G.726/MP2L2,Dual Stream, BLC, ROI STANDARD: ONVIF, PSIA, CGI, ISAPI, Operating Conditions -30°C to 60°C (-22°F to 140°F).

b. Camera Specification (Indoor Dome Type):

1/3" CMOS HD sensor, Indoor Dome fix Lens H.264 Compression, 1.3 mega Pixels CMOS, 3DNR, The highest resolution can be up to 1280×960, Shutter Speed: 1/3 s to 1/100,000s, Min. Illumination:0.01Lux @ (F1.2, AGC ON) ,0 Lux with IR 0.028 Lux @ (F2.0, AGC ON) ,0 Lux with IR, Video Bit Rate 32 Kbps – 8 Mbps, Support Protocol: TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS, ARP, ICMP, POP3, NTP and RTSP, Support ONVIF 2.0, Lens : 3.6mm 1.3Mega Pixel Lens SD, 3DNR, D-WDR, Motion Detection, Privacy Mask, 24pcs LED, 20m IR distance, POE(802.3af), Support Dual stream, Impact protection:IK10, operating condition, Support ROI, BLC, Standard : ONVIF, PSIA, CGI, ISAPI, Image Settings: Rotate mode, Saturation, Brightness, Contrast adjustable by client software or web browser, H.264 Type: Baseline Profile / Main Profile.

c. Camera Specification (Outdoor PTZ Type):

HD PTZ, PoE type, 2 Megapixel, with illuminated IR range of 150 metres, IP-66 outdoor type with 360 degree view. Camera shall be suitable for operating temperature up to 60 deg Celsius ambient.

1. The monitoring of cameras shall be done at Main Control room. The required no. of hardware/ software licenses to meet the requirements shall be supplied by the bidder.
2. All the designing of hardware / software required for the CCTV system along with erection & supervision and commissioning of the same shall also be in the scope of bidder. Layout

location, architecture and configuration scheme will be prepared and submitted by bidder in the event of order placement. It is the responsibility of bidder to provide a new system and supply suitable hardware/software & accessories.

3. All video and control signals from cameras shall be connected via Cat-6 Cable for distances up to 90m and FO Cables for distances more than 90m. All unarmoured and FO cables shall be routed through flexible conduits. Weather proof JB shall be provided for housing network equipment for connecting outdoor cameras with Control room/Inverter room rack

4. Outdoor Cameras to be installed in any particular location shall be mounted on rigid vibration proof CCTV Pole protected against corrosion. The height shall be 5m above ground level. Mounting locations shall be easily accessible for servicing purposes. They shall be fitted with climbing and relevant safety facility.

5. Local junction boxes for cameras shall be of weather-proof, of minimum protection Class IP-65. Junction Boxes shall be suitable for accommodating Network Equipment, LIU & Power Distribution Equipment.

6. 5-metres camera Pole with Required Foundation Bolt/Frame shall be supplied. Civil foundation works is in vendor's scope.

7. Camera structures shall have hoisting facility, fixing facilities for cables along the whole structure and for the cameras to be installed with ample space for servicing purposes.

8. One LED colour monitor (min 40 inch diagonally) will be installed in Control room Building. Industrial grade monitor shall only be supplied.

9. The monitors shall be versatile and aesthetic units. It shall also be S-VHS/composite video compatible and shall have built in audio. Monitors are to be operable at 230V AC, 50 Hz (Power supply shall be arranged by supplier from CCTV Rack) and shall comply to the following specifications:

i. General Automatic degaussing, fast warm up time Display tube, integral implosion protection.

ii. Resolution: 1920 x1080. Minimum Controls Colour system select, volume, colour, brightness, contrast, power, video input select and Y/C termination.

Notes:

1. The items mentioned shall be supplied by bidder as minimum requirement. However, any material not listed in above but required by bidder for successful completion and guarantee run of the project / system shall be included in the scope of the bidder on EPC basis and shall be done by bidder without any commercial implication to BHEL.

2. I&C Prices shall be inclusive of travel expenses, lodging, transport and complete man day charges. No extra charges will be paid.

3. The vendor shall guarantee satisfactory performance of the equipment under stipulated variations of voltage and frequency. The design and manufacture shall be such that equipment / components of same type and rating are interchangeable.

4. Camera and database servers shall offer both video stream management and video stream storage management. These servers shall also manage and store configuration information/database for the whole system. Recording frame rate & resolution in respect of individual camera shall be programmable. It shall be possible to view and record at different resolutions and frame rates and this shall be individually programmable on every camera. It shall be possible to take back-up of system configuration and database on portable media device and restoring the same if required. System shall ensure that once recorded, video cannot be altered. It shall be possible to view, record, search and replay simultaneously without affecting performance of the system.

4. The system shall be complete in all aspects for reliable performance. The contractor shall submit the detailed block schematic, video, signal & power wiring diagram, describing

the connections between the network switch/camera server systems and various cameras, monitors, keyboard etc.

5.32 Design, supply and installation of Plant lighting System

Plant lighting system shall consist of following components:
1. Lighting along the peripheral roads of 2.5m width +shoulders width and Internal roads of 3.5m width + shoulders width
2. 132KV Switchyard lighting- Switchyard size approx 25m X 70m approx. Pole height shall be minimum 9m for switchyard lighting
3. 33KV Transformer yards lighting at each inverter room- 2 transformer yards (size 6.5m X 7.5m approx) in each inverter room, a total of 7 Inverter rooms.
4. 33KV Transformer yards lighting at Control room- 1 yard of size 7.5m X 24m approx
5. Lighting at other installations- This shall additionally include lighting near main gates (3 main gates approx), security room/cabins (6 nos approx), Weather monitoring station, water storage tank/pump station (8 nos approx), RO plant (25m X 25m approx), storage yard.

1. Standards and Codes

LED luminaires shall be tested at independent laboratory as per the following test standards:
LM79-08- Electrical and Photometric Measurements of Solid-State Lighting Products
LM 80-15- Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules

2. General specification

2.1 This specification covers design, supply and installation of uniformly Illumination system along the peripheral & internal roads, transformer yards, metering yards/ switchyard and other facilities including entry points/gate(s), WMS inside the plant area.
2.2 The Contractor shall furnish Guaranteed Technical Particulars of the LED luminaires, from renowned brands available in the market for approval of Employer.
2.3 Lighting system shall work on the auxiliary supply and same shall be incorporated in auxiliary loads. The Contractor shall provide minimum 20% of total lighting points as emergency lighting points, fed from UPS DB. Outdoor emergency lights shall be provided at each security room and all plant entry gates.

3. Lighting Levels

3.1 The average LUX level of 10 lm is to be maintained in metering yard/ switchyard. However, a lux level of 20 lm ((10+10) additional switchable on requirement only) is to be maintained in switchyard on transformer.
3.2 The lighting system of solar power plant shall be designed in such a way that uniform illumination is achieved. Average LUX level to be maintained in different areas shall be as under:

Area	Area LUX
Internal/Periphery Roads	4
Transformer yard/Switchyard	20
Other places	10

The lighting level shall take into account appropriate light output ratio of luminaires, coefficient of utilization maintenance factor (of 0.7 or less) to take into account deterioration with time and dust deposition.

4. LED Luminaire for Outdoor Applications

4.1 LED luminaires shall meet the following parameters.

S.No	Parameter	Specified Value
i.	Input voltage	170-260 V
ii.	Input Frequency	50 Hz +/- 1 Hz
iii.	Power Factor	0.90 (Minimum)
iv.	Luminous efficacy	>90 lumens per watt
v.	Beam Angle	Minimum 120°
vi.	Total Harmonic Distortion	< 10 %
vii.	Working Humidity	10% - 90% RH (Preferably Hermetically sealed unit)
viii.	Degree of Protection	Minimum IP 65 (for Outdoor fixtures)
ix.	Luminaire Casing	Powder coated metal / Aluminium.
x.	Color Temperature	5700 K (cool day light)
xi.	Color Rendering Index	>65
xii.	Moisture protection in case of casing damage	IP 65 (driver unit shall preferably be totally encapsulated)

4.2 The LED luminaire (outdoor) housing, heat sink, pole mounting bracket, individual LED reflectors and front heat resistant tempered glass should be provided.

4.3 The LED luminaire (outdoor) housing should be made of non-corrosive, high pressure, die-cast aluminium and the housing should be power coated grey, so as to ensure good weatherability. Each individual LED source should be provided with an asymmetrical distribution high reflectance aluminized reflector, which should ensure that the light distribution of the luminaire is suitable for road lighting applications (wide beam distribution) and should ensure high pole to pole spacing.

4.4 The luminaire should be provided with in-built power unit and electronic driver.

4.5 The luminaire should be suitable for standard street light poles and should be suitable for side entry and bottom entry (post top).

4.6 GI Lighting pole of suitable diameter capable of withstanding system and wind load, shall be provided with average Zn coating thickness of 80micron. The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.

4.7 All outdoor lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.

4.8 Lighting panels shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, etc. shall be earthed by means of separate earth continuity conductor. Cable armour shall be connected to earthing system at both the ends. Proper earthing of street light poles shall be ensured.

4.9 Junction box for lighting shall be made of fire retardant material. The degree of protection shall be IP55 for outdoor JB.

4.10 Lighting cables, wherever exposed to direct sunlight, shall be laid through Double Wall Corrugated (DWC) HDPE conduits.

4.11 Cables: All Cables required for plant lighting system shall be supplied and installed by vendor. This includes cable from plant ACDBs located in control rooms and inverter

rooms to lighting poles, lighting poles to lighting poles, lighting poles to luminaires. Specification of cable shall be as per relevant Indian standards.
4.12 Cabling shall be done in such a way that lights are distributed equally between R, Y and B phases. Sequence of poles shall be R,Y,B,R,Y,B,… and so on. Poles shall be painted with R,Y,B colour coding.
4.13 Cable trenches and laying of cables shall be as per IS: 1255. Cables shall be laid in buried cable trenches. Excavation, laying of cables and closing of cable trenches (including bricks) as per relevant Indian standards is in the scope of vendor.

All related supplies, installation including trenches, civil works etc. for lighting system shall be in scope of vendor. All necessary labour, machinery, tools, instruments shall be in vendor scope.

5.31 Firefighting systems

Firefighting systems: Fire extinguishers and sand buckets
Vendor shall provide fire extinguishers/ sand buckets as follows for fighting fire of oils, solvents, gases, paints, varnishes, electrical wiring, live machinery fires and flammable liquid/ gas as per recommendation by relevant fire safety authority and as per relevant standards IS: 2171 and IS: 10658 marked.
All buildings shall be installed with required no. of fire extinguishers as per relevant BIS standard and NBC. LiquefiedCO_2/ foam/ ABC type fire extinguisher shall be upright type of capacity 10kg conforming to IS: 2171, IS: 10658.

- DCP type (ABC) 10 Kg designed/tested IS 15683/ IS 2171 with safety release valve, NRV and CE approved valve. Dry powder IS 14609 with standard accessories.
- CO2 type 10 Kg with wheel. Designed/tested IS 2878/ IS 15683/ IS 8149 complete with hose, screw valve, CO2 gas IS 1522, cylinder IS 7285, valve IS 3224. Tested at 250 Kgf/cm2.
- Sand bucket should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546 at strategic locations.

Minimum Quantity requirements:

Type of extinguisher	DCP type (ABC) 10 Kg	CO2 type Hand 10 Kg	Sand bucket stand (4 sand bucket on one stand)
Main control room	2	2	2
Inverter room	14	14	14
Inverter room transformer yard	28	28	28
Control room transformer yard	2	2	2
132KV Switchyard	2	2	4
132KV Substation bay	2	2	4
Security room (5 nos)	-	1	1

5.32 Identification marking using painting
Following items shall be identified by way of artistic painting in black letters with yellow background. For danger symbol/text, white letters in red background. Identification number/ text to be painted shall be submitted for BHEL/SECI/SCCL approval during detailed engineering for the following.
(1) Solar array structures: ~3300 Nos

	(2) String monitoring boxes: 224 Nos (3) Size/ source/ destination of DC cable 1Cx400 with arrow mark (power flow direction) to be painted on SMBs and PCUs (4) PCUs front side: PCU ID number (1 to 32) with rating 1250kW, AC chamber/ DC chamber, Danger text/symbol. (5) PCUs DC chamber back side: SMB ID numbers, cable size (1Cx400 +,-) with upward arrow mark, danger text/symbol (6) PCUs AC chamber back side: Inv Trnfmr ID, cable size (3Rx1Cx630 / ph) with downward arrow mark, danger text/symbol (7) Same way as above, the corresponding panel ID with rating, cable destination with arrow mark in power flow direction, danger text/symbol shall be painted for all VCB panels, Inverter transformers (HV and LV sides), Aux transformer (HV and LV sides), ACDB panel. (8) For UPS/ FCBC/ SCADA/ ABT metering panels, C&R panel, all DB boards/ fire alarm panels ID number shall be painted. Cable size/ destination/ arrow marks not required to be painted as cable tags shall be adequate. (9) For earth chambers of inverter rooms, main control room, switchyard, array, ID number with resistance value and due date shall be painted. (10) All switchboards shall be painted with ID number.
5.33	**Cable markers and cables tags** (1) Cable markers and joint markers for underground cables shall be provided along the route of the cables as per section "**Cable installation methodology**" of this specification. (2) Cable tags shall be provided at either of the cable (at the entry point to the panel / equipment to which it is connected / terminated) shall be provided as per section "**Cable installation methodology**" of this specification. (3) Cable tags details shall be provided by BHEL during detailed engineering.

5.34 Display boards and sign boards

Sl. No	Description	Qty for Inverter rooms	Qty for Control room
1	Board displaying instruction chart for restoration from Electric Shock	5 No	1 No
2	Board displaying instruction chart for artificial respiration	5 No	1 No
3	Board displaying dos and don'ts.	5 No	1 No
4	Board displaying fire extinguishers details and operations	5 No	1 No
5	"No smoking" board	10 Nos	5 Nos
6	Danger boards: 33000V with danger symbol in Hindi, Telugu, English	As required	As required
7	Identification boards, of suitable sizes, within and outside control room such as Inverter room, Main control room, Executive lounge, Store room, Gents toilet, Ladies toilet, SCADA room, Battery room, Pantry room etc. BHEL will provide list.	5 set	5 set

(a) 5mm thick sun board with LG make vinyl sticker (computerized cutting and pasting) shall be used for Sl Nos 5, 6 and 7.
(b) For others, flex banner with design & printing shall be used.

5.35 Electrical insulation mat

(1) Vendor shall supply electrical insulating mats as follows:
- (a) Reputed make as shall be approved by BHEL/SECI/SCCL
- (b) As per IS: 15652:2006
- (c) Class C
- (d) Thickness 3 mm minimum
- (e) Size = 2m x 1m minimum, exact size shall be as approved by BHEL/SECI/SCCL during detailed engineering.
- (f) Colour: to be approved by BHEL/SECI/SCCL
- (g) Max use voltage = 33 kV
- (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 all the indoor electrical panels viz. PCUs, VCB panels, ACDB panels, SCADA panels, UPS panels, FCBC battery charger, battery banks etc. in inverter rooms and control room.

5.36 Supply and Installation of Miscellaneous Items

(1) Split Air conditioner of 1.5 tonne (4 Nos) of split type for SCADA room, conference room and office room of Voltas/ Hitachi/ Samsung/LG make.
(2) Furnitures for SCADA room as below
- Table with drawer for desktop PC – 5 Nos
- Chair, industry standard, revolving type, with wheels, arm rest, provisions for adjustment of height (hydraulic/ gas lift):5 Nos
- Storage almirah: 4 No
- Filing cabinet: 4 No
- Printer table: 1 No

(3) Furniture for Conference Room
- 1 number of LED TV of 50 inch of Sony/ Phillips / Samsung make,

- 1 no of conference table of 10 person equipped power sockets and 10 chairs revolving type with wheels.

(4) Furniture for security room and security cabins

- Table with drawers – 2Nos
- Chairs revolving type with arm rest – 10 Nos

Note : Make of the above mentioned furniture shall be Godrej or equivalent.

5.37 Tool kits and instruments

A. Measuring instruments

1	Earth Resistance Tester	Reputed make	2 No
2	Array tester	Reputed Make	1 No
3	Insulation tester	Reputed make	2 No
4	Digital multimeter	Reputed make	2 No
5	Clamp meter	Reputed make	2 No
6	Infra-red thermal imaging camera	Reputed Make	1 No
7	Digital lux meter	Reputed Make	1 No

Note: Make / model number etc shall be approved by BHEL/SECI prior to procurement. All testing equipment shall possess valid calibration certificate issued from approved NABL labs.

B. Tool kits

1	Double ended spanner Set of sizes 10-11, 12-13, 14-15, 16-17, 17-18, 19-20	2 set
2	Screwdriver Set	10 Set
3	Crimping tool with Dye range 50-630sq-mm cable, mechanical gear power, hand or foot operated	1 Set
4	Crimping tool up to 10 sq-mm cable	4 set
5	Drilling machine AC, hand operated, with bit size up to 20 mm	1 set
6	Measuring Tape, 5m	1 No
7	Measuring Tape, 50 m	1 No
8	Allen Key set	2 Set
9	Adjustable spanner 2-inch size	2 Nos
10	Hammer	1 No
11	Rough file kit	1 Set
12	Platform balance, 50Kg range	1 No
13	Cutting Pliers	3 No
14	Nose Pliers	3 No
15	Vacuum cleaner, of industrial type, for control room sweeping / cleaning.	1 No
16	Blowers for cleaning the panels	1 No
17	Battery powered wrench with bits suitable for hardwares of sizes M6 to M20	1 No

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

Detailed specification of the instruments are as below-

Earth resistance tester

Parameter	Specification
Display	Backlit LCD or LED display
Range	Earth Resistance: up to 2000 Ω Earth Voltage: 200 V
Accuracy	± (2% + 5)
Safety Ratings	IP 56
Programmable Limits setting	Enabled

Accessories-

Earth Ground Stakes (4 Nos)
Three cable reels with cable length up to 20 m
Carry Case-1 (capable of handling tester along with accessories)
1 set of spare battery

Array tester

Parameter	Specification
Display	Backlit LCD or LED display
Functionality	All electrical tests required by IEC 62446-1:2016
Memory	Up to 200 records & USB downloadable to Computer

Accessories

A set of two, 4mm fused leads for extra protection during installation tests.
Leads which enable the array tester to connect directly to PV arrays
1 set of spare battery

Insulation tester

Parameter	Specification
Display	Backlit LCD or LED display
Insulation Test Range	0.1 MΩ to 10 GΩ
Test Voltage	250V, 500V, 1000V, 5000V
Test Voltage accuracy	+20% on positive side only no negative variation is allowed
Insulation Test Current	1 mA nominal
Auto Discharge	Discharge time< 0.5 Second for C = 1
Open Circuit test Voltage	>4 V, <8 V

Accessories

Heavy duty Test Lead Set – 4 Nos.
Carry Case with sufficient space for accommodating accessories.

Digital Multimeter

Parameter	Specification
Display	Backlit LCD or LED display; Minimum resolution: 5 ¾ places for DC, 4 ¾ places for AC
Measuring Category	1000V CAT III as per IEC Standard 61010-1; wave shape independent RMS measurement (True RMS) suitable for operation in the site conditions.
Additional Functions	Resistance (Ω), Temperature (oC), Continuity, Diode, Capacitance, Frequency, Duty cycle measurement

Accessories
Temperature Probe
Silicon Test Lead
Alligator Clip
Carry Case with sufficient space for accommodating accessories.

Clamp meter

Parameter	Specification
Display	Backlit LCD or LED display
Measuring Category	1000V CAT III as per IEC Standard 61010-1; wave shape independent RMS measurement (True RMS) suitable for operation in the site conditions.
Current Range	AC&DC Current up to 1000A/400 A
Voltage range	AC&DC Voltage upto 1000V
Additional Functions	Resistance, continuity, diode and non contact voltage detection, Active, Reactive and Apparent Power, THD, PF

Accessories
Test leads
Electrical test leads
Probe light & extender
Carry Case with sufficient space for accommodating accessories.

Infra-red thermal imaging camera

Parameter	Specification
Spectral response	8 µm to 14 µm (LW)
Temperature-sensitivity and calibration range	–20 °C to +120 °C
Atmospheric air temperature	-10 °C to +40 °C
Thermal sensitivity	NETD ≤ 0.1 K at 30 °C
Geometric resolution	640 x 480 pixels

Photo camera resolution	Approx. 30 times of IR camera resolution
Absolute error of measurement	< ± 2 K
Adjustable parameters	Emissivity, ambient temperature
Adjustable functions	Focus, temperature level and span
Measurement functions	Measuring spot, measuring area with average and maximum temperature
Calibration	The measuring system (Camera, lens, aperture and filter): The camera has to be traceably calibrated at least every two years. The calibration has to be documented. If the camera is not compliant, it has to be readjusted by the manufacturer.
Documentation	Storing of the infrared picture with the radiometric data

Digital lux meter

Parameter	Specification
Range	0 – 1000 lux
Accuracy	± (2% + 5)
Resolution	1 lux
Display	3½ digits, Backlit LCD/LED

All the tools and instruments are required for post-commissioning of the plant. Items shall be handed over to BHEL in new condition. Used tools and instruments will not be accepted. Any tools and instruments required by Vendor during I&C activities will be arranged separately by vendor.

5.38 Cable installation Methodology

1. CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubulars and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:2309	Code of Practice for the protection of building and

	allied structures against lightning.
IS:2629	Recommended practice for hot dip galvanizing of iron & steel
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3043	Code of practice for Earthing
IS:3063	Fasteners single coil rectangular section spring washers.
IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal - arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 6.6kv up to and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial & commercial power systems
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands elastomers and plastic insulated cables.
	Indian Electricity Act
	Indian Electricity Rules.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

2. DESIGN AND CONSTRUCTIONAL FEATURE

Inter Plant Cabling

Interplant cabling for main routes shall be laid in Cable trenches/duct banks. Cables from main plant to control room shall be laid in Cable trenches/duct banks. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly burried cables, if essential ,shall not have concentration of more than 4 cables in one route. All buried cables shall be armoured.

Trenches

PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

No subzero level cable vault/trenches shall be provided below control building/switchgear rooms in plant.

General

The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.

Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. foraluminium conductor and 2.5 sq.mm. for copper conductor cable.

Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:

- Meet all safety requirements
- Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc

3. Cable accessories

3.1 Cable trays, Fittings & Accessories

a) Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

b) Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

c) Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.

d) Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

3.2 Support System for Cable Trays

(a) Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".

(b) Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types: (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

1. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
2. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares, fitings and accessories shall be prefabricated factory galvanised.
3. The main support and cantilever arms shall be fixed at site using necessary

brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvansied surface shall be brushed and red lead primer, oil primer &aluminium paint shall be applied.

4. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drill ing and other machining operation.
5. Support system shall be able to withstand
   - weight of the cable trays
   - weight of the cables (75 Kg/ Metre run of each cable tray)
   - Concentrated load of 75 Kg between every support span.
   - Factor of safety of minimum 1.5 shall be considered.

3.3 Pipes, Fittings & Accessories

a) Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

b) GI Pipes shall be of medium duty as per IS:1239

c) Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

d) Hume pipes shall be NP3 type as per IS 458.

3.4 Junction Boxes

a) Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

b) Terminal blocks shall be 1100V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded copper conductors of size upto 2.5 sq mm each. All internal wiring shall be of minimum 1.5 sq. mm cu. Conductor PVC wire.

3.5 Terminations & Straight Through Joints

a) Termination and jointing kits for 33kV,11kV, 6.6 kV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 33kV, 11kV and 6.6 kV grade joints and terminations shall be type tested as per IS: 13573. 3.3kV grade joints and terminations shall be type tested as per VDE0278. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall

be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solderless crimping type cable lugs & ferrule as per DIN standard.

b) Straight through joint and termination shall be capable of withstanding the fault level for the system.

c) 1.1 KV grade Straight Through Joint shall be of proven design and make shall be approved by BHEL.

3.6 Cable glands

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.

3.7 Cable lugs/ferrules

Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to relevant standard.

3.8 Trefoil clamps

Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.

3.9 Cable Clamps & Straps

The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

3.10 Receptacles

Receptacles boxes shall be fabricated out of MS shet of 2mm thickness and hot dipped galvanized or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break, AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt

ELCB rated for suitable mA sensitivity.

3.11 Galvanising

- Galvanising of steel components and accessories shall conform to IS: 2629, IS: 4759 & IS: 2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.
- The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

3.12 Welding

The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595.

4. CABLE INSTALLATION

4.1 Cable tray and Support System Installation

a) Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.

b) Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with relevant standard.

c) The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.

d) The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval.

e) All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

f) In certain cases it may be necessary to site fabricate portions of trays, supports and other non- standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

4.2 Conduits/ Pipes/ Ducts Installation

a) The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.

b) GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

c) Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.

d) Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	Spacing
Upto 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm and above	3.0 M

e) For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.

4.3 Junction Boxes Installation

Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

4.4 Cable Installation

a) Cable installation shall be carried out as per IS: 1255 and other applicable standards.

b) For Cable unloading , pulling etc following guidelines shall be followed in general :

- Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.
- While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable

drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.

c) Cables shall be laid on cable trays strictly in line with cable schedule

d) Power and control cables shall be laid on separate tiers in line with approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, HT cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two meter. All multi core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multi core power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multi core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

e) Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

f) Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.

g) No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.

h) In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

i) Wherever few cables are branching out from main trunk route troughs shall be used.

j) Wind loading shall be considered for designing support as well Cable trays wherever required.

k) Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.

l) The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

4.5 Separation

At least 300mm clearance shall be provided between :

- HT power & LT power cables,

- LT power & LT control/instrumentation cables,

4.6 Segregation

a. Segregation means physical isolation to prevent fire jumping.
b. All cables associated with the unit shall be segregated from cables of other units.
c. Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.
d. In switchyard, control cables of each bay shall be laid on separate racks/trays.

4.7 Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

No. of cores in cable	No. of spare cores
2C,3C	NIL
5C	1
7C-10C	2
14C and above	3

4.8 Directly Buried Cables

a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS: 1255. Reference drawing for buried cables is included as a tender drawing and enclosd with this specification.
b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.

4.9 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags.

4.10 While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.

5. Cable Terminations & Connections

a) The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary

evidence/experience reports of the jointers to be deployed at site.

b) Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.

c) The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

d) Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self-locking type nylon cable ties with de interlocking facility to keep them in position.

e) All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, -etc along with cable numbers and coiled up after end sealing. Supply of ferrules is in Vendor's scope.

f) All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

5.39 **Pre-commissioning inspections / checks / tests, MRT tests and coordination / liaison activities with state / central departments / Transco/ DISCOM/ CEIG/ CEA etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant**

Vendor shall be responsible for carrying out following activities-

#	**Scope description** **Vendor shall be responsible for carrying out following minimum tests/ checks for IRs, CR, transformer yards and any other tests as per requirements of SECI / SCCL/ concerned state / central departments / TSTRANSCO/ TSNPDCL/ CEIG/ CEA etc.**
1	Pre-commissioning inspections / checks / tests, MRT tests and coordination / liaison activities with state / central departments / Transco/ DISCOM/ CEIG/ CEA etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant. (Clearances shall include obtaining prior approvals for all applicable drawings/ documents etc from concerned state / central departments / Transco/ DISCOM/ CEIG/ CEA etc.)

A	Basic checks	
	A1	Tightness checks:
		1) Terminations of AC/DC power cables at SMBs, PCUs, Inverter transformers, Aux transformer, ACDB panel, UPS/ FCBC/ Battery banks, Aux AC/DC DB boards, 33kV VCB panels, LV side of Inverter transformer, SCADA panels etc. 2) Terminations of Control/ Instrumentation/ Data/ Communication cables wherever applicable.

						3) Terminations of earthing at all electrical equipment/ panels of inverter rooms/ control room 4) Terminations of earthing of inverter transformers, aux transformer 5) Terminations of earth chambers of vendor scope. **Note:** For M10 and above, torque wrench settings shall be followed for reference.		
					A2	Electrical continuity checks		
					A3	Megger (5kV) checks for all HT (33kV) cables		
					A4	Hi-pot testing for all HT (33kV) cables prior to connection to the panels/ transformers.		
					A5	Megger (1kV) checks for all 1.1kV grade cables		
					A6	AC/DC supply checks at TBs of all electrical panels/ DBs/ Transformers.		
				B	Pre-commissioning electrical tests:			
					B1	Power conditioning units (with the support of PCU service engineer at site)		
						1) DC side open circuit voltage and verification with SMB side measurements 2) Vendor to provide technician support to PCU service engineer for all other pre-commissioning tests as per OEM checklist 3) Functioning of duct fans (operation, direction of rotation)		
					B2	Inverter transformers and Aux transformer		
						1) Oil filtration: Equipment of adequate evacuation/ heating/ oil circulation capacity shall be deployed at site for this purpose. Filtration shall be carried out adequately in order to achieve the BDV, ppm, tan delta values within the limits as per relevant standards and as measured by NABL accredited laboratory. The machine shall have built-in BDV measuring set up for in-situ checking of BDV during filtration process. DG if required for oil filtration shall be arranged by vendor. 2) IR tests LV-HV, HV-E, LV-E 3) Vector group 4) Voltage ratio 5) Magnetizing current 6) Magnetic balance 7) Winding resistance at all taps 8) Fault simulation checks (at VCB breaker panels): Buchholz, OTI, WTI, PRV, LOLA etc 9) Alarm, trip settings (S1, S2) for WTI, OTI 10) Oil level at conservator (to be topped up, if required)		
					B3	CTs 33kV of 33KV breaker panel		
						1) IR tests (all cores): Pri-Sec, Sec-Sec, Pri-E, Sec-E 2) Ratio tests / primary injection		
					B4	PTs 33kV of 33KV breaker panel		
						1) IR tests (all cores): Pri-Sec, Sec-Sec, Pri-E, Sec-E 2) Voltage ratio test 3) Polarity test		
					B5	33KV breakers panels		

						IR tests Contact resistance measurement (CRM) Timing test: close/ open/ close-open Functional checks: breaker open/close, spring-charged motor Remote operation from SCADA panels: open/close, command/ status, lamp indications		
					B6	Numerical relays at 33KV breaker panels		
						1) Relay calibration using applicable kit/ software 2) IDMT, DT curves with timing/pickup settings in all relays based on gradation across from downstream to upstream taking into account settings at substation 3) Overcurrent/ earth fault pickup/ tripping time tests		
					B7	CT ratio / PT ratio to be set in meters/relays		
						i. All MFM meters ii. Protection relays		
					B8	ACB breaker settings (with the help of PCU service engineer)		
						1) Over load, Short time fault, ground fault		
					B9	Earth resistance measurements for all chambers of vendor scope		
						1) With electrode connected to grid 2) Without connecting electrode to grid		
					B10	UPS/ FCBC charger/ Battery banks		
						1) All functional checks: battery charging/ discharging, FCBC/ battery output parameters etc. as per OEM checklists		
					B11	Tests on 30KV LA		
				C	Testing agency			
						Credentials of testing agency shall be submitted to BHEL for approval prior to awarding of work.		
				D	Coordination and Liaison activities to be carried out by vendor:			
						1) Vendor shall suitably support the upstream contractor of BHEL executing the 132kV switchyards (at SPV, Substation ends) and transmission lines in the process of obtaining approval from Transco/ DISCOM/ CEIG/ CEA etc as applicable for line charging/ grid synchronization/ plant commissioning. 2) Liaison responsibility for getting the approvals rests with the respective vendors for their scope of works. However, wherever technical clarifications are required by the approving agencies with regard to SPV portions (including solar array) up to 33kV side of power transformer, vendor shall suitably coordinate/liaison with the concerned state/central approving agencies to make the approval process successful. Accordingly, vendor shall participate in direct discussions with the approving agency whenever necessary. Also, all the necessary payments/expenditures to be incurred with ref to such coordination/ liaison in this regard shall be borne by the respective vendor. 3) Following are the areas of approval, as applicable, for the SPV-side portions including solar array and up to 33kV side of power transformers. (a) GTP/ datasheets/ GA drawings/ Bill of materials, MQP etc of BHEL/ Vendor supply items. (b) Site test reports of transformers, transformer oil, VCB breakers, CTs, PTs, resistance of earth mat grids etc		

					(c) Interaction with supervising/ inspection agency such as MRT departments, Transco, CEIG, CEA etc, as applicable, for applying to them/ inviting them for supervision/ inspection at site. (d) Interaction/ coordination with customer (SCCL/SECI) in the above process as and when required. (e) All necessary testing kits/ instruments shall be arranged as per the requirements of inspection agency. Basic instruments such as digital multimeter, 5kV digital megger with PI feature, earth resistance meter, VCB open/close timing test kit, clamp meters etc shall be organized at site at the time of inspection. Competent electrical technician shall also be made available at the site. (f) Subsequent to site inspection by the concerned agency, vendor shall obtain the clearance for grid synchronization of their respective. 4) Vendor shall implement all the observations of CEIG related to SPV-side portion including solar array and up to 33kV side of Power transformer.		
				E	Commissioning of power plant		
					1) Vendor shall organize all necessary tools/ measuring instruments required to operate the various electrical equipment at the time of commissioning: Digital megger 5KV with PI feature, Earth resistance tester, Phase sequence meter, Clamp meters etc., discharge rods, PPE safety gadgets (helmets, shoes etc.). 2) It is the responsibility of the vendor to interact technically with upstream contractors for successful charging of 132kV grid line followed by charging of 33/132kV transformer at SPV plant end. 3) Vendor shall participate actively in the commissioning until it is established that there is successful export of power from all the PCUs at full load and through the 132kV transmission line/ switchyards of power plant		
				F	Trial run and Performance Guarantee test		
					After commissioning and completion of all works including clearing of all punch points, trail run of the plant will be commenced for 7 consecutive days based on acceptance by SECI. Immediately after trial Performance Guarantee test shall start for a period of 30 days. During trial run and PG test vendor shall deploy manpower, operate and maintain the plant and ensure that there are no breakdowns in any equipment, all required tools and spares are available. Vendor shall suitably coordinate with upstream contractor and support the upstream contractor of BHEL executing the 132kV switchyards.		

5.40	**Spares required to be supplied along with main consignment:** 1) Fuses of all types: 1 % of total population of respective items 2) MCB of all types: 1% of total population of respective items 3) Indicating lamp set of all types: 1% of total population of respective items 4) Surge protection devices/ MOV: 1% of total population of respective items 5) Y-connectors: 330 Sets (1 set = 2 nos) 6) MC4 connectors: 990 sets (1 set = 2 nos) 7) 33KV, 1C, 300 sqmm (E) Indoor End termination kits- 15 Nos 8) 33KV, 1C, 300 sqmm (E) Outdoor End termination kits- 2 Nos 9) 33KV, 1C, 300 sqmm (E) Straight through jointing kits- 5 Nos 10) Spares of aux transformers: a) HV bushings with metal parts and gaskets: 1 set

	b) LV bushings with metal parts and gaskets: 1 set c) Neutral bushing with met metal parts an gaskets: 1 set d) Gaskets : 2 sets e) Silica gel breather with charge: 1 set f) Diaphragm of explosion vent: 1 set g) Prismatic oil level gauge: 1 set h) Valves: 1 set 11) Luminaires with lights for all types -2% each type, rounded off to next integer 12) Lighting Junction boxes- 2% each type 13) CCTV- Bullet Camera - 1 No, Dome Camera – 1 No, PTZ Camera -1 No, Network Switch -1 No (each type), Patch Card (cat-6 Cable) – 2 Nos, Media converter- 2 nos Notes: (a) 1 set refers to total quantity of the item used in one transformer. (b) In case quantity arrived based on percentage is a decimal figure, it shall be rounded off to next higher integer.

6 General conditions applicable during supply, installation, commissioning and O&M

BOS contractor shall ensure that technically qualified people from local areas shall be provided employment during I&C. Such technically qualified people shall be as proposed by Nodal officer/ area Engineer of SCCL through BHEL.

6.1	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.
6.2	Similarly, water required for construction works shall be organized by vendor (tankers etc).
6.3	All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement and installation of materials / panels / equipment etc shall be organized by the vendor.
6.4	All necessary tools and tackles such as crimping tool (including heavy duty tools for crimping copper/ aluminium cables up to 630 sq-mm), screw driver set, power screw drivers, 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/ shuttering materials for RCC works, spade, shovel, hammer etc shall be organized by the vendor.
6.5	All necessary measuring instruments such as digital multimeters, measuring tapes, vernier calipers, electrical testers, digital meggers (1kV, 2.5kV, 5kV), earth resistance meters, clamp meters, transformer oil BDV kit, relay testing kit (secondary injection), primary injection kit, infrared thermal imaging handheld temperature meter etc. All these instruments shall possess valid calibration certificate issued from approved NABL laboratory.
6.6	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.
6.7	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 etc for their labour deployed at site.
6.8	Vendor shall maintain updated labour register, with name, age, qualification, salary, attendance details etc. at the site.

6.9	Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site.
6.10	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.
6.11	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.
6.12	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.
6.13	Any damages on the building, structures etc. attributable to the acts of labour / employees of vendor shall be rectified and made good by the vendor at their own cost.
6.14	No child labour shall be employed for execution of the present contract.
6.15	Any miscellaneous materials, which are found essential for technical completion of the contract 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.
6.16	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.
6.17	BHEL/SECI shall witness routine/ acceptance/ type tests performed at manufacturer works for the items supplied by vendor. Vendor shall accordingly provide inspection call to BHEL with submission of quality assurance plan in advance. For the items 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/SECI for procurement of the item from dealers.
6.18	Field Quality Plan / Quality control system (if applicable) Vendor shall set up a field quality control laboratory with full set up to facilitate testing of all construction materials in accordance with FQP (Field quality control plan) as approved by BHEL/SECI. Vendor shall deploy a well experienced quality control engineer to monitor all QC activities at site as per approved FQP. Specifically with reference to civil works, vendor shall submit all concrete mix designs and bituminous mix designs for BHEL/SECI approval before starting of the work. All the third party testing should be conducted in NABL approved laboratories only. Vendor shall submit the FQP for the civil construction works before starting of the works for approval of BHEL/SECI.
6.19	Any deviations shall be discussed with BHEL/SECI site engineers and implementation shall be taken up only after approval from BHEL /SECI.
6.20	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.
6.21	Vendor shall, as and when required by BHEL/SECI, participate in the review meetings conducted by BHEL/SECI at project site, BHEL-EDN (Bangalore), BHEL-Corporate office (New Delhi), SECI office, New Delhi etc
6.22	**General Guidelines** a) Any civil or electrical work which is not mentioned or included in this tender document but necessary for functional requirements of the plant shall be carried out by vendor. b) Vendor shall prepare all designs / drawings based on the specifications given in the tender and in light of relevant BIS/IS/ equivalent standard. c) Vendor shall provide type test reports and datasheet/ GTP for all equipments covered under vendor scope of supply.

	d) BHEL reserves right to modify the design at any stage to meet local site conditions / project requirements. e) All work shall be carried out in accordance with the latest edition of the Indian Electricity Act and rules formed thereunder and as amended from time to time.
6.23	For all current carrying parts and earthing, S.S hardware shall be provided and all other places, G.I hardware shall be provided. M.S hardware shall not be used in any place.

7 Documents to be submitted for BHEL/SECI approval during detailed engineering

7.1	BHEL/SECI approval shall be obtained for the following technical documents, which shall be submitted to BHEL in phased manner based on priority sequence of activities during detailed engineering (after receipt of purchase order from BHEL).
7.2	Name of vendor/ make, model number/ part number, specification/ sizes/ dimensions/ drawings/ datasheets shall be submitted for all the vendor supplied items.
7.3	Design calculations/ general arrangement drawings/ single line diagrams/ GTP particulars/ datasheets/ schemes/ layouts/ bill of materials etc., as applicable.
7.4	Manufacturing Quality Plans for all the vendor supplied items
7.5	Field quality plan for the field work: civil works, electrical works
7.6	Detailed activity-time chart for project implementation
7.7	Detailed manpower deployment schedule