

	PURCHASE SPECIFICATION; GROUP: PHOTOVOLTAICS SUPPLY OF BOS ITEMS , 25KV SWITCH YARD & HT LINE ITEMS, I & C, 1 YEARS O & M (WITH SECURITY) FOR 1.7 MW SPV POWER PLANT FOR INDIAN RAILWAY AT SUKHI SEWANIYA, BHOPAL, M.P	PS-439-1252
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Technical Specification for

Supply of Balance of System items, HT switchyard, Overhead Transmission line,

Installation & Commissioning for

Indian Railways grid connected 1.7 MW Solar PV plant for Indian Railways at

Sukhi Sewaniya, Bhopal, Madhya Pradesh

Revision details :	Prepared by:	Reviewed by:	Approved by:	Date:
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1.0 Introduction :

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up 1.7MW, single phase, 25 kV voltage level Railway's grid Connected SPV Power Plant for Indian Railways at Sukhi Sewaniya, Bhopal, Madhya Pradesh.

The plant shall have fixed angle module mounting structures with 310Wp Poly-crystalline type PV modules mounted, 2 nos. PCUs (Single phase Inverters) each of 850kW rating. Output of PCUs shall be fed to single phase, 2-winding outdoor rated dry type transformers (Qty-2 nos.) each of 1 MVA rating, which will step up the voltage to 25kV level.

The solar array will have 12 nos. of string monitoring boxes (SMBs-16 input :1 Output) to provide DC power input to the PCUs located at Pre Engineered Building (PEB) control room. PEB control room building shall have SCADA cum operator room, store room and toilets and shall also house 25 kV HT Control Panels, UPS, FCBC with battery bank, CCTV server and screen etc. A typical layout of PEB room shall be provided. The plant SCADA will gather DC, AC and other parameters from SMBs, PCU, Weather monitoring equipment, transformers, and HT panels for remote monitoring.

This technical specification provides requirements of BHEL for Design, Supply, Installation, Commissioning and testing of balance of system items including 25kV transmission with 25 kV switchyard and termination at 25kV traction sub-system at Sukhi Sewaniya except BHEL scope of supply and work which is mentioned under section 4.2.

Note:

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

2.0 Documents enclosed with this specification :

1	Tentative Single line diagram of PV plant
2	Tentative Site layout with locations of solar array, control room (AutoCAD drawing of site layout can be provided on request by vendor through e-mail)
3	Tentative Control Room Layout

3.0 Documents to be submitted along with offer :

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

Note: In case Vendor desires to carry out part of the work from its sub-contractors then same can be done with prior written approval from BHEL. For all the items which need to supply and wherever approved vendors are not provided, approval of makes shall be obtained from BHEL before placement of P.O on sub-vendors.

4.0 Scope of Supply and work :

4.1 Vendor scope of supply and work:

The table below indicates the vendor's scope of Design, Supply and Installation & Commissioning. Quantities mentioned below are indicative only and not exhaustive. Vendor shall estimate exact

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requirement and quote accordingly. Further in case of extra material /Services required to complete the work is deemed to be included in the scope of vendor.

S.No	Item description	Qty	Unit
1	Supply of Cable ties, HDPE conduits, Ferrules etc. for DC cable dressing and routing	01	Set
(i)	Supply of HDPE DWC pipe 100 mm for DC cables	1500	M
(ii)	Supply of HDPE DWC pipe 38 mm for LT AC cables	100	M
(iii)	Supply of HDPE DWC pipe 30 mm for OFC cable	1.5	KM
(iv)	Supply of HDPE DWC pipe 30mm for RS485 cable	750	M
2	Supply of SMB mounting structures, associated civil works and suitable hardware's. (SMB Shall be supplied by BHEL)	12	Sets
3	Supply of MC4 type connectors (each positive and negative, suitable for 10 sq. mm cable)	200	Sets
4	Supply of MC4 type Y- connectors(input side 4 sq. mm and output side 10 sq. mm cable)	350	Nos
5	Supply of 300 sq.mm Cable glands, lugs with Bimetallic washers and hardware for SMBs	24	Sets
6	Supply of Cable trays for cable routing from PCU to Inverter Transformer	100	M
7	Supply of Cable tray support structure with hardwares	02	Sets
8	Supply of 300 sq. mm cable glands, lugs with Bimetallic washer and hardware's at DC side of PCU	24	Nos.
9	Supply of 300 sq.mm cable glands, lugs with Bimetallic washer and hardware's at AC side of PCU & at LT side of transformer	64	Sets
10	Supply of 25A FCBC (Float cum boost charger) with 110V, 100AH battery bank	01	Set
11	Supply of ACDB(AC main distribution board-Several feeders-to be decided during detailed engineering)	01	No
12	Supply of 5KVA UPS (single Phase) with 2 hours back up, battery bank and UPSDB	01	Set
13	Supply of weather monitoring System (WMS) (includes Pyranometer, temperature sensor for Ambient and Module temperature, Anemometer, Interface, mounting structures etc.)	01	Set
14	Supply of auxiliary cables(For lighting, CCTV, LT supply etc.) and control cables along with suitable lugs, washers and hardwares	01	Set
15	Supply of complete Earthing system components viz. Earth electrode, earthing GI/CU strips, earthing cable, hardwares etc. for solar array structure, SMBs, PCU, Control room equipments, Switchyard equipments SCADA, UPS FCBC, plant lighting system, CCTV system and other electrical panels and equipment's in solar plant. As per IS:3043 25x3 mm GI earth strip – 4500 meter 50x4 mm GI earth strip – 750 meter GI PIPE OF 50 NB EACH OF 3 METER LONG – 30 nos. including chemical compounds. Quantities mentioned above are indicative only and not exhaustive. Extra quantities required to complete work included in scope ,will be supplied by Vendor.	1	Set

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16	Design and Supply of ESE LA including civil works and earthing system(For LA Nos. of earthing electrodes and suitable earth strips to be decided in detailed engineering)	01	Set
17	Design and Supply of Plant lighting system such as street light poles, bend pipes, luminaires, LED lamps, junction boxes, cable, conduits, foundation items and all related accessories, hardware etc. (Periphery lighting, switchyard lighting etc.) Nos to be decided by vendor by detailed engineering considering site requirements	01	Set
18	Design and Supply of Plant CCTV system (with 30 days storage and net connectivity-Locations, Quantities and type of camera and other details to be finalized in detailed engineering)	01	Set
19	Design and Supply of complete module cleaning system (excluding submersible pump & borewell) , booster pump, overhead water tank, hoses, GI pipes with fittings, valves etc,	01	Set
20	Supply of Identification tags, markers etc.	01	Set
21	Design and supply of 25kV switchyard at Solar Power plant side as per IS/CEA norms (Items supplied by BHEL listed at cl. 4.2, all other items shall be supplied by vendor). Design and drawing shall be prepared as per BHEL norms and submitted for approval.	01	Set
22	Design and supply of 25kV Overhead transmission line from solar PV plant to Indian Railways TSS, Sukhi Sewaniya. Design and drawing shall be prepared and submitted for approval from BHEL/Indian Railways/RDSO norms.	01	Set
23	Design and supply of ABT type Bi-Directional Energy Main meter with check meter along with suitable CT, PT and cubicle. Complete supply is required. Make of Energy meter should be L & T or Secure.	1	Set
24	Design, supply and erection of termination of transmission line at PVCB (Supplied by BHEL) along with supply and erection of CT, PT, LA and earthing. (Items supplied by BHEL listed at cl. 4.2, all other items shall be supplied by vendor). Termination details and drawing shall be prepared and shall be submitted for approval from BHEL/ Indian Railways. Note : Lightning Arrestor, Current transformer, Potential transformer, PCVCB mounting structure and pole supports, earthing, civil material etc are required for completion of switchyard, transmission line and termination at TSS are in the scope of vendor. In case any other material required to complete the work is deemed to be included in the vendor's scope without any cost and extra time implication to BHEL. Supply and installation of Metering CT, PT, ABT meters, metering cubicle and cables also in the scope of vendor.	01	Set
25	Supply of multimode Optical fibre cable (suitable to lay underground) with necessary termination kits and splicing if required.	1.5	km
26	Supply of Hoarding board	02	Set
27	2 MBPS Internet connection with Static IP for 12 month	12	Month
28	Supply of signal cable for Transformer, breaker and other equipment's with lug, termination, numbering ferrules, cable ties etc	1	Set
29	Supply of Danger boards, Display boards and sign boards	01	Set

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30	Supply of Electrical insulation mats	01	Set
31	Supply of Chequered plates	01	Set
32	Supply of Air conditioner	01	Set
33	Supply of Tool kits and instruments	01	Set
34	Supply of Office furniture	01	Set
35	Design and Supply of Fire alarm system, fire extinguishers, sand buckets etc. and safety related items such as hand gloves, discharge rods, boots, safety harness, helmet etc.	01	Set
36	Supply and Erection of Temporary storage Yard with approx. 200 sq. m of covered shed area inside PV plant	01	No
37	Installation & Commissioning as per respective clauses in specifications	01	AU
38	Supply of all items (such as Gravel, cement, rod, sand, brick etc.) required for constructing cable and earthing trenches, foundation for structures limited to BOS scope.	1	Set

#	Scope of work (as briefly outlined)	Qty	Unit
1	I & C : Temporary site office of Porta Cabin type, arranging electrical power and water for construction, construction of temporary storage yard, unloading and movement of consignments as per clauses 5.1 to 5.4	01	AU
2	I & C : Interconnection of SPV modules, cabling (4 sq mm to 10 sq.mm. Y connector) from PV modules-Strings-SMBs, installation of string monitoring boxes including cable terminations, formation of cable trenches , laying and termination of 1Cx300 sq-mm DC cables to PCUs and inspection thereof as per clauses 5.5 to 5.13.	01	AU
3	I & C: Erection of electrical panels such as inverters, ACDB, FCBC, Battery bank, C & R panels, erection of cable trays and cable supports, routing and terminations of AC cables from PCUs to LV side of transformers in switchyard as per clauses 5.14 to 5.16	01	AU
4	I & C: 2 nos. of 1000kVA, 25kV /400 V dry type transformer supplied by BHEL as per clause 5.17	01	AU
5	I & C: of 25kV switchyard at Solar PV plant end. Install the 25kV switchyard including suitable two pole /four pole structures. Refer Single Line Diagram indicated in clause 2 (1). Switchyard shall be as per the approved drawing which would have prepared by vendor and approved by BHEL. All necessary electrical standards shall be followed by vendor as per clause 5.18. I & C: of Metering panel, ABT meters and metering CT& PT including cable laying and terminations.	01	AU
6	I & C : of 25kV, Single phase Transmission line till Indian Railways TSS (Traction substation), Sukhi Sewaniya, Bhopal : Vendor shall erect and commission single phase 25kV transmission line as per the approved drawing. Transmission line shall be as per the relevant local relevant Indian railways and electricity rules. Optical fiber cable shall be laid underground at suitable depth along the transmission line from TSS till PV plant control room as per clause 5.19	01	AU

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7	I & C: of PCVCB 25kV and associated component including SCADA panel at Indian Railways TSS, Sukhi Sewaniya, Bhopal : 25kV Overhead transmission line shall be terminated at Indian Railways Traction Sub-Station as per the design approved by BHEL/Indian Railways. Except BHEL supplied items which is listed at cl. 4.2 all the necessary items shall be supplied and installed to complete the work. This may require supply and installation of Gantry and additional bay. Vendor shall visit TSS for the requirement before the quoting against the tender. A SCADA panel shall be installed and connected to Indian Railways SCADA panel as per clause 5.20	01	AU
8	I & C : Weather monitoring station installation, associated civil works, cable connections and termination etc. as per clause 5.21	01	AU
9	I & C : Auxiliary cables laying, connections and terminations as per clause 5.22 to 5.23	01	AU
10	I & C: SCADA, cable trenches, cable laying, cable terminations for control, communication and OFC cables from SMBs, inverters, transformers, VCB Panels, C & R panels, and other equipment to SCADA as per clauses 5.24 to 5.25. SCADA cable laying, termination and testing from TSS to PV control room is part of this work.	01	AU
11	I & C: Earthing system for solar array field, control room panels, inverter panels and switchyard equipment including installation of Chemical earthing electrodes, erection & electrical interconnection of earth chambers, earthing of module mounting structures, laying of GI/copper earth strips in control room, as per clauses 5.26 to 5.27.	01	AU
12	I & C: Plant lighting system for approach road, switchyard and boundary wall including cable trenches, cable laying and cable terminations at lighting poles as well as ACDB panel in control room as per clauses 5.28.	01	AU
13	I & C: Lighting arrester including earthing and associated civil works as per clause 5.29	01	AU
14	I & C of module cleaning system (excluding drilling of bore well & supply of submersible pump), supply and installation of water storage tanks, trenches for pipelines, laying of pipelines from bore well to solar array field through water storage tanks, erection of submersible and booster pumps, ball valves, non-returnable valves as per clauses 5.30 and 5.31.	01	AU
15	I & C of miscellaneous and safety items such as cable tags, danger boards, cable markers, hoarding board, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, office furniture, fire extinguishers, fire alarm system etc. as per clauses 5.32 to 5.42	01	AU
16	I & C: Pre-commissioning inspections / checks / tests, as per the BHEL / Indian Railways / RDSO standards for commissioning, synchronization with Railways grid and post-commissioning operation of the plant as per clause 5.44.	01	AU
17	Commissioning of entire PV plant including commissioning of 25kV transmission line with termination at IR TSS with trial period of 7 days.	01	AU

4.2 BHEL scope of supply and work :

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

#	BHEL Scope of supply	Qty	Unit
1	Supply of Solar PV Modules	5840	Nos.
2	Supply of Cable, 1Cx 10 sq.-mm XLPO CU cable as per EN 50681(Copper or Aluminum cable) for connection of PV modules to string monitoring boxes	16	Kms.

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3	Supply of String monitoring boxes (16-in, 1-out)	12	Nos.
4	Supply of 1Cx300 sq. mm XLPE Armored Aluminum cable	7	KM
5	Supply and Erection of Solar array structures with modules mounted on structures (MMS), with each having 20 Nos. of PV modules	90	Ton
6	Supply of Power conditioning unit (PCU) of 850 KW rating along with duct	2	Nos.
7	Supply of Dry type transformer 1000kVA, 25kV/400V	2	Nos.
8	Supply of SCADA system with PC, accessories and software including SCADA panel for Indian Railways TSS side.	1	Set
9	Supply of RS-485 cable for SCADA	1	Set
10	Supply of PCVCB, & C & R Panel (Mounting, earthing, cabling and other incidental arrangement not included in BHEL supply).	04	Set

Note: For all civil related activities which in the scope of vendor, quality documents (Material test reports, Design mix report etc.) shall be submitted by vendor.

5.0 Detailed technical specification for supply, installation and commissioning, Testing, and O & M for 1 Year:

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

#	BHEL specification	Vendor compliance (Yes / No) In case of non-compliance or deviation, vendors shall record their comments:
5.1	Setting up of temporary site office (1) Vendor shall set up a temporary site office using one porta cabin of minimum 160 sq. ft along with chemical toilet, water tank and septic tanks for BHEL use within 10 days from the date of purchase order to enable speedy commencement of site activities. (2) Porta cabin shall be retained at the site at least for one month after the plant commissioning. (3) Cabin shall be furnished with essential amenities such as one Desktop computer with internet connection, printer and printer consumables including A4 papers, two work tables, four chairs and necessary number of power points, lamps, air conditioner and fans. (4) Vendor shall arrange drinking water in site office for the site engineers of BHEL and the staff/employees of vendor. (5) Vendor shall make arrangement for pantry shed for preparation of beverages such as Tea/Coffee/Snacks etc. Vendor shall depute office boy-cum-cook for	

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	preparation of Tea/Coffee/snacks. All the utensils, consumables such as milk, tea, coffee powder, snacks facilities, LPG connection shall be in the scope of vendor.	
5.2	Electrical power and water for construction (1) Vendor shall organize necessary electrical power supply and water supply required for construction activities and also for the porta cabin on chargeable basis. Vendor shall pay the charges to BHEL/Railway based on consumption. Necessary metering arrangement shall be made by vendor.	
5.3	Construction of temporary Godown/yards for safe storage of BHEL as well as vendor supplied items Vendor, at suitable locations at the site, shall construct a temporary yard for safe storage of all BHEL as well as vendor supplied items. This includes storage of items such as Electrical panels (SMBs, PCUs, Transformers, Distribution boards etc), cables, spares, tools, instruments etc. (1) Area of storage yard area of 200 sq. m shall be provided with suitable temporary roof and side covers (asbestos, FRP, steel sheet etc.) for storage of critical electrical panels (PCUs, SMBs, electrical DBs etc.) in order to ensure that there will not be any water spillage which may damage the equipment. This should be supported by steel poles that shall be grouted using suitable concrete foundations. Height should be appropriately decided to ensure safe operation of hydra for loading/unloading etc.. (2) Necessary raised/covered arrangements shall be provided to the individual panels / equipment to ensure that these items are not affected by water at the ground level during time of rain storm, flood etc. (3) Yards shall be fenced all around with a steel gate of width of 4m minimum. Height of fence and gate shall be 2.5m minimum above the ground level. (4) Suitable fencing shall be provided using steel poles at every 3m intervals and barbed wires between the poles. (5) Gate shall be suitably secured to the fencing poles and shall be provided with lock and key.	
5.4	Receipt, unloading, safe storage and movement of BHEL and vendor supplied items (1) Vendor shall organize all necessary resources such as labour, machinery and tools (cranes, hydra, forklifts, transportation trucks / trolleys, lifting accessories etc.,) for unloading the BHEL and vendor supplied items received at the site and subsequent movement to the storage yard. Similar arrangements shall also be made by vendor for movement of the items from storage yard to the point of construction in vendor's scope of works. (2) Vendor shall maintain proper documentation / compilation of all the records related to shipping (invoices, delivery challans etc.) and shall take verification and approval from BHEL site engineer for every consignment. The documents shall be suitably preserved for further handing over to BHEL. (3) Safeguarding the items from pilferage etc. is responsibility of vendor. For this purpose, vendor shall post adequate watch and ward for the yard on round-the-clock basis. (4) Registers shall be maintained for the yard to keep track of incoming / outgoing items.	
5.5	Interconnection of SPV modules to form strings. Vendor shall interconnect the modules as follows: Each module is fitted integrally with a junction box having positive and negative polarity cables (4 sq-mm). (a) Positive cable of one module shall be connected to the negative cable of adjacent module. The cables have MC4 type of connectors. One end of cable has male type connector, while the other has female type connector.	

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	(b) This way, 20 modules shall be connected in series. Each set of connections is called as a series string. (c) After placing the purchase order on vendor, BHEL will provide layout drawings that will describe the exact way in which the series strings are formed and interconnected to the respective SMBs. Vendor shall implement the interconnection as per these drawings. (d) Interconnected cables shall be neatly routed and dressed using UV resistant nylon cable ties of appropriate dimension. (e) These cable ties shall be in vendor scope of supply. Recommended make: 3M, Phoenix contact, Weidmuller, Hellermannntyton, and Panduit. BHEL approval shall be obtained by vendor for use of any other make. Specs: Nylon cable ties, polyamide 6.6 UV stabilized black, UL94 flammability rating V2, meant for outdoor use. Operating temperature up to 85 deg C. Width of cable tie shall be minimum 4.5 mm. BHEL approval shall be obtained for the selected brand and length of cable tie. (f) Cables shall not be loosely hanging. (g) DC cables shall be routed through HDPE DWC conduits at crossing between tables and wherever required. (h) All string cables shall be numbered using ferrules.	
5.6	Supply of MC4 type Y- connectors and MC4 Type connectors and Interconnection of SPV string cables to 10 sq-mm cable using leap frog method (1) Each SPV module string shall be connected to SMB using 1Cx 10 sq-mm cable. Overall diameter ~ 10 mm. (2) SPV module is provided with positive and negative cables (4 sq-mm) having male and female parts of MC4 type connectors. (3) Vendor shall supply MC4 Y- connectors and plug connectors of MC4 type, each set having a pair of male and female parts, to join the 10 sq-mm cable with SPV module string. Necessary crimping and termination is in the scope of vendor. (4) MC4 connectors shall have rating of 1000VDC (IEC), rated current of 25A (min.), Type approved by TUV Rheinland for product safety. (5) Approved make: Multi-contact, Staubli, Bizlink or other reputed equivalent subject to BHEL approval during detailed engineering. (6) Total quantity of MC4 Y- connector required = 350 Nos. (Suitable for 10 Sq.mm cable) (7) Total quantity of MC4 connector sets required = 200 sets (each set having a male and a female part). –Suitable for 10 Sq. mm. cable (8) Extra quantity shall also be procured considering possibilities of damages during the installation. Vendor shall ensure that there shall not be any shortage during execution time. Vendor should make available MC4 tool kits of quantity as required during execution for simultaneous working on the array.	
5.7	Routing of 1Cx 10 sq-mm cable from PV modules to SMBs : (1) 10 sq-mm cables connecting the SPV module strings to SMBs shall be neatly routed along the module mounting structures using cable ties. (2) Cable ties, nylon polyamide 6.6 UV stabilized black, UL94 flammability rating V2, operating temperature up to 85 deg C, shall be used to arrest any possibility of movement or sagging. Cable ties shall be of make: 3M, Phoenix contact, Weidmuller, Hellermannntyton, and Panduit. Width of the cable ties shall be a minimum of 4.5 mm. BHEL approval shall be obtained for the selected brand and length of cable tie. (3) Cables shall not be loosely hanging.	
5.8	Underground laying of 10 sq-mm cables between the rows	

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	(1) Where 10 sq-mm cables run between two rows of structure, HDPE double walled corrugated (DWC) pipe shall be used to guide the cables underground from one row to the other in trenches. (2) HDPE DWC pipe of required length shall be within scope of vendor supply. Vendor to procure necessary quantity of HDPE pipes based on the actual requirement and ensure no shortfall in supply during the time of installation. (3) Inner Diameter (ID) shall be selected to accommodate a number of 10 sq-mm cables to be guided. However, Inner diameter shall be limited to a minimum of 100mm. Make: Tirupati Plastomatics, Jaipur or reputed make, as approved by BHEL. (4) Make, part number, sizes / dimensions, datasheet shall be submitted to BHEL for approval. (5) Details of cable trench: (a) Trench depth = 500 mm minimum. (b) Trench width = 200 mm minimum. (c) Bottom layer shall be sand of IS: 383 with 100mm thick. (d) HDPE conduit shall be laid over the sand layer. (e) Another layer of sand of 100 mm thick. (f) Then, a single layer of class-2 brick (burnt clay type) of 75 mm thickness shall be laid. trench shall, then, be filled with refill soil and compacted.	
5.9	Installation of string monitoring boxes (Qty-12 nos.) (1) Supply of string monitoring boxes (SMB) is in BHEL scope. These SMBs are 16-in and 1-out type. (2) Vendor shall install the SMBs on Module mounting structure in the solar array field as per final array layout. (3) Supply of SMB mounting structures using GI channels/angles and necessary hardware required for installation of SMBs is in the scope of vendor. (4) Drawings of SMB and the fixing arrangement will be provided to the vendor after placement of purchase order. (5) SMB location layout/drawing will be identified and provided by BHEL. (6) SMBs shall be fixed on the structures using necessary hardwares, which shall be supplied by vendor. (7) All tools necessary for mounting shall be in vendor scope. (8) All associated civil works and supply shall be in vendor scope.	
5.10	Connecting the 10 sq-mm cables on input side of SMBs (1) 10 sq-mm cables of positive and negative polarities originating from SPV module strings shall be terminated at the input side of SMBs using cable glands, lugs etc. (2) Cable gland are fitted on input side of SMBs. (3) Vendor scope includes removal of sleeve at the cable end, crimping with suitable cable lug of appropriate type/size and connecting the lugged end to the bus bar within the SMB. (4) All necessary tools such as pliers, strippers, crimping tool etc. shall be within vendor scope.	
5.11	Connecting the DC power cables on output side of SMBs (1) Cables of size 2R per SMB, 1Cx 300 sq.mm (Aluminium, armoured, XLPE insulation, PVC sheathed) shall be terminated at the output side of SMBs. (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 bus bar within the SMB. Cables shall enter the SMB through the cable glands. (3) Aluminum Cable lug and washer shall be in vendor scope of supply. Vendor shall submit catalog and datasheet of lug before procurement. Make: Dowell's /3D / 3M or any other reputed equivalent as shall be approved by BHEL. Quantity required ~ 24 Sets.	

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	(4) Hardware such as bolts, nuts, plain washers and spring washers shall be in vendor scope of supply. The size and type of these shall be in accordance with termination arrangement on the bus bar of SMB. Hardware should be SS304. Spring washers should be Zn coated. (5) All necessary tools such as pliers, strippers, crimping tool etc., required to complete the work shall be within vendor scope.	
5.12	Cable trenches for laying power cables from SMB to PCUs/ inverters: (1) 2R per SMB, 1Cx 300 sq. mm (Aluminium, armoured, XLPE insulation, PVC sheath) cables of positive and negative polarities are routed from each SMB box to power conditioning units (PCU) located at PEB Inverter room. (2) These cables shall be laid underground from the point near SMB to PEB Control room as per IS: 1255 (Latest amendment). (3) Two cables one for positive polarity and other for negative polarity from each of the SMBs have to be routed to each 850KW inverters. (4) Tentative Array layout with location of SMBs and control room is enclosed for vendor's reference and for estimation purpose. Exact solar array layout will be provided by BHEL after placing purchase order. Vendor shall prepare and furnish cable routing layout as per standards for approval by BHEL. (5) Vendor shall estimate the length of cable trench. Generally these power cables will be packed in 500 m drums. Vendor has to carefully plan laying of farther cables first to ensure cut lengths can be used for shorter cables. Any shortage of cable occurring because of vendor's works will be in the scope of the vendor. (6) Vendor shall construct the underground trench as follows: (7) Trench depth = 750 mm minimum. (8) Trench width shall vary en route to PEB Control room, based on the number of cables. As the cables join from SMBs en route, bunching takes place and the width of trench shall increase. Max trench width expected = 1.5m. (9) Sand as per IS: 383 of 100 mm layer thickness shall be laid at the bottom most level of trench. (10) Over the sand layer, cables shall be laid one adjacent to the other. Cables shall not be laid one over the other. In other words, only one layer of cables shall be allowed. (11) Over the layer of cables, one more layer of sand of 100mm shall be laid. (12) Then, a single layer of class-2 brick (burnt clay type) of 75 mm thickness shall be laid. (13) Trench shall then be filled up with refill soil. (14) Subsequently, land over the cable trench shall be leveled and compacted suitably. The cables shall be laid inside Class-B GI pipes/ RCC hume pipes of suitable size under road crossings, drains, sewerage lines, entry and exit points of the buildings or where there are chances of mechanical damage Only terminal cable joints shall be accepted. No cable joints to join two cable ends is acceptable. Supply of GI/RCC hume pipes is in the scope of vendor. Numbering of cable to be carried out by using aluminum tags.	
5.13	Power cable terminations on DC side of PCUs (1) On DC side of PCU, vendor shall carry out the required number of cable terminations for positive and negative inputs connections by unsleeving, crimping and connecting. (2) All cable glands, cable lugs, bolts, nuts and washers required for termination on DC side of PCU shall be supplied by the vendor. Qty of lugs and glands required ~24 Nos. (3) All tools and accessories required to carry out the termination shall be within scope of vendor.	

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5.14	Installation of PCUs with ducting, SCADA panel, ACDB etc. inside PEB control room : (1) Vendor shall organize necessary resources such as labour, cranes, hydra, forklifts, transportation trucks / trolleys and other accessories for movements and positioning of the following items/equipment : - PCU panels: 2 set - ACDB panel: 1 No - SCADA panel: 1 No - FCBC and battery bank-1 No - UPS etc. - Supply of ACDB,FCBC with battery bank, and UPS is in vendor scope (2) All equipment shall be placed over the cable trenches in PEB Inverter room, in the exact sequence and locations as shown in BHEL drawings that will be provided to vendor at an appropriate time during the period of execution. (3) All equipment shall be suitably grouted using welding / bolting methods as appropriate. BHEL approval shall be obtained for the grouting arrangement. All necessary hardware for the same shall be within vendor scope of supply. (4) Vendor shall supply and install cable trays of required length and corner bends as required within PEB control room for laying DC, AC & signal cables over the trays. Vendor shall supply cable trays as follows: - Ladder type GI cable trays - Hot dip galvanized - Depth = 40 mm min. - Width = 600 mm min. (5) Vendor shall fix the cable trays on the projecting steel sections in cable trench of control room. Supply and works related to the appropriate placement of these steel sections will be in the vendor's scope. (6) Adjacent cable trays shall be interconnected using suitable hardware items that shall be in vendor scope of supply. (7) Cables shall be laid over the cable trays and neatly dressed using appropriate cable ties etc. Cables from AC side of PCU (16Rx1Cx300 sq. mm per PCU) shall be laid underground up to LV side of 1000 KVA inverter transformer located at outside of control room in switch yard .	
5.15	Supply and installation of UPS Vendor shall supply and install 1No. 5KVA UPS with UPSDB in the PEB control room for auxiliary supply to PCU, SCADA panels, PCs and emergency lighting. Vendor shall supply battery for UPS with a backup of 2 hours. Vendor shall submit the sizing calculations for battery considering design margin, temperature correction factors and safety margins for approval.	
5.16	Power cable terminations on AC (LT) side for PCUs and transformers (1) On AC side, 1-phase and 1- neutral, total 16 runs per PCU of 1Cx300 Sq.mm Aluminum, armored, XLPE FRLS insulated cable each side interconnections shall be made between PCUs and transformer using suitable lugs, glands etc. For AC cable terminations at PCU end and transformer end, vendor shall supply the required number of cable glands, cable lugs, bolts, nuts, plain washers, spring washers. Aluminum lugs with bimetallic washer (Al-Cu) shall be supplied. Bolts, nuts, plain washers shall be of SS304 type. Spring washers shall be zinc plated steel. Make of lug: Dowell's /3D / 3M or any other reputed equivalent shall be approved by BHEL. Quantity of lugs and glands required ~as required.	

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	(2) BHEL will furnish the exact diameter of the cable at an appropriate time during the period of execution. Vendor shall make suitable size cut-outs using hole-saw cutters in the gland plates of the transformers for entry and exit of cables. (3) Vendor shall make the measurements between the equipment, cut the cables to the required lengths, fix them with glands, unsleeve them at the ends, crimp them with the lugs and terminate them at the respective bus bar provisions within the panels. Ferrules for numbering shall be in the scope of vendor. (4) All tools and accessories required to carry out the termination shall be within scope of vendor.	
5.17	Installation of 1000kVA, 25kV /400 V dry type transformer(Qty-2 nos.) supplied by BHEL (1) Dry type transformer and its accessory parts to be supplied by BHEL shall be moved from storage yard and installed in 25 kV switchyard at solar plant. All parts and hardware shall be assembled as per guidance at site provided by BHEL / transformer vendor. (2) Vendor shall provide all necessary support and assistance to the representative of transformer manufacturer during installation and commissioning checks.	
5.18	Installation of 25kV switchyard at Solar PV plant end : Vendor shall design, supply and install the 25kV switchyard as per the Single Line Diagram indicated in clause 2 (1). Switchyard shall be as per the approved drawing which would have prepared by vendor and approved by BHEL. All necessary electrical standards shall be followed by vendor. Installation and commissioning of metering panel, ABT meters and metering CT& PT including cable laying and terminations. ABT's metering panel shall be pole mounted/ground mounted to be decided in detailed engineering	
5.19	Installation of 25kV, Single phase Transmission line till Indian Railways TSS, Sukhi Sewaniya : Vendor shall erect and commission single phase 25kV transmission line as per the approved drawing. Transmission line shall be as per the relevant local relevant Indian railways and electricity rules. Optical fibre cable shall be laid underground at suitable depth along the transmission line from TSS till PV plant control room.	
5.20	Installation of PCVCB 25kV and associated components including SCADA panel at Indian Railways TSS, Sukhi Sewaniya : 25kV Overhead transmission line shall be terminated at Indian Railways Traction Sub-Station as per the design approved by BHEL/Indian Railways. Except BHEL supplied items which is listed at cl. 4.2 all the necessary items shall be supplied and installed to complete the work. This may require supply and installation of Gantry and additional bay. Vendor shall visit TSS for the requirement before the quoting against the tender. A SCADA panel shall be installed at Sukhi Sewaniya TSS and connected to Indian Railways SCADA panel.	
5.21	Supply and installation of Weather monitoring station (WMS) : Vendor shall supply and install Weather monitoring Station (WMS) on stand at shadow free area adjacent to PEB control room. Exact location shall be decided by BHEL during execution. WMS shall consist of Pyranometer (1 No.), Anemometer (1 No.), Module temperature sensor (1No.) and Ambient temperature sensor (1 No.). All the sensors of WMS shall be provided with output of 4-20mA signal. Converters if any required for conversion of sensor output to 4-20mA shall be in the scope of vendor. All necessary communication/ signal cables required for termination of WMS sensors in SCADA panel shall be in the scope of vendor. Supply and installation of	

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	Galvanized Mounting structure for WMS along with pedestal is in the scope of vendor. Approved makes: Kipp & Zonen/ Campbell Instruments / Aeron Systems / Metone / Hukeflex or any other reputed make as shall be approved by BHEL. BHEL approval shall be obtained for make and GTP prior to procurement. Detailed technical specifications of the equipment are given below. PYRANOMETER: (with angle adjustable stand) 1. Spectral Response- 300 to 2800 nano meters. 2. Sensitivity- 8 to 20 $\mu\text{V}/\text{W}/\text{m}^2$ 3. Operating temperature range: 0 deg to +70 deg. 4. Resolution: Min +1W/m² 5. Output: Analog form 4-20 mA 6. Standard: ISO 9060 -second class or equivalent. 7. Maximum operational irradiance: 2000W/m² 8. Response Time (95%) : <30s 9. IP rating: IP65(minimum) Pyranometer shall be supplied with necessary cables. Sample calibration certificate with calibration traceability to World Radiation Reference (WRR) World Radiation Centre (WRC)/ IMD shall be furnished along with the offer. ANEMOMETER: Anemometer shall be 3-cup tubular stainless steel type. Velocity range shall be up to 45 m/s and accuracy limit of 0.5 m/s up to 10 m/sec. AMBIENT TEMPERATURE SENSOR: PT100 sensors mounted inside a radiation shield, communication cable of adequate length, temperature range: -40 to +60 deg C with accuracy of +/- 0.2 deg C. MODULE TEMPERATURE SENSOR: Module temperature sensor shall be fixed to one of PV modules using heat conducting tape and output shall be connected to nearest SMB. Temperature range: 0 to +80 deg C with accuracy of +/- 0.2degC.	
5.22	Supply and terminations of power cable at ACDB panel (1) 2 C X 70 Sq mm XLPE FRLS AL cable of length shall be used to connect auxiliary Transformer (Transformer is in Railway scope) output to ACDB. Supply and laying of this cable shall be in vendor scope. Qty of cable- 500 m (2) Vendor shall carry out termination on input and output side of ACDB and Auxiliary Transformer. Cable glands, cable lugs, bolts, nuts, plain washers and spring washers shall be within vendor scope of supply.	
5.23	Supply and terminations of auxiliary cable at different feeders from ACDB panel (1) All aux cables shall be in vendor scope of supply. Sizing shall be as per design calculations. (2) Vendor shall submit make/ GTP etc for BHEL approval during detailed engineering. (3) Vendor shall establish an auxiliary AC supply system for (a) various utility power consumption purposes such as control room lamps, ceiling fans, exhaust fans, booster pumps, plant lighting, Plant CCTV system air conditioner, other electric appliances, VCB panels, transformers etc and also, for powering the battery chargers that in-turn charge the battery banks for 110V DC supply.	
5.24	Support and assistance for SCADA integration for the power plant (3) SCADA of power plant comprises of data station panel and PC based control desk with software to collect, store, process and report the data parameters of power plant as follows:	

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	(a) String monitoring boxes in solar array field: string current, voltage, box temperature, module temperature, status of SPD and load break switch in SMBs (b) Weather monitoring equipment: solar irradiation, ambient temperature, wind velocity. (c) Power conditioning units: DC input /AC output parameters of inverters, grid data, fault status and events logged, etc. (d) HT panels: status of breakers, status of protection relays of transformers, Multi-Function meters. (e) Transformers: winding temperature (f) Energy export to the grid from ABT meters etc. (2) Vendor shall carry out following activities: (a) Formation of underground cable trenches and cable laying and termination for data communication cables from SMBs to SMBs (daisy chain) and from end SMB of each loop to SCADA, from transformers, VCB panels to SCADA. (b) Data cable laying from PCUs, transformer, VCBs, ACDB panels to SCADA. (c) Data cable terminations at PCUs, ACDB panels, transformers and VCB panels.	
5.25	Data & Control cable laying and terminations in control room Vendor shall carry out following data cable laying and terminations at 1000 kVA Transformers, VCBs panels, ACDB panels and PCUs, SMBs etc. (1) Terminations at marshalling box of 1000kVA transformers (WTI). (2) Terminations at VCB panel for SCADA. RS485 cable for MFM and numerical relay to SCADA shall be supplied by BHEL. (3) Terminations at PCU of 850kW for RS485 MODBUS communication over TCP/IP cable connections using LAN cables. Supply of LAN cable is in BHEL scope. (4) Terminations at ACDB panel. (5) All the cables required for the above terminations shall be within vendor scope of supply. Cable specification as follows: Cable, 1.1kV grade, copper conductor, stranded, PVC type-A insulation, twisted pair, overall shielded with aluminium backed mylar sheet, inner sheath of extruded PVC type ST1, Galvanized steel strip / round wire armoured as per IS, outer sheath of extruded FRLS PVC type ST1, conforming to IS:1554 / part-1 with latest amendments up to date. (6) Vendor shall submit the cable schedule for data, control and communication cables. Control cables shall be 2.5 sq-mm minimum, copper conductor, PVC, armoured. Communication cables shall be 0.5 sq-mm minimum, copper conductor, PVC, armoured. (7) Make of cables: Polycab, Advanced cables, Lapp, KEI or any other reputed equivalent as shall be approved by BHEL. (11) Cable lugs and all hardware required for making the above terminations shall be in vendor scope of supply. Note: Along with the above activities, DC/AC power supply cable laying and terminations shall be also be carried out for transformers and VCB panels using 2Cx2.5 sq-mm copper, armoured, PVC cables which is in vendor scope of supply.	
5.26	Earthing of solar array structures (1) Vendor shall interconnect solar array structures using welding of min. 25x3 mm GI strips. (2) Every row of such interconnected structures shall be terminated in a earthing electrode of 3000 mm long, hot dip galvanized and metal coated for rust proof, OD of minimum 50 mm shall be supplied by vendor.	

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	(3) Vendor to ensure that every earthed structure is provided with two alternate paths to earth. Accordingly, vendor shall provide suitable number of earth pits and ensure that the earth resistance of all earthed structures is less than 1 ohm. (4) Earth pit shall be drilled and earthing electrode shall be placed in the pit, filled with back filling chemical compound all around the electrode as per manufacturer's datasheet/ installation instructions. (5) Earth chambers of brick masonry shall be constructed. All items of earth chambers, including lid, shall be in vendor scope of supply. (6) Earth chambers shall be interconnected in the solar array field, using min. 25x6 mm GI strip that shall be laid underground. (7) Terminations at the electrode end shall be made using bolting method. Welding shall not be applied at electrode end. For this purpose, a separate link with multiple mounting holes shall be used at the electrode end. This way, GI strips (25x3 mm) running from structure leg and the GI strips (25x6mm) from adjacent electrodes shall be terminated at this link, which shall, in turn, be connected to the electrode. Joining of 25x6 mm GI strips at intermediate positions, wherever applicable, shall be made using either welding or bolting method. Either way, the overlapping of the two strips shall be for a minimum length of 150mm. Welding shall be for the entire overlapping length. In case of bolting, minimum three bolt joints shall be used per overlap length. For each earth pit, necessary Test Point shall have to be provided. (8) All GI strips, earthing electrodes and all hardware (nuts, bolts, washers of SS304) shall be in vendor scope of supply. (9) Vendor shall provide calculations for earthing, layout drawings showing earth chamber locations during detailed engineering. (10) For SMB earthing, independent earth electrodes of min. 2000 mm length shall be provided separately for each SMB. SMB earthing shall not be interconnected with module mounting structure earthing. Quantity required ~12 Nos. (11) Power SPD inside SMB shall be earthed using min. 16 sq.mm copper cable and communication SPD shall be earthed using min. 2.5 sq.mm copper cable as per SMB manufacture's recommendations that will be finalized during drawing approval.	
5.27	Earthing lines for control room panels – PCUs, transformer, ACDB, SCADA panels, etc. (1) 50x4 copper strips shall be laid in the cable trenches of control room till earthing point. Copper strips of required length shall be in vendor scope of supply. (2) Strips shall be covered by heat-shrinkable sleeves. Sleeves and Heater gun for heat-shrinking the sleeves over copper strips shall be organized by vendor. (3) Copper strips shall be anchored to the cable trench wall using insulation bush supports that will be in the scope of vendor. (4) Expansion bolts of appropriate size (Minimum M8) shall be used to fix the insulation bush supports. (5) Vendor shall provide the earthing line layout drawing along with calculations. Minimum two Nos. earthing pit shall be considered for each of control room panels such as PCUs, transformer, ACDB, SCADA panel etc. All the earth chambers shall be interconnected using 50X4 copper earth strip. (6) Copper strips shall be connected to the earthing terminals of all the control room panels except PCUs using min. 25 sq-mm copper, unarmoured, PVC cables that shall be supplied by the vendor. Cable lugs and hardware (bolts, nuts, washers etc shall be of SS304) required for connecting the 25 sq-mm cable to the earth terminals of panels and also to the copper strip end shall be in vendor scope of supply.	

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	(7) These chambers shall be located near the PEB control room. Exact locations will be intimated by BHEL site engineer. (8) Connection between earth chamber and copper earthing strip shall be made using cable, 1Cx 25sq-mm, copper, unarmoured, 1100V, PVC cables as per IS:1554 (part-1) that shall be in vendor scope of supply. (9) For PCU earthing, min. 70 sq.mm copper cable shall be used as per PCU manufacturer recommendations. Quantity ~ 10 m. (10) Routing of 1Cx25 sq-mm cables to electrode earth chambers shall be using 1-inch CPVC pipes, joints, bends and elbows that shall be in vendor scope of supply. Routing shall be underground outside the inverter and control room, at a depth of ~450mm below the ground level. Required length of CPVC pipe shall be supplied. Number of CPVC joints and elbows shall be as applicable. (11) Expansion bolts, cable lugs and all hardware required for this activity shall be within vendor scope of supply. Qty of electrode-14 nos. (12) Vendor to ensure that the earth resistance of all earthed structures is less than 1 ohm.	
5.28	Plant lighting system for switchyard, approach roads, pathways and compound wall (periphery lighting) : (1) Vendor shall supply and install required number of lights in switchyards, approach road, pathways and pre-cast type compound wall to maintain minimum LUX requirement of 20 LUX (In switch yard lux requirement of min. 50 Lux). Vendor shall prepare drawing and get approved from BHEL/Indian railways. (2) Light fitting, Bajaj/Havells/Equivalent make LED type shall be supplied and fitted on the GI bend pipes/poles/angles available in compound wall using necessary hardware. (3) Adequate spacing between the poles shall be provided to ensure the minimum lux requirement. (4) Underground armoured, PVC insulated, copper/ Aluminum cables of suitable size and required length shall be laid for power supply. Supply of these cables is in the scope of the vendor. Vendor shall submit cable sizing calculation for approval. (5) Junction box shall be at a height of 1m above ground level. MCB of suitable rating along with junction box shall be provided for each pole. (6) The Junction box shall be made of stainless steel (IP65), Dust & vermin Proof and shall have suitable brass or copper made connector terminal. MCB (1A, single pole) of Schneider or reputed make, 3 glands for incoming and outgoing cables. (7) The junction box, cable lugs, steel bracket for mounting the box on the lighting pole and all hardware items shall be in vendor scope. (8) Glands shall be located at the bottom side of Junction box. (9) Necessary underground cabling work is in the scope of the vendor. (10) Vendor shall submit the lighting layout, lighting illumination calculations, cable trench layout, shadow calculation, foundation pedestal details, detailed BOM for BHEL approval. (11) Supply of necessary hardware such as nuts, bolts, washers (SS304) is in the scope of vendor. (12) Vendor to ensure the lighting arrangement does not cast shadows on the PV modules. (13) All necessary tools and tackles shall be in the scope of vendor.	
5.29	Lightning arrestors (ESE) type (1) Vendor shall supply and install Early streamer emission lightning arrestors as per standards: UNE 21186 and NF C-17 102,	

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	Make: Ingescor/ABB/DEHN /OBO equivalent as shall be approved by BHEL, with minimum protection radius of 100 m. with counters and earthing systems. (2) Quantity : As required to cover the entire area of the plant, switchyard and separate LA for PEB control room building as per manufacturer recommendations. (3) Lightning arrestors shall be mounted on top of a mast of height 5m minimum above ground level using GI pipe of 100 mm minimum average diameter; Each mast shall be secured by three steel stay wires that are suitably grouted. Masts shall have appropriate steel base plate for mounting on an RCC concrete foundation pedestal of 450x450 mm size, 1m depth below ground level, 300mm minimum above ground level, PCC 1:4:8 as the bottom layer (~100 mm thick), steel rods of diameter 8mm minimum, concrete M25 with four J bolts (M16) of 750mm long, with nuts and washers. (4) Minimum two earthing chambers per lightning arrestor set using earthing electrodes shall be constructed as per manufacturer's recommendations. (5) All mechanical and electrical connections, cables, junction boxes, hardware etc shall be within vendor scope. (6) Vendor shall submit general arrangement and detailed drawings with bill of materials / quantities of the overall lightning arrestor arrangement including foundation pedestal details to BHEL for approval.	
5.30	Water supply for O & M, electrical cabling and plumbing works (1) Vendor shall lay pipe line from water storage tank next to borewell to various location in array and to PEB. (2) Pressure pump of required capacity (1-ph) with all necessary electrical cabling up to the ACDB located in control room shall be provided for pumping water from storage tank (approx.. 5000 Liter – Not part of this scope). Vendor shall submit the calculations for deciding pump rating and cable size. (3) Booster Pump and the electrical cables shall be in vendor scope of supply. Cable (Armoured, PVC) of suitable size depending on pump rating and of required length shall be laid underground with protection as per IS. (4) Pump make: CGL, Suguna, Kirloskar, or other make for which BHEL approval shall be taken. Vendor shall supply and install 1 No. PVC water storage tanks of 500 liters capacity adjacent to PEB Control room for toilet purpose. All materials required for water cleaning system are in vendor scope.	
5.31	SPV module cleaning system (1) Vendor shall lay 2-inch CPVC pipelines from overhead tanks to the solar array field with all necessary CPVC nipples, T-joints, reducers, bends, couplers etc. This forms the main header pipeline. Suitable valves such as brass valves of 2-inch etc shall be provided for this main header line. For the branching out lines that spread into various rows of the solar array to provide water delivery points for module cleaning, 1-inch CPVC pipelines shall be used. Supply of CPVC pipe shall be in vendor's scope. (2) Centrifugal 1-ph booster pump of required capacity shall be supplied and installed at PEB Inverter room to draw the water from storage tanks to solar array field for solar PV module cleaning. Vendor shall furnish design/pressure calculations for selection of pump size. (3) Starter and DP switch shall be supplied and installed in PEB Inverter room for operating the pump. (4) Supply of electrical cables (with lugs, hardware) and wiring the pump up to the ACDB panel / starter in the control room shall be in vendor scope. Cable of required dimension, Cu, armoured, PVC cable shall be supplied and used.	

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	(5) CPVC pipelines shall be laid underground (at a depth of ~500 mm below ground level). (6) There shall be adequate nos of delivery points for module cleaning. At these delivery points, 1-inch riser lines shall be provided to tap the water from underground line to the delivery point ~300 mm above ground level. Ball valve forged steel type, 1-inch, with suitable nipple for connecting the hose pipe, shall be provided at each delivery point. (7) After installation and testing of water lines, excavated trenches shall be closed with refill soil. Further, the soil, all along the water lines, shall be suitably leveled and compacted. (8) Hosepipes (ribbed, flexible) of 50m long shall be provided for connecting the hose to the nearest ball valve/nipple. The other end shall be provided with nozzle/appropriate gun to direct the pressurized water on the module for cleaning. 6 such sets shall be provided. (9) Vendor shall ensure adequate pressure of water is available for module cleaning. (10) Vendor shall submit detailed scheme with BOM etc. for module cleaning system from storage tank to solar array field.	
5.32	Identification markings using ferrules, paint and cable tags, as applicable to the individual cases and as approved by BHEL, shall be provided : (1) String monitoring junction boxes: Identification marking by way of painting on nearby module structure. (2) All equipment such as PCU, transformers etc. shall be provided with suitable identification markings using painting, with inscriptions as approved by BHEL. (3) Cable sizes with arrow marks using painting. (4) Identification markings for all the earth chambers (using painting) with inscriptions as approved by BHEL. (5) Cable tags using aluminium plate of 1-2 mm thickness with suitable inscriptions as approved by BHEL for all the power cables of the electrical panels such as PCU, ACDB panel, UPS etc.	
5.33	Cable markers (1) Steel cable markers with suitable labels (DC cable, LT cable, Data cable, CPVC water pipeline etc) and arrow marks (pointing to the cable destination) shall be supplied and installed along the cable trenches at appropriate locations for following cases: - For DC cable from string monitoring boxes to respective inverters - For data communication cables from string monitoring boxes to PEB control room - For cables of yard lights of solar array field, compound wall/chain-link fencing - For electrical cables of pump connections - For CPVC water pipelines (2) Cable markers shall be suitably grouted with concrete foundation depth of minimum 300 mm below the ground level. Cross section of foundation shall be minimum 200mm diameter. (3) Cable markers shall have a minimum height of 300 mm above the ground level. (4) Cable markers shall be suitably painted.	
5.34	Hoarding board for the solar power plant. (1) 2 Nos. hoarding for the plant shall be made of 1500x1800x 3mm thick MS plate. Approximate dimension of board 1500x1800 mm. (2) Board shall be given a red oxide coat and painted background. Colour for background and letters shall be as approved by BHEL site in-charge.	

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	(3) Board shall be fixed on a frame constructed using ISA 50x50x8 angles. Diagonal supports shall also be provided. The frame shall be supported by two vertical legs of ISA 75x75x8 that is grouted with concrete foundation. (4) Depth of foundation shall be 600 mm below ground level, with 100mm thick PCC layer 1:4:8 of 400x400mm, M25 concrete of 300x300mm, foundation pedestal of 200mm height above ground level. (5) Bottom level of board shall be at a height of 1.8 m above the ground level. (6) Vendor shall submit the drawing of hoarding arrangement to BHEL for approval. (7) Suitable lighting on one hoarding board is required to be done which shall be installed near Solar PV plant.		
5.35	Display boards and sign boards		
	1	Board displaying instruction chart for restoration of person from Electric Shock	1 No
	2	Board displaying instruction chart for artificial respiration	1 No
	3	Board displaying dos and don'ts.	1 No
	4	Board displaying fire extinguishers details and operations	1 No
	5	"No smoking" board	5 No
	6	Board showing list of O&M staff with name, qualification and work responsibility	1 No
	7	Board showing list of contact details of BHEL, O&M team, O&M security, police station, fire service, hospital, medical store etc with names, address, mobile numbers etc	1 No
	8	Danger boards with details such as value of voltage etc for string monitoring boxes, PCUs, , Transformers etc.	Qty as required
	9	Identification boards, of suitable sizes, within PEB control room such as SCADA room, store room, batter, security room, gents / ladies toilets, pantry etc shall be supplied by vendor. BHEL will provide the list.	Qty as required
	10	Route marker in the array for indication of route of underground cable path (every 30 meter and each on turn)	Qty as required
	(a) 5mm thick sun board with LG make vinyl sticker (computerized cutting and pasting) shall be used for SI Nos 4, 5, 8 and 9. (b) For others, flex banner with design & printing shall be used. Required number of danger notice plates shall be provided wherever necessary Suitable size of each Danger Notice plates shall be provided as per statutory requirement, made of mild steel sheet and at least 2mm thick, and vitreous enameled white on both sides, and with inscription in signal red colors on front side as required. The inscriptions shall be in Tamil and English language.		
5.36	Electrical insulation mats		
	(1) Vendor shall supply required number of electrical insulating mats as follows: (a) Make: Vardhman House Private Ltd or reputed equivalent as shall be approved by BHEL. (b) Colour: Black. (c) Max use voltage = 1.1 KV/ 25KV depending on location (d) Marking of IS standard shall be there on the mat (2) Test certificate shall be provided by vendor (3) Vendor shall lay the mats in front of electrical panels (PCU, ACDB panels etc.) in PEB control room.		

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5.37	Checkered plate for closing the cable trenches (a) behind the panels such as PCUs, ACDB panels etc. in PEB control room and also (b) other open areas of cable trench (1) Vendor shall supply and install checkered plate. Plate shall have a suitable handle (welded to the plate) to facilitate ease of lifting and movements. (2) Plate thickness = 6mm min. (3) Width = 1000 mm max, total length as required (4) These width and length dimensions are indicative. Actual dimensions shall be based on site conditions. (5) Plate shall be red oxide coated followed by black painting. (6) BHEL approval shall be obtained for overall arrangement of checkered plate.																																																																												
5.38	Air conditioner Vendor shall supply and install 1 No. Split air conditioners of 1.5T capacity (min BEE 3 star rating) with stabilizer in SCADA room. Make: Voltas, LG, Videocon, Bluestar, Godrej or reputed equivalent that shall be approved by BHEL.																																																																												
5.39	Tool kits and instruments Vendor shall supply the following tool kits and instruments: A. Measuring instruments <table border="1"><tr><td>1</td><td>Digital Earth Resistance Tester</td><td>Cambridge Instruments/equivalent</td><td>1 Nos</td></tr><tr><td>2</td><td>Digital multimeter</td><td>Reputed make</td><td>2 Nos</td></tr><tr><td>3</td><td>AC-DC Clamp Meter</td><td>Lutron/equivalent</td><td>2 Nos</td></tr><tr><td>5</td><td>Digital thermometer</td><td>Reputed Make</td><td>1 Nos</td></tr><tr><td>6</td><td>Megger – 5KV</td><td>Shanti Electric Instruments, Nippen/equivalent</td><td>1 Nos</td></tr><tr><td>7</td><td>Electrical Tester</td><td>Reputed Make</td><td>2 Nos</td></tr></table> Note: Make / model number etc. shall be approved by BHEL prior to procurement. B. Tool kits <table border="1"><tr><td>1</td><td>Double ended flat spanners of sizes 6mm to 32mm</td><td>1 Set</td></tr><tr><td>2</td><td>Double ended ring spanners of sizes 6mm to 32mm</td><td>1 Set</td></tr><tr><td>3</td><td>Double ended tubular box spanners of sizes 6mm to 32mm</td><td>1 Set</td></tr><tr><td>4</td><td>Screwdriver Set</td><td>1 Set</td></tr><tr><td>5</td><td>Crimping tool with Die range 50-400sq-mm cable, mechanical gear power, hand operated</td><td>1 Set</td></tr><tr><td>6</td><td>Crimping tool up to 10 sq-mm cable</td><td>2 set</td></tr><tr><td>7</td><td>Drilling machine AC, hand operated, with bit size up to 20 mm</td><td>1 set</td></tr><tr><td>8</td><td>Measuring Tape, 5m</td><td>2 Nos</td></tr><tr><td>9</td><td>Measuring Tape, 50 m</td><td>2 Nos</td></tr><tr><td>10</td><td>Allen Key set</td><td>2 Set</td></tr><tr><td>11</td><td>Adjustable spanner 2-inch size</td><td>2 No</td></tr><tr><td>12</td><td>Hammer</td><td>2 Nos</td></tr><tr><td>13</td><td>Rough file kit</td><td>2 Set</td></tr><tr><td>15</td><td>Cutting Pliers</td><td>2 Nos</td></tr><tr><td>16</td><td>Nose Pliers</td><td>2 Nos</td></tr><tr><td>17</td><td>Vacuum cleaner with blower function, for control room sweeping / cleaning.</td><td>1 No.</td></tr><tr><td>18</td><td>MC4 tool kits consisting of crimping plier, open end spanner set, stripping plier, socket wrenches</td><td>2 Sets</td></tr></table>	1	Digital Earth Resistance Tester	Cambridge Instruments/equivalent	1 Nos	2	Digital multimeter	Reputed make	2 Nos	3	AC-DC Clamp Meter	Lutron/equivalent	2 Nos	5	Digital thermometer	Reputed Make	1 Nos	6	Megger – 5KV	Shanti Electric Instruments, Nippen/equivalent	1 Nos	7	Electrical Tester	Reputed Make	2 Nos	1	Double ended flat spanners of sizes 6mm to 32mm	1 Set	2	Double ended ring spanners of sizes 6mm to 32mm	1 Set	3	Double ended tubular box spanners of sizes 6mm to 32mm	1 Set	4	Screwdriver Set	1 Set	5	Crimping tool with Die range 50-400sq-mm cable, mechanical gear power, hand operated	1 Set	6	Crimping tool up to 10 sq-mm cable	2 set	7	Drilling machine AC, hand operated, with bit size up to 20 mm	1 set	8	Measuring Tape, 5m	2 Nos	9	Measuring Tape, 50 m	2 Nos	10	Allen Key set	2 Set	11	Adjustable spanner 2-inch size	2 No	12	Hammer	2 Nos	13	Rough file kit	2 Set	15	Cutting Pliers	2 Nos	16	Nose Pliers	2 Nos	17	Vacuum cleaner with blower function, for control room sweeping / cleaning.	1 No.	18	MC4 tool kits consisting of crimping plier, open end spanner set, stripping plier, socket wrenches	2 Sets	
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	Note: Prior to procurement, vendor shall obtain approval from BHEL for the make and specification of the items.		
5.40	Office furniture :		
	Vendor shall supply and install the following:		
	1	Executive table, wooden type with draws and side racks	1 No
	2	Chairs, swivel type, with arm rest	4 Nos
	4	PC table	1 No
	5	Storage almirah	1 No
	6	Filing cabinets	1 No
Make: Godrej or reputed equivalent as shall be approved by BHEL. BHEL approval shall be obtained, for the type of office furniture, for which catalog with model numbers, sizes / dimensions etc shall be submitted to BHEL.			
5.41	Fire alarm system for PEB control room:		
	(1) Fire alarm system with smoke detectors, hooters, manual call points, an electronic control panels and interconnection wiring shall be supplied and installed by vendor. Make: Zicom/ Notifier /Ravel or any other reputed equivalent as shall be approved by BHEL.		
	(2) Control panels in sheet steel enclosure, power coated finish, shall be a microprocessor based system with central processing unit, input / output modules, power supply with battery and battery charger, control electronics and display mechanisms. The panel shall be a 4 zone system with audio-visual provisions (LED indications and beeps) for zone-wise annunciation. Individual detector-wise traceability / addressability is not required. It shall have provisions for acknowledgement of alarm and manual resetting. Batteries used shall be lead acid maintenance free type provided with connecting leads.		
	(3) Smoke detectors shall be of conventional / optical / photoelectric type. It shall not be of ionization type that employs radioactive materials.		
	(4) Electrical hooters shall sound the alarm upon detection of smoke by the detectors.		
	(5) Manual call point shall be with high-gloss finish, alarm LED provision, breakable glass unit, hammer and chain.		
	(6) All the system components shall be installed and commissioned using suitable wiring using copper cable, min. 2C x 1.5 sq-mm, armoured, fire retardant low smoke PVC, of required length, as approved by BHEL. Cable shall be laid in PVC conduit and fixed to the ceiling of control room.		
	(7) Sufficient quantity of sensors, alarms, hooter, manual call points etc. shall be supplied and installed as per the necessary statutory requirements. Vendor should ensure the design of fire protection system in line with the regulations of the Fire Safety department of the state.		
	(8) Vendor shall submit fire alarm layout/scheme along with the detailed BOM to BHEL for approval.		
	(9) Fire alarm control panels shall have provision for RS-485 Modbus output so that status can be monitored in plant SCADA system.		
5.42	Other safety related items :		
	(1) Safety gadgets:		
	1	Gum boot	4 Nos

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		2	First Aid Box with essential medicines and bandage cotton, antibiotic cream, Dettol, etc.	2 set	
		3	Hand Gloves 1KV and 33kV rated for Maintenance of SMB	2 sets	
		4	Safety Helmet	4 Nos	
		5	Rain Coat	2 Nos	
	(2) Fire extinguishers and sand buckets, as per the regulations of the Fire safety department of the state, shall be supplied and commissioned at the power plant. BHEL approval shall be obtained for locations at which they shall be kept. Quantities mentioned below are minimum. Vendor to comply the requirements of statutory bodies.				
		1	Dry powder fire extinguisher (stored pressure type)	Capacity: 9 Kg IS: 2171, IS:10658 CM/L-7759096 Suitability for Class A, B & C fire, related to solid combustibles, flammable liquid and gases.	3 Nos
		2	Carbon di-oxide (CO2) type fire extinguisher with trolley	Capacity: 9 Kg IS: 2878 Suitability for Class B&C fires Involving flammable liquids & gases, electronic equipment.	3 Nos
		2	Sand buckets	GI fire buckets (as per IS: 2546) with suitable steel stand and cover arrangement. All items shall be painted with red oxide and BHEL approved red paint. BHEL approval shall be obtained for the overall arrangement. Each set of stand shall carry four sand buckets. A suitable cover shall be designed and provided to protect the buckets from rain.	2 sets
5.43	Spares to be supplied along with main supply: a) MC4 Y Connectors – 30 Nos. MC-4 connector – 30 Nos, cable lugs.				
5.44	Pre-commissioning inspections / checks / tests and coordination with Railway departments for necessary approvals and clearances for commissioning, synchronization with grid and post-commissioning operation of the plant: (B) Vendor shall carry out following minimum pre-commissioning checks: (1) Verification of firmness of terminations in all electrical equipment: SMBs, PCUs, SCADA stations, weather monitoring equipment and PV array earthing. (2) Verification of earthing for all these electrical equipment. (3) Measurement and verification of parameters at string monitoring boxes at solar array field: string current, voltage, combined SMB output current, module temperature, SMB temperature. (4) Measurement and verification of parameters on DC input side of PCUs: DC current and voltage; Vendor shall support the PCU engineer on these tests. (5) Insulation resistance measurements (megger tests) for all the electrical equipment of control room. (6) Functional checks for PCU: Vendor shall support the PCU engineer during the pre-commissioning tests.				

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	(7) Verification of parameters at SCADA station: (a) DC/AC parameters from SMBs, HT panels, ACDB panels, Metering panels, (b) status of ACB/VCB breakers and transformer protection relays, (c) weather monitoring parameters. (8) Functional checks on SCADA software: mimic diagrams, trend graphs, remote accessibility etc. (9) Earth resistance measurements at the electrode chambers for solar array, control room panels and switch yard equipment.	
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6.0 Tests at manufacturer / sub-vendor works and witnessing by BHEL

7.1	BHEL shall witness routine / acceptance tests performed at manufacturer works for following items. Vendor shall accordingly provide inspection call to BHEL, with submission of quality assurance plan to BHEL in advance. 1) All cables under vendor scope (LT, power, data, control and communication cables) 2) Earth Electrode and Earth resistance measurement at site. 3) Lightning arrestor (ESE) 4) Fire alarm system 5) ACDB 6) UPS with battery 7) WMS 8) FCBC with battery bank 9) CT,PT,LA etc. Note: In case the item is bought out from dealers, test certificates, as per relevant IS / IEC standards, as issued by manufacturer shall be submitted to BHEL. However, prior approval shall be obtained from BHEL for procurement of the item from dealers.	
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7.0 General conditions applicable during installation and commissioning phase

8.1	All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement of materials shall be organized by the vendor.	
8.2	All necessary tools and tackles such as crimping tool (including heavy duty tools for crimping cables), screw driver set, power screwdrivers, cutting pliers, nose pliers, spanner sets, adjustable spanners, hole saw cutter set, bending tools, torque wrenches, hack saw blades, pipe wrenches, flat / round files, HV termination tools, drilling machines, welding machines, concrete mixers, steel bar bending tools / templates for RCC works, spade, shovel, hammer etc shall be organized by the vendor.	
8.3	All necessary measuring instruments such as digital multimeters, electrical testers, meggers (1kV, 5kV), earth resistance meters, water level indicators etc shall be organized by the vendor.	
8.4	Vendor shall make their own arrangements for drinking water and accommodation for their labour and employees posted at the site.	
8.5	Vendor shall organize all necessary steps to meet statutory requirements such as labour license, PF, ESI etc and also ensure compliance with relevant acts such as minimum wages act, income tax act, employee insurance act, BOCW act etc for their labour deployed at site.	
8.6	Vendor shall maintain updated labour register, with name, age, qualification, salary, attendance details etc at the site. Vendor has to satisfy all the statutory requirements as per the labour law regulations in the state. Vendor shall furnish proof of payment of wages to labour when asked by BHEL. Vendor shall take	

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	adequate insurance (as per relevant labour act) for labour and O & M staff, before deputing to site and copy of insurance policy to be submitted to BHEL.	
8.7	Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site.	
8.8	Vendor shall adhere to all necessary safety norms such as use of helmet, goggles, hand gloves, gumboots, aprons etc. It is the ultimate responsibility of the vendor in all respect to prevent accidents at the site and safeguard their labour from accidents.	
8.9	Vendor shall, at the completion of every work, clear off the debris, which resulted out of the work. In case of excavation work such as cable trench etc, vendor shall finish the land neatly with necessary leveling, rolling etc.	
8.10	Vendor shall carry out the work without causing inconvenience to other contract groups at the site. In case of conflicts with other groups, vendor shall ensure that the matter is resolved at once amicably so that the progress of work is not affected.	
8.11	Any damages on the building, structures etc attributable to the acts of labour / employees of vendor shall be rectified and made good by the vendor at their own cost.	
8.12	No child labour shall be employed for execution of the present contract.	
8.13	Any miscellaneous materials, which are found essential for technical completion of the contract as per regulations/standards but not mentioned explicitly in this specification, shall be deemed to be included in the specification. Accordingly, such materials shall be included by the vendor as part of the offer.	
8.14	In certain cases, approximate quantities are only mentioned. This is for the purpose of providing guidance to vendors and are as per BHEL estimation. Such quantities shall, therefore, be considered only indicative. Vendor shall, however, take into account the exact quantities that shall be required to meet the functional requirements of I&C activities as per clause 5.0.	
8.15	Special instruction for earthing: In compliance with Rule 33 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode. Accordingly, all cases such as cable support structures, cable ladders, cable trays (control room) etc shall be earthed.	
8.16	Any deviations shall be discussed with BHEL site engineers and implementation shall be taken up only after approval from BHEL.	
8.17	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.	
8.18	Vendor has to design all the foundations required as per this specification based on the soil report and site conditions and to be submitted to BHEL for approval before construction. However, minimum requirements are specified in this specification for ready reference. Soil report will be made available to vendor after placement of PO upon request.	
8.19	Supply and installation of all auxiliary supply cables from ACDB to various plant equipment viz., UPS, building lighting & fan, AC supply, PV module system etc., shall be in the scope of the vendor which will be intimated from time to time.	
8.20	All cable terminations shall be done in such a way that bending radius of the cable is strictly as per IS: 1255	
8.21	In case project is not completed as per BHEL scope due to reasons arising out of materials from BHEL end/vendor's end, contractor has to complete the job at later stage without any extra charges. No overrun charges shall be paid in case of extension of project schedules	

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8.22	Vendor shall prepare and submit as-built drawings after execution of works.	
8.23	The vendor shall comply with the provision of all relevant Acts of Central or State Governments including payment of Wages Act 1936, Minimum Wages Act 1948, Employer's Liability Act 1938, Workmen's Compensation Act 1923, Industrial Dispute Act 1947, Maturity Benefit Act 1961, Employees State Insurance Act 1948, Contract Labor (Regulations & Abolishment) Act 1970 or any modification thereof or any other law relating thereto and rules made there under from time to time.	

9.0 Defect Liability Period:

9.1	Date of commencement of defect liability period : Zero date for defect liability period shall be the actual date on which the complete capacity (with all vendor supplied material, system and works) is commissioned with synchronization / export of power to 25kV Railway grid and completion of all the works in the scope of the vendor which-ever is later.	
9.2	Work during defect liability period: Vendor shall depute competent person/s at site on to attend the problems that may arise in the plant during defect liability period within 24 hours.	

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

10.1	BHEL approval shall be obtained for the following technical documents, which shall be submitted to BHEL in phased manner based on priority sequence of activities. However, it shall be ensured that all documents are submitted within 14 days from date of purchase order.	
10.2	Vendor, make, model number / part number, specification / sizes / dimensions / drawings / datasheets of all the vendor supplied items.	
10.3	General arrangement drawings/ schemes/ layouts etc. with bill of materials / quantities shall be submitted for the following (list is indicative and not limited to): (1) SMB Mounting structure (2) Cable trench layout in array yard (3) ESE Lightning arrestor arrangement with foundation details. (4) Water pipeline layout from storage tank to solar array field for module cleaning system with pressure calculations (5) Fire alarm system scheme / layout (6) Cable support structures and cable ladders within control room (7) Cable trench for LT cables between inverters and transformers (8) Transformer foundation and switchyard drawing/layout (9) 25 KV Transmission line from PV plant to Railways TSS drawing/layout (10) CCTV design (11) Plant lighting drawing/layout	
10.4	Detailed activity-time chart for project implementation.	
10.5	Detailed manpower deployment schedule.	

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Codes and Standards: IS:7098 (Part -I)	Specification for XLPE insulated PVC sheathed cables. Part-I: For working voltages up to 3.3 KV
IS:7098 (Part -II)	Specification for XLPE insulated PVC sheathed cables. Part-I: For working voltages from 3.3 KV up to and including 33 KV
IS:1554 (Part-I)	Specification for PVC insulated cables for working voltages upto and including 1100V
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 KV rating
IS: 3043	Code of practice for earthing