Bharat Heavy Electricals Ltd.,

(A Government of India undertaking)

Electronics Division

PB No.2606, Mysore Road, Bangalore-560026, India

Quotations are invited under two part bid system for Design, Supply, I&C and O&M for Balance of Systems for 15MW (AC) Solar PV Plant as per BHEL technical specifications through e-procurement route.

RFQ NO and date	SPKSCPV002 dated 19.07.2017 (E-tender)
RFQ due date & time	02.08.2017 up to 13.00 hrs (IST)
Date, Time & Venue of Part-I Bid Opening	02.08.2017 after 13.30 hrs (IST) (E-tender) – Website - https://bheleps.buyjunction.in
Date, Time & Venue of Price Bid opening	Will be intimated later for technically accepted vendors
Address for Communication & Contact Person in BHEL	Mr. S.Pankaj Kumar (08126333426)/ Mr. Chendhil Kumar R (09449869644), SC&PV MM Department, BHEL Elecrtronics Division, PB NO 2606, Mysore road, Bangalore-560 026. INDIA Email: spankaj@bheledn.co.in, chendhil@bheledn.co.in Telephone number: +91 80 26989667, +91 80 26998391
Name and address of the Independent External Monitor for this tender	Shri D.R.S Chaudhary,IAS (Retd.), Flat No. L-202 & L-203 (1st Floor)Ansal Lake View EnclaveShamla HillsBhopal- 462 013 (M.P.) Ph: +91 755 4050495 Email - dilip.chaudhary@icloud.com

REQUEST FOR QUOTATION

MMI:PU:RF:003

BHARAT HEAVY ELECTRICALS LIMITED
Electronics Division
PB No. 2606, Mysore Road Bangalore - 560026
INDIA

RFQ NUMBER: SPKSCPV002

RFQ DATE : 17.07.2017

Due Date : 02.08.2017
Time : 13:00 HRS

VENUE : NEW ENGG. BLDG

(address for communication) :

(for all correspondence)
Purchase Executive : S. Pankaj Kumar
Phone : 080-26989667
Fax :
E-mail: spankaj@bheledn.co.in

Please submit your lowest quotation subject to our terms and conditions attached for the materials mentioned below.

Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
1	PS0679062742 Supply of MC4 ,Cable tie,HDPE pipe etc. * HSN/SAC : 8536 Test Certificate Supply of MC4 connectors, cable ties, HDPE conduits, ferrules etc as per clause 5.6 # 5.12 of BHEL Spec PS-439-1139 Supply of MC4 connectors, cable ties, HDPE conduits, ferrules etc as per clause 5.6 # 5.12 of BHEL Spec PS-439-1139	1	ST	1	30.09.2017
2	PS0679062750 Supply of Array earthing items * HSN/SAC : 7209 Test Certificate Supply of items of earthing system for solar array field, control room panels, switchyard equipment etc including GI flats, MS rods (for earth mat) etc and all related miscellaneous hardware etc as per clauses 5.29-5.30 of BHEL SPec PS-439-1139 Supply of items of earthing system for solar array field, control room panels, switchyard equipment etc including GI flats, MS rods (for earth mat) etc and all related miscellaneous hardware etc as per clauses 5.29-5.30 of BHEL SPec PS-439-1139	1	ST	1	30.09.2017
3	PS0679062769 Supply of Array LA items * HSN/SAC : 7209 Test Certificate Supply of lightning arrestors for the complete solar power	1	ST	1	30.09.2017

TWO PART BID - SUBMIT TECHNICAL AND PRICE BID IN SEPARATE SEALED COVERS

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For and On behalf of BHEL.

S. Pankaj Kumar
Semiconductors & Pho

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	plant as per clauses 5.33. of BHEL Spec PS-439-1139 Supply of lightning arrestors for the complete solar power plant as per clauses 5.33. of BHEL Spec PS-439-1139				
4	PS0679062777 Supply of Module cleaning system items * HSN/SAC : 3917 Test Certificate Supply of items of module cleaning system such as pumps, GI pipes with fittings, valves etc, as per clause 5.32. of BHEL Spec PS-439-1139 Supply of items of module cleaning system such as pumps, GI pipes with fittings, valves etc, as per clause 5.32. of BHEL Spec PS-439-1139	1	ST	1	30.09.2017
5	PS0679062823 I&C: Array earthing works * HSN/SAC : 9954 I&C: Earthing system for solar array field including laying of underground earth mat grids and interconnection to the module mounting structures, I&C of lightning protection system (lightning arrestors) with earthing provisions per clause 5.29, 5.31 of BHEL Spec PS-439-1139 I&C: Earthing system for solar array MMS structures and SMBs including laying of underground earth mat and interconnection to MMS structures, SMB earthing, earth chamber construction, earthing	1	AU	1	30.10.2017

TWO PART BID - SUBMIT TECHNICAL AND PRICE BID IN SEPARATE SEALED COVERS

Please note the tender will be opened in the presence of the bidders or his authorised representatives (maximum two per organisation) who choose to be present with authorisation letters. Refer annexure for the terms and conditions.

Preference will be given to vendors who accepts our standard payment terms i.e.100% payment within 30 days of receipt of material at our works.

Please specify Terms of delivery, Excise duty, sales tax, Ex-BHEL, Ex-works surcharge, Insurance, P&F, Freight and other taxes very clearly

For evaluation, exchange rate (TT selling rate of SBI) as on scheduled date of tender opening (Part-I bid incase of two part bid) shall be considered.

The offers of the bidders who are on the banned list as also the offer of the bidders, who engage the services of the banned firms, shall be rejetcted The list of banned firms is available on BHEL web site www.bhel.com

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	terminations etc as per clause 5.17. Note: 1 AU= activity equivalent to one inverter room measured pro-rata on total three rooms of PS-439-1045.				
6	PS0679062858 I&C: Module cleaning system works * HSN/SAC : 9954 I&C of module cleaning system including trenches for pipelines, laying of pipelines from water tanks to solar array field, erection of pumps, valves etc as per clause 5.32. of BHEL Spec PS-439-1139 I&C: Module cleaning system including underground water tanks, underground trenches/ laying of UPVC pipes/ couplers/ joints/ valves etc, erection of submersible pumps/ surface pumps, pressure regulated tanks, pressure gauges, electrical cabling works etc as per clause 5.20 of PS-439-1045.	1	AU	1	30.10.2017
7	PS0679062874 I&C: Inteconnection of Modules,SMB etc. * HSN/SAC : 9997 I&C: Interconnection of SPV modules, installation of string monitoring boxes including power cable terminations as per clauses 5.6 to 5.12 of BHEL Spec PS-439-1139 1 AU = Work proportionate to approx. 5.7 MWp I&C: Interconnection of SPV modules, foundation/erection of	3	AU	3	30.10.2017

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	SMB mounting structures and SMBs, laying/ termination of solar array 1Cx10 cable including related underground trench/conduit works as per clauses 5.6- 5.12. Note: 1 AU= activity equivalent to 1 SMB measured pro-rata on total quantity of SMBs for 16.5 MW of PS-439-1045.				
8	PS0679062882 Supply of control cable, kits etc. * HSN/SAC : 8544 Test Certificate Supply of LT power/control/Instrumentation cables, cable installation accessories such as cable trays/ cable ties/ casing / capping/ glands/ lugs/ trefoil clamps etc, LT/DC/HT/control cable termination hardware, HT termination kits, LT/DC/HT straight through jointing kits, HDPE DWC conduit pipes, PVC pipes below plinth etc as per clauses 5.12-5.16, 5.18-5.20 of BHEL Spec PS-439-1139 Supply of LT power/control/Instrumentation cables, cable installation accessories such as cable trays/ cable ties/ casing / capping/ glands/ lugs/ trefoil clamps etc, LT/DC/HT/control cable termination hardware, HT termination kits, LT/DC/HT straight through jointing kits, HDPE DWC	1	ST	1	30.09.2017

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	conduit pipes, PVC pipes below plinth etc as per clauses 5.12-5.16, 5.18-5.20 of BHEL Spec PS-439-1139				
9	PS0679062890 Supply of Aux Trf, ACDB,DCDB,UPS etc * HSN/SAC : 8504 Test Certificate Supply of auxiliary transformer, ACDB panel, DB boards of all types with MCBs, UPS Panels, FCBC/battery banks with all related accessories/ hardware etc as per clauses 5.23-5.25 of BHEL Spec PS-439-1139 Supply of auxiliary transformer, ACDB panel, DB boards of all types with MCBs, UPS Panels, FCBC/battery banks with all related accessories/ hardware etc as per clauses 5.23-5.25 of BHEL Spec PS-439-1139	1	ST	1	30.09.2017
10	PS0679062912 Supply of Plant lighting system * HSN/SAC : 9405 Test Certificate Supply of items for plant lighting system such as street light poles, bend pipes, luminaires, lamps, junction boxes, cable conduits, foundation items and all related accessories, hardware etc as per clause 5.28. of BHEL Spec PS-439-1139 Supply of items for plant lighting system such as street light poles, bend pipes, luminaires, lamps, junction boxes, cable conduits,	1	ST	1	30.09.2017

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	foundation items and all related accessories, hardware etc as per clause 5.28. of BHEL Spec PS-439-1139				
11	PS0679062920 Supply of Misc items * HSN/SAC : 8536 Test Certificate Supply of miscellaneous items such as cable tags, cable markers, hoarding board, sign boards, danger boards, display boards, electrical insulation mat, checkered plates, air conditioners, tool kits, measuring instruments, office furniture, items for remote connectivity of SCADA, etc as per clauses 5.16, 5.17, 5.36-5.42. of BHEL Spec PS-439-1139 Supply of miscellaneous items such as cable tags, cable markers, hoarding board, sign boards, danger boards, display boards, electrical insulation mat, checkered plates, air conditioners, tool kits, measuring instruments, office furniture, items for remote connectivity of SCADA, etc as per clauses 5.16, 5.17, 5.36-5.42. of BHEL Spec PS-439-1139	1	ST	1	30.09.2017
12	PS0679062939 Supply: Fire alarm sys, Extinguisher etc * HSN/SAC : 9030 Test Certificate Supply of safety related items including fire alarm systems for	1	ST	1	30.09.2017

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	buildings, fire extinguishers, safety gadgets etc as per clauses 5.33- 5.34. of BHEL Spec PS-439-1139 Supply of safety related items including fire alarm systems for buildings, fire extinguishers, safety gadgets etc as per clauses 5.33- 5.34. of BHEL Spec PS-439-1139				
13	PS0679062947 Supply of CCTV system * HSN/SAC : 9030 Test Certificate Supply of CCTV system as per clause 5.35. of BHEL Spec PS-439-1139 Supply of CCTV system as per clause 5.35. of BHEL Spec PS-439-1139	1	ST	1	30.09.2017
14	PS0679062955 Supply of spare items * HSN/SAC : 8536 Test Certificate Supply of spare items as per clause 5.47. of BHEL Spec PS-439-1139 Supply of spare items as per clause 5.47. of BHEL Spec PS-439-1139	1	ST	1	30.09.2017
15	PS0679062963 I&C: Cable Trench works * HSN/SAC : 9997 I&C: Cable trenches & laying of cables for LT AC/DC power cables, HT (33kV) cables, data communication / control / SCADA / OFC cables as per clause 5.13-5.15, 5.19-5.20. of BHEL Spec PS-439-1139 Note: 1 AU = 25% of total work as certified by BHEL site in-charge.	4	AU	4	30.10.2017

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	I&C: Underground cable trenches and laying of cables for Aux AC/DC power cables, HT (33kV) cables, control/ data /instrumentation/ OFC cables as per clause 5.11. Note: 1 AU = 25% of total work as certified by BHEL site in-charge.				
16	PS0679062971 I&C : Panel installation in IR rooms * HSN/SAC : 9954 I&C: Erection of indoor electrical panels (PCUs, VCB panels, DB boards of all types, UPS with battery, FCBC/ battery bank, SCADA panels, PCU ducts etc) in the individual inverter rooms including grouting of panels, laying/fixing of cable trays, routing/terminations of cables at the electrical panels and up to LV side of transformers in the switchyard as per clauses 5.17-5.20. of BHEL Spec PS-439-1139 1 AU = Work proportionate to one of three inverter rooms I&C: Erection of indoor electrical panels (PCUs, VCB panels, DB boards of all types, UPS/ FCBC/ battery bank, SCADA panels etc) in the individual inverter rooms including grouting of panels, laying/fixing of cable trays, routing/terminations of cables at the electrical panels and up to LV side of transformers in the switchyard as per clauses 5.6-5.9. 1 AU = Work proportionate to one of three inverter	3	AU	3	30.10.2017

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	rooms.				
17	PS0679062980 I&C: 33kV Trf yards * HSN/SAC : 9954 I&C: Erection of 33kV transformer yards (attached to individual inverter rooms) with necessary land leveling within switchyard, laying of underground earth mat grid, foundation/ erection of transformers, underground cable trenches, laying/termination of 33kV/ LT / data / control / SCADA cables between yard and the inverter room panels, stone jellies, fencing and gate for switchyard, drains/ drain pipes etc as per clause 5.21. of BHEL Spec PS-439-1139 Note: 1 AU = Work proportionate to one of the three inverter rooms. I&C: Erection of 33kV transformer yards (attached to individual inverter rooms) with necessary land leveling within switchyard, laying of underground earth mat grid, foundation/ erection of transformers, underground cable trenches, laying/termination of 33kV/ LT / data / control / SCADA cables between yard and the inverter room panels, stone jellies, fencing and gate for switchyard, drains/ drain pipes etc as per clause 5.10. Note: 1 AU = Work proportionate to one of the three inverter rooms.	3	AU	3	30.10.2017
	PS0679062998 I&C: CMCS	1		1	30.10.2017

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18	* HSN/SAC : 9954 I&C: Erection of indoor electrical panels (VCB panels, AC/DC DB boards/panels, UPS system, FCBC/ battery banks, SCADA panels etc) in the main control room including grouting of panels, laying/fixing of cable trays, routing/terminations of LT/HT power/control cables to the electrical panels and to 33kV side of 16MVA transformer in switchyard etc as per clauses 5.17-5.20. of BHEL Spec PS-439-1139 I&C: Erection of indoor electrical panels (VCB panels, AC/DC DB boards/panels, UPS system, FCBC/ battery banks, SCADA panels, ABT metering panels etc) in the main control room including grouting of panels, laying/ fixing of cable trays, routing/terminations of LT/HT power/control cables to the electrical panels and to 33kV side of 16.5MVA transformer in switchyard etc as per clauses 5.6-5.9.		AU		
19	PS0679063005 I&C: switchyard attached to CMCS * HSN/SAC : 9954 I&C: Erection of 33kV portion of the 33/66kV switchyard (attached to main control room) with erection of aux transformer (including foundation), laying/termination of 33kV cables between 16MVA transformer and VCB panels, laying/termination of 33kV/LT cables between aux	1	AU	1	30.10.2017

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* The HSN/SAC no mentioned against the line items in the RFQ are indicative only.

For and On behalf of BHEL.

S. Pankaj Kumar
Semiconductors & Pho

REQUEST FOR QUOTATION

MMI:PU:RF:003

BHARAT HEAVY ELECTRICALS LIMITED
Electronics Division
PB No. 2606, Mysore Road Bangalore - 560026
INDIA

RFQ NUMBER: SPKSCPV002

RFQ DATE : 17.07.2017

Due Date : 02.08.2017
Time : 13:00 HRS

VENUE : NEW ENGG. BLDG

(address for communication) :

(for all correspondence)
Purchase Executive : S. Pankaj Kumar
Phone : 080-26989667
Fax :
E-mail: spankaj@bheledn.co.in

Please submit your lowest quotation subject to our terms and conditions attached for the materials mentioned below.

Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	transformer and control room panels as per clause 5.21. of BHEL Spec PS- 439-1139 I&C: Erection of 33kV portion of the 33/132kV switchyard (attached to main control room) with erection of aux transformer (including foundation), laying/termination of 33kV cables between 16.5MVA transformer and VCB panels, laying/termination of 33kV/LT cables between aux transformer and control room panels as per clause 5.10.				
20	PS0679063013 I&C: SCADA System * HSN/SAC : 9954 I&C: Installation and commissioning of SCADA system by integrating the data cables from all the electrical and weather monitoring equipments of the power plant at the data logger/ PLC panel / HMI computer control desk at main control room etc as per clause 5.26-27. of BHEL Spec PS- 439-1139 I&C: Installation and commissioning of SCADA system by integrating the data cables from all the electrical and weather monitoring equipments of the power plant at the data logger/ PLC panel / HMI computer control desk at main control room etc as per clause 5.17.	1	AU	1	30.10.2017
21	PS0679063021 I&C: Earthing * HSN/SAC : 9954	1	AU	1	30.10.2017

TWO PART BID - SUBMIT TECHNICAL AND PRICE BID IN SEPARATE SEALED COVERS

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Please submit your lowest quotation subject to our terms and conditions attached for the materials mentioned below.

Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	I&C: Earthing system for inverter rooms, main control room and 33kV transformer yards including laying of underground earth mat grids, earth chambers with lids, laying/termination of earthing strips from all electrical equipments to earth mat grid etc as per clause 5.30. of BHEL Spec PS-439-1139 I&C: Earthing system for inverter rooms, main control room and 33kV transformer yards including laying of underground earth mat grids, earth chambers with lids, laying/termination of earthing strips from all electrical equipments to earth mat grid etc as per clause 5.19.				
22	PS0679063030 I&C: Plant lighting system * HSN/SAC : 9954 I&C of plant lighting system including outdoor cable laying, cable terminations at poles/lights as well as DB boards of inverter rooms / main control room etc as per clause 5.28. of BHEL Spec PS-439-1139 I&C of plant lighting system including outdoor cable laying, cable terminations at poles/lights as well as DB boards of inverter rooms / main control room etc as per clause 5.18.	1	AU	1	30.10.2017
23	PS0679063048 I&C: Misc items * HSN/SAC : 9997 I&C of miscellaneous and safety items such as, cable tags,	1	AU	1	30.10.2017

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	cable markers, hoarding board, sign boards, danger boards, display boards, electrical insulation mat, checkered plates, air conditioners, office furniture, fire extinguishers, fire alarm system, weather monitoring system, items for remote connectivity of SCADA, identification markings using painting etc as per clauses 5.16, 5.17, 5.36-5.42. of BHEL Spec PS-439-1139 I&C of miscellaneous and safety items such as ABT metering panels, cable tags, cable markers, hoarding board, sign boards, danger boards, display boards, electrical insulation mat, checkered plates, air conditioners, office furniture, fire extinguishers, fire alarm system, Nitrogen injection fire protection system for 16.5 MVA transformer, weather monitoring system, items for remote connectivity of SCADA, connection from sump tank to OH tank, identification markings using painting etc as per clauses 5.15-5.17, 5.24-5.31.				
24	PS0679063056 I&C: CCTV system * HSN/SAC : 9954 I&C of CCTV system as per clause 5.35 of BHEL Spec PS-439-1139 I&C of CCTV system as per clause 5.22.	1	AU	1	30.10.2017
25	PS0679063064 I&C: Pre-Commissioning checks etc. * HSN/SAC : 9997	1	AU	1	30.10.2017

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Please submit your lowest quotation subject to our terms and conditions attached for the materials mentioned below.

Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	I&C: Pre-commissioning inspections/ checks/tests, MRT tests, coordination/liaison with state /central departments/CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning as per clause 5.46 of BHEL Spec PS-439-1139 I&C: Pre-commissioning inspections/ checks/tests, MRT tests, coordination/liaison with state /central departments/CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning as per clause 5.35				
26	PS0679063072 O&M : Monthly basis * HSN/SAC : 9985 Operations and Maintenance per month as per clause 7.0. of BHEL Spec PS-439-1139 Operations and Maintenance per month as per clause 7.0. of BHEL Spec PS-439-1139	120	AU	120	10.11.2017
27	PS0679063137 Supply of Weather monitoring system * HSN/SAC : 9030 Test Certificate Supply of Weather Monitoring system as per clause 5.26. of BHEL Spec PS- 439-1139 Supply of Weather Monitoring system as per clause 5.26. of BHEL Spec PS- 439-1139	1	ST	1	30.09.2017

Total Number of Items - 27

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Electronics Division
PB No. 2606, Mysore Road Bangalore - 560026
INDIA

RFQ NUMBER: SPKSCPV002

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For and On behalf of BHEL.

S. Pankaj Kumar
Semiconductors & Pho

1.0	Introduction	
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	1.2	Scope of this tender specification
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	5.3	Electrical power/ water for construction, drinking water
	5.4	Construction of open yards/ covered sheds for safe storage of vendor supplied items
	5.5	Unloading, safe storage and movement of supply items received at site
	5.6	Series interconnection of SPV modules to form strings
	5.7	Installation of string monitoring boxes including supply/erection of mounting structures
	5.8	Interconnection of SPV module strings to 1Cx10 cable
	5.9	Ferruling for 1Cx10 cable
	5.10	Routing of 1Cx 10 cable below the SPV modules
	5.11	Routing of 1Cx10 cable in pipes underground between the rows of solar array
	5.12	Termination of 1Cx10 cables on input side of SMBs
	5.13	Underground cable trenches and laying of 1Cx300 and RS485 cables in solar array field
	5.14	Laying of 1Cx300/RS485 cables in inverter rooms and terminations at PCU/SCADA
	5.15	Termination of 1Cx300 DC power cables and RS 485 cables at SMBs
	5.16	Identification marking of cables using cable tags
	5.17	Installation of electrical panels in inverter rooms and main control room
	5.18	Installation of cable trays, cable laying/dressing etc in inverter rooms/ main control room
	5.19	Supply, laying, termination of LT/HT/aux supply cables in inverter/ main control rooms
	5.20	Supply, laying, termination of Control / data / instrumentation / OFC cables
	5.21	Erection of 33kV Transformer yards attached to inverter rooms and main control room
	5.22	Underground cable trenches and laying of HT/LT/Control/Instrumentation/OFC cables
	5.23	Specification of auxiliary transformer 200kVA 33kV/433V Dyn11 outdoor ONAN
	5.24	Auxiliary AC/DC power supply system
	5.25	LT switchgear panels
	5.26	Supply and installation of weather monitoring system
	5.27	Installation and commissioning of SCADA integration systems
	5.28	Plant lighting system

	5.29	Earthing for solar array structures and SMBs
	5.30	Earthing system for inverter rooms, main control room, 33kV transformer yards
	5.31	Lightning arrestor (ESE) system for protection of solar array/ inverter/control rooms
	5.32	Water washing system for SPV modules (Module cleaning system)
	5.33	Firefighting/ detection/ alarm systems
	5.34	Other safety related items
	5.35	CCTV system
	5.36	Identification marking using painting
	5.37	Cable markers and cables tags
	5.38	Display boards and sign boards
	5.39	Electrical insulation mat
	5.40	Checkered plate
	5.41	Air conditioner
	5.42	Tool kits and instruments
	5.43	General specification of LT cables
	5.44	Cable installation methodology
	5.45	General civil works
	5.46	Pre-commissioning inspections/ checks/tests, MRT tests, coordination/liaison with state /central departments/CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning
	5.47	Spares required to be supplied along with main consignment
6.0	General conditions applicable during supply, installation and commissioning phase	
7.0	Operations and Maintenance	
8.0	Documents to be submitted for BHEL/GACL approval during detailed engineering	

1.0 Introduction

1.1 Project outline of 15MWp solar photovoltaic power plant

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up a 17.1MWp(DC) solar photovoltaic (SPV) power plant for Gujarat Alkalies & Chemicals Limited (GACL), Vadodara at Charanka Solar Park, Gujarat with the overall project scope comprising of three major portions as follows:

Solar PV modules employed at the plant generates DC electricity that in turn shall be inverted to AC in the range 300-400V. Output of each solar block (5.7 MWp) with independent inverter room/ transformer yards shall be stepped up to 33kV. Combined AC output is stepped up to 66kV using a 16MVA power transformer. At this outgoer level, there is outdoor switchyard together with necessary gantries/ towers/ beams/Cables to facilitate 66kV transmission.

Power generated at the above SPV plant shall be transported to CTU/STU substation using 66kV underground cables. Distance between SPV plant and substation is 400m approximately. At substation, an outdoor switchyard bay exclusive for this plant shall be constructed with necessary gantries/ towers/ beams to facilitate 66kV transmission.

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, commissioning of certain identified activities of the solar photovoltaic power plant.

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

Also, the scope includes operations and maintenance, for a period of 10 years, of the complete Solar PV plant (including solar array, DC+AC sides and, all infrastructures therein) up to and inclusive of 33kV side of 16MVA 33/66kV transformer.

Vendor shall have capability for design of systems such as foundations for inverter transformers, firewalls, earth mat grid for inverter room panels/transformer yards, peripheral lighting system,module cleaning system, outdoor cable trench layout for HT/LT/OFC cables etc. as envisaged under this specification. In case they do not have design/drafting capability, after receiving purchase order from BHEL, the vendor shall tie up with competent design consultants in which case vendor shall submit the credentials of the proposed consultants to BHEL.

Subsequent to approval by BHEL, vendor shall award the work on the consultants. All drawings/ design documents shall be originated by the consultants, endorsed by the vendor clearly stating the name of the project, names of clients (BHEL/GACL), drawing/document number, revision number, number of sheets etc. Details of drawings/ design documents to be submitted are brought out under section 5.1 and 8.0 of this specification.

All civil related works shall be tested as per BHEL/GACL-approved FQP that will be issued during course of project execution. All third party testing shall be carried out only at NABL accredited laboratories (or) Government laboratories.

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 Location / approach particulars of the power plant

15MW (AC) Solar Photovoltaic Power Plant
Charanka Solar Park
Patan district
Gujrat

1.4 Enclosures to this tender specification (Tender purpose only)

1	Overall map of project site
2	Provisional single line diagram of overall Solar PV power plant
3	Typical site layout with solar array, control/ inverter rooms, switchyards
4	Typical layout of main control room
5	Typical layout of inverter room
6	Indicative soil report
7	Indicative drawing of SMB
8	Indicative drawing of Module Mounting Structure
9	Request for Quotation with instructions, terms and conditions, formats for filling-up etc.
10	Approved vendor list for procurement of BOS items.

2.0 Pre-Qualification Criteria (PQC) for vendors

(a) Vendor should have carried out electrical installation and commissioning of minimum cumulative of 15MWp solar photovoltaic power plants in India in last 3 years from RFQ date, with individual power plant projects of 5MW and above. Evidence in form of PO copies/ completion certificates from clients shall be submitted for the same along with technical offer.

(b) The bidder should have achieved average annual financial turnover of Rs. 10 Cr. in the last three years ending 31st March of the previous financial year. The bidder shall submit the following details along with the bid: a) Audited balance sheets for last three years

3.0 Scope of work

3.1 Vendor scope – breakup of supply, I&C, O&M

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

#	Scope of work (as briefly outlined)	Qty
1	Supply of MC4 connectors, cable ties, HDPE conduits, ferrules etc as per clause 5.6 – 5.12	1 set
2	Supply of LT power/control/Instrumentation cables, cable installation accessories such as cable trays/ cable ties/ casing / capping/ glands/ lugs/ trefoil clamps etc, LT/DC/HT/control cable termination hardware, HT termination kits, LT/DC/HT straight through jointing kits, HDPE DWC conduit pipes, PVC pipes below plinth etc as per clauses 5.12-5.16, 5.18-5.20	1 set
3	Supply of auxiliary transformer, ACDB panel, DB boards of all types with MCBs, UPS Panels, FCBC/battery banks with all related accessories/ hardware etc as per clauses 5.23-5.25.	1 set
4	Supply of items of earthing system for solar array field, control room panels, switchyard equipment etc including GI flats, MS rods (for earth mat) etc and all related miscellaneous hardware etc as per clauses 5.29-5.30	1 set
5	Supply of lightning arrestors for the complete solar power plant as per clauses 5.33.	1 set
6	Supply of items of module cleaning system such as pumps, GI pipes with fittings, valves etc, as per clause 5.32.	1 set
7	Supply of items for plant lighting system such as street light poles, bend pipes, luminaires, lamps, junction boxes, cable conduits, foundation items and all related accessories, hardware etc as per clause 5.28.	1 set
8	Supply of miscellaneous items such as cable tags, cable markers, hoarding board, sign boards, danger boards, display boards, electrical insulation mat, checkered plates, air conditioners, tool kits, measuring instruments, office furniture, items for remote connectivity of SCADA, etc as per clauses 5.16, 5.17, 5.36-5.42.	1 set
9	Supply of safety related items including fire alarm systems for buildings, fire extinguishers, safety gadgets etc as per clauses 5.33-5.34.	1 set
10	Supply of CCTV system as per clause 5.35.	1 set

11	Supply of spare items as per clause 5.47.	1 set
12	Supply of Weather Monitoring system as per clause 5.26.	1 set
13	I&C: Interconnection of SPV modules, installation of string monitoring boxes including power cable terminations as per clauses 5.6 to 5.12 1 AU = Work proportionate to approx. 5.7 MWp	3AU
14	I&C: Cable trenches & laying of cables for LT AC/DC power cables, HT (33kV) cables, data communication / control / SCADA / OFC cables as per clause 5.13-5.15, 5.19-5.20. Note: 1 AU = 25% of total work as certified by BHEL site in-charge.	4AU
15	I&C: Erection of indoor electrical panels (PCUs, VCB panels, DB boards of all types, UPS with battery, FCBC/ battery bank, SCADA panels, PCU ducts etc) in the individual inverter rooms including grouting of panels, laying/fixing of cable trays, routing/terminations of cables at the electrical panels and up to LV side of transformers in the switchyard as per clauses 5.17-5.20. 1 AU = Work proportionate to one of three inverter rooms.	3 AU
16	I&C: Erection of 33kV transformer yards (attached to individual inverter rooms) with necessary land leveling within switchyard, laying of underground earth mat grid, foundation/ erection of transformers, underground cable trenches, laying/termination of 33kV/ LT / data / control / SCADA cables between yard and the inverter room panels, stone jellies, fencing and gate for switchyard, drains/ drain pipes etc as per clause 5.21. Note: 1 AU = Work proportionate to one of the three inverter rooms.	3 AU
17	I&C: Erection of indoor electrical panels (VCB panels, AC/DC DB boards/panels, UPS system, FCBC/ battery banks, SCADA panels etc) in the main control room including grouting of panels, laying/fixing of cable trays, routing/terminations of LT/HT power/control cables to the electrical panels and to 33kV side of 16MVA transformer in switchyard etc as per clauses 5.17-5.20.	1 AU
18	I&C: Erection of 33kV portion of the 33/66kV switchyard (attached to main control room) with erection of aux transformer (including foundation), laying/termination of 33kV cables between 16MVA transformer and VCB panels, laying/termination of 33kV/LT cables between aux transformer and control room panels as per clause 5.21.	1 AU
19	I&C: Installation and commissioning of SCADA system by integrating the data cables from all the electrical and weather monitoring equipments of the power plant at the data logger/ PLC panel / HMI computer control desk at main control room etc as per clause 5.26-27.	1 AU
20	I&C: Earthing system for solar array field including laying of underground earth mat grids and interconnection to the module mounting structures, I&C of lightning protection system (lightning arrestors) with earthing provisions per clause 5.29, 5.31	1 AU
21	I&C: Earthing system for inverter rooms, main control room and 33kV transformer yards including laying of underground earth mat grids, earth chambers with lids, laying/termination of earthing strips from all electrical equipments to earth mat grid etc as per clause 5.30.	1 AU
22	I&C of plant lighting system including outdoor cable laying, cable terminations at poles/lights as well as DB boards of inverter rooms / main control room etc as per clause 5.28.	1 AU
23	I&C of module cleaning system including trenches for pipelines, laying of pipelines from water tanks to solar array field, erection of pumps, valves etc as per clause 5.32.	1 AU
24	I&C of miscellaneous and safety items such as, cable tags, cable markers, hoarding board, sign boards, danger boards, display boards, electrical insulation mat, checkered plates, air	1 AU

	conditioners, office furniture, fire extinguishers, fire alarm system, weather monitoring system, items for remote connectivity of SCADA, identification markings using painting etc as per clauses 5.16, 5.17, 5.36-5.42.	
25	I&C of CCTV system as per clause 5.35.	1 AU
26	I&C: Pre-commissioning inspections/ checks/tests, MRT tests, coordination/liaison with state /central departments/CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning as per clause 5.46	1 AU
27	Operations and Maintenance per month as per clause 7.0.	120 Mon

BHEL scope

For clarity to the vendor, other items and activities within BHEL scope of AC part (up to and inclusive of 33kV connection to 16MVA 33/66V transformer) of solar PV plant end of the project are listed below:

1	Supply of LT cable, 1C x 300, Al, XLPE, armoured as per IS: 7098 (from SMB to PCU and PCUs to Inverter transformers)	~9,000m
2	Supply of 33kV cable, 1C x 300, Al, XLPE, armoured as per IS: 7098 (for all 33kV connections within plant including Aux transformer HV side); 1 Run x 1C x300 per phase to be connected.	~6,000m
3	Supply of RS485 cables for SMB to SCADA	As required
4	Supply of Ethernet cables for PCUs to SCADA	As required
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)	As required
6	Supply of power conditioning units (PCUs) of 1250 kW with ducts	12 Sets
7	Supply of inverter transformer 2.7MVA, 33kV/350-350 V, ONAN	6 Nos
8	<u>Supply of 33kV breaker panels</u> Vacuum circuit breaker (VCB) panels – indoor type – with CTs, PTs, numerical relays, MFM meters etc: (a) 6 incomers, 3 outgoers in inverter rooms (b) 3 incomers, 1 outgoer, 1 aux outgoer, 1 Bus PT panel in main control room.	1 set
9	Supply of SCADA system including data loggers / PLC panels, computers, software systems and related peripherals & accessories.	~ 4 panels
10	Supply of GPS time synchronization (master clock) to interface with ABT meter.	1 No
11	Supply of spare items of SPV modules, string monitoring box, power conditioning unit, 2.7MVA transformer, HT (VCB) panels etc.	1 Set
12	Unloading/ movement/ storage/ security for BHEL supplied items.	-
13	Construction of PEB inverter rooms, main control room except those vendor scope supply/I&C activities defined under this specification.	3 + 1 rooms
14	Construction of civil works such as approach roads, pathways, drains, overall plant boundary fencing, soak pit, septic tank.	-

4.0 Instructions to vendors on bid submission

4.1	Offer shall be submitted in two-parts (Two part-bid). Both parts shall be in separate sealed envelopes as per instructions in tender. The individual envelopes shall be enclosed in a common bigger envelope with markings (address etc) on the envelope as per instructions provided in tender.
4.2	First-part shall be techno-commercial bid. Following details shall be furnished: 1. Technical offer with covering letter expressing acceptance to BHEL tender specification. 2. Separate list clause-wise in case of deviations, if any. 3. Filled-up enclosures as per BHEL formats (meant for first-part) provided in tender.
4.3	Second-part shall be price bid with filled up enclosures as per BHEL formats provided in tender.
4.4	In addition to the above instructions, tender document provides detailed instructions for bid submission. Vendor shall submit the bid based on instructions in tender document.

5.0 Technical specification for design, supply, installation and commissioning

#	BHEL specification
5.1	**Design and drafting** Vendor shall either have in-house design expertise (or) shall outsource consultancy in case of inadequacy of internal expertise. Vendor shall carry out electrical / mechanical / civil design computations wherever applicable. Typical design areas are as listed below. (1) Computation of cable drop, power loss, rating etc for LT aux power cables (2) Selection basis/computations for data and control cables (3) Earth mat calculations for inverter rooms, main control room, transformer yards (4) RCC foundation design calculations for 2.7MVA transformers and auxiliary transformer (5) Lightning arrestors – area coverage calculation and lightning protection layout (6) Illumination lux calculations and layout design for plant lighting poles (7) Cross section/ layout design for underground trenches (LT / HT/ control/ OFC cables) (8) Layout design for 33kV transformer yard attached to inverter/ main control rooms (10) Layout design for 33kV portion of the 33/66kV switchyard attached to CMCS room (11) Battery bank sizing calculations The above list is indicative and not exhaustive. Wherever BHEL/GACL finds applicability, vendor shall carry out design and submit documents viz. GA drawings / datasheets / GTP / MQP/ type test reports etc for BHEL/GACL approval. **Note:** Design and drafting is not a separate billing item. These activities shall be treated as integral part of the related supply and I&C items of the tender.
5.2	**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 GACL shall be arranged by BHEL.
5.3	**Electrical power / water for construction, drinking water** (1) Vendor shall organize, on their own, necessary electrical power supply such as DG sets etc required for construction activities
5.4	**Construction of open yards/ covered sheds for safe storage of vendor supplied items** (1) Vendor shall, at a suitable location at the site, as decided based on discussions with BHEL site engineer, construct temporary yards/sheds for safe storage of vendor supplied items. (a) Open storage yard (without roof) with fencing all around and a gate. This shall be for storage of items supplied by the vendor such as UPS panels, earthing materials, Plant lighting poles/ bend pipes etc. (b) Covered shed with a lockable door for storage of light-weight items such as control cables (in drums), spare parts, tools, measuring instruments, other lighter construction materials. (c) Separate storage yard shall be used for civil construction items such as cement bags. (2) Area of storage yards/cabins shall be selected based on sizes of storage items. Vendor shall submit drawings/ sketches/ dimensions etc to obtain approval from BHEL. (3) Wherever applicable, suitable raised platforms / arrangements shall be provided to ensure that the items are not affected by water at the ground level during rain, storm, flood etc.

	(4) Storage yards shall have clearance (within the yard) for movement of concerned transportation vehicles/ equipments such as forklifts, hydra, trucks etc as applicable.
5.5	**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. Accordingly, vendor shall organize all necessary resources such as labour, machinery and tools (cranes, hydra, forklifts, transportation trucks/ trolleys, lifting accessories etc) for this purpose.
5.6	**Series interconnection of SPV modules to form strings** Supply of SPV modules is in BHEL scope. Type of module: L24270 (~315Wp) as per BHEL drawing enclosed with tender. Total quantity = 54,300 Nos 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 series string. Thus, a total of 2,715 strings shall be connected to achieve 2715x 20x ~315Wp = ~17.1 MWp (DC). (d) 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. Vendor shall implement the interconnection as per these drawings.
5.7	**Installation of string monitoring boxes including supply/erection of mounting structures** (1) Supply of string monitoring boxes (SMB), 180 sets, is in BHEL scope. These are 16-in/ 1- out type. This way, on input side of SMB, there are 16 series strings connected in parallel. (2) SMB shall be mounted on the Module Mounting structures. Provision will be provided in the Module mounting structure to mount the SMB. However, necessary hardware and accessories required for mounting the SMB shall be in the vendor scope of supply. Structures for mounting the SMBs are in vendor scope of supply.

	(3) Typical drawing (for tender purpose only) is enclosed along with this specification. Vendor shall design the fixture based on the actual SMB drawing/datasheet that shall be provided by BHEL after placement of purchase order. Vendor shall submit the drawing/BoM of complete mounting fixture for BHEL/GACL approval during detailed engineering. (4) Supply of hardware for mounting the SMBs on the mounting structures is in vendor scope. (6) Vendor shall install the SMBs on the module mounting structures. (7) All necessary labour, tools, machinery etc for erection work shall be in vendor scope.
5.8	**Interconnection of SPV module strings to 1Cx10 cable** (1) Vendor shall connect each series string of 20 SPV modules to SMB using 1Cx10 cable (copper, XLPO insulation as per TUV 2pfg 1169/08.2007) supplied by BHEL. (2) SPV module is provided with positive and negative cables (1Cx4) having male and female parts of MC4 type connectors. (3) Vendor shall supply plug connectors of MC4 type, each set having a pair of male and female parts, to join both the 1Cx10 and 1Cx4 cables. (4) MC4 connectors shall have rating of 1000VDC (IEC), rated current of 30A, Type approved by TUV Rheinland for product safety. (5) Approved make: Multicontact, Bizlink, Sunlont or other reputed equivalent subject to BHEL/ GACL approval during detailed engineering. (6) Total quantity of MC4 connector sets required = 3,000 sets (each set having a male and a female part) that include 2715 sets to complete installation, 285 sets as mandatory spares. Vendor shall ensure that there shall not be any shortage during execution time. (7) Two sets of tool kits (with box enclosure) 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 1Cx4 and 1Cx10 (of both pliers).
5.9	**Ferruling for 1Cx10 cable** 1) For 1Cx10 sqmm DC solar array cable, vendor shall provide UV resistant ferrules printed with source/destination identification of cable. Printing details shall be submitted for BHEL/GACL approval during detailed engineering. Printing shall be of appropriate size to ensure readability. 2) Supply of ferrule shall be in vendor scope. Make shall be reputed brand and approval shall be obtained from BHEL/GACL prior to procurement for make, type, colour, size/ dimension. 3) Ferrules shall be provided on both the termination ends: module end, SMB end
5.10	**Routing of 1Cx 10 cable below the SPV modules** (1) 1Cx10 sq-mm cables connecting the SPV module strings to SMBs shall be suitably routed below the SPV modules and along the horizontal C-lip purlin member of MMS structure. Also, the cables shall be fastened to the purlin using UV resistant cable ties. (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 BHEL/GACL. Width of the cable ties shall be a minimum of 4.5 mm. Length shall be so appropriate as to ensure that the bunched cables are held firmly to the mounting structure. During detailed engineering, BHEL/GACL 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.

5.11	**Routing of 1Cx10 cable in pipes underground between the rows of solar array** (1) Where 1Cx10 cables run 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. In such a case, the pipe shall also be laid vertically to cover the distance from purlin to the ground on either ends. Vertical arrangement shall be firmly tied to the MMS structure using suitable cable ties. (2) HDPE DWC pipe together with necessary HDPE couplers/joints (T-joints, elbows, bends etc) shall be within scope of vendor supply. Vendor shall submit the bill of materials and the drawing showing the details of routing for BHEL/GACL approval during detailed engineering. (3) Specification of HDPE DWC pipe: As per IEC 61386 part 1-4; ID shall be selected to accommodate the number of 1Cx10 cables to be guided. ID shall be minimum 63mm. However, exact ID shall be selected to ensure that only a maximum of 60% of the ID space is occupied by the cables. Make, part number, sizes/ dimensions shall be submitted for BHEL/GACL approval during detailed engineering. (4) Cables with HDPE pipe (and couplers/joints etc) shall be directly buried underground as per IS: 1255. a. Trench depth = 750 mm minimum b. Trench width = As per conduit size and number of conduits c. Bottom layer shall be sand as per IS: 383 with 75mm minimum thick. d. HDPE conduit with cables shall be laid over the sand layer. e. Another layer of sand as per IS: 383 with 75 mm minimum thick. f. Single layer of brick as protective cover g. Trench shall, then, be filled with refill soil and compacted (5) Total length of HDPE DWC pipe and quantity of couplers/joints shall be as required. (6) Bending radii for cables shall be as per IS: 1255. (7) At road crossings, cables shall be routed through GI pipe of appropriate size that shall be in vendor scope of supply and technical details/ brand etc shall be submitted for BHEL/ GACL approval during detailed engineering. (8) 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. Make, item description, part number etc shall be submitted for BHEL/GACL approval during detailed engineering.
5.12	**Termination of 1Cx10 cables on input side of SMBs** (1) 1Cx10 cables of positive and negative polarities originating from SPV module strings shall be terminated at the input 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 terminal block (connector) within the SMB. Cables shall enter the SMB through the cable glands that are provided as part of the SMBs supplied by BHEL. (3) Cable lug shall be in vendor scope of supply. Type of lug (pin type etc) shall be in accordance with the termination arrangement within the SMB. Quantity required shall be appropriately selected by the vendor (cable lug + any other hardware if required). (4) 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. (5) All necessary tools such as pliers, strippers, crimping tool etc shall be within vendor scope.

5.13	**Underground cable trenches and laying of 1Cx300 and RS485 and OFC cables in solar array field** DC power cable 1Cx300 (from SMB to PCU) and data cable RS485 (from SMB to SCADA) shall be laid underground by way of direct burying as per IS:1255. Supply of both the cables shall be in BHEL scope. Typical trench details/dimensions are below only for tender purpose. During detailed engineering, cable trench layouts and cross section drawings as per IS: 1255 shall be submitted for BHEL/GACL approval. (a) Total trench depth = 750 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 thick. 2. 1Cx300 cable shall be laid over the sand layer. 3. Another layer of sand of 75 mm minimum thick. 4. Single layer of brick as protective cover 5. Layer of sand of IS:383 with 75mm minimum thick 6. RS485 and OFC cable (unarmoured) shall be laid in HDPE duct. Supply of HDPE pipe for RS 485 cable and OFC cables in BHEL scope 7. Layer of sand of IS:383 with 75mm minimum thick 8. Single layer of brick as protective cover 9. Trench shall, then, be filled with refill soil and compacted Data communication (RS 485) cables shall be laid between SMBs to form daisy chain loop (Not more than50 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. Bending radii for cables shall be as per IS: 1255. At road crossings, cables shall be routed through GI pipe of appropriate size that shall be in vendor scope of supply and technical details / brand etc shall be submitted for BHEL/GACL approval. Vendor shall take utmost care in laying the cables in order to prevent damages on outer sheath and inner insulation. In case cables found to be damaged/ cut after the laying in trenches, vendor shall remove the damaged portion and join
5.14	**Laying of 1Cx300/RS485 cables in inverter rooms and terminations at PCU/SCADA** (1) 1Cx300 cables (Al conductor, XLPE insulation, armoured: BHEL scope of supply) and RS 485 (unarmoured, BHEL scope of supply) running from SMBs (through outdoor cable trenches) shall be routed into the respective inverter rooms and laid on the cable trays therein. Supply and laying of cable trays within the rooms shall be in vendor scope of supply. Vendor shall route/lay/dress the cables neatly on the trays. Cable ties shall be in vendor scope of supply. RS 485 Cable shall be laid inside the HDPE pipe. The minimum clearance of 300 mm between DC cable and Rs 485 cable shall be maintained (2) Vendor shall carry out drilling of holes in cable gland plates of the PCUs for the 15 positive and 15 negative DC inputs of 1Cx300 cable. Similarly, holes for entry of RS 485 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/relaying 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. (5) Vendor shall carry out the 1Cx300 cable terminations for the 15 positive and 15 negative inputs that include tasks such as unsleeving, crimping, connecting to the tinned copper bus bars, tightening using

	torque wrench etc. Glands (metallic, double compression), bimetallic cable lugs (Cu/Al), SS304 bolts/nuts/plain washers/ spring washers shall be in vendor scope of supply. (6) Vendor shall carry out the RS485 cable terminations at SCADA end that include tasks such as unsleeving, crimping, connecting to the tinned copper bus bars, tightness using torque wrench etc. Shield of the cables shall be properly earthed at SCADA end. Cable glands (metallic, single compression), cable lugs (appropriate type/size), SS304 bolts/nuts/plain washers and Zinc/epoxy coated spring washers etc as applicable shall be 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) Vendor shall submit details of cable glands/lugs/ties/hardware (Make, part number, size, quantity etc) for BHEL/GAC L approval. Glands shall be of COMET make or other reputed equivalents subject to BHEL/GACL approval. Cable lugs shall be of Dowell/ 3D/ Braco or other reputed equivalents subject to BHEL/GACL approval. (9) All tools/accessories such as crimping tools etc required to carry out the termination shall be within scope of vendor.
5.15	**Termination of 1Cx300 DC power cables and RS 485 cables at SMBs** (1) Cables of 1Cx300 (Al conductor, XLPE/XLPO 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) Cable lug shall be bimetallic (Cu/Al) and shall be in vendor scope of supply. Make shall be Dowell, 3D, Braco or equivalent subject to approval of BHEL/GACL. (4) SS304 bolts/ nuts/ plain washers and Zinc/epoxy coated spring washers shall be in vendor scope of supply. (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. (7) Similarly, vendor shall carry out RS485 cable terminations at SMBs. Cable glands in BHEL scope as part of SMBs. Cable lugs, connecting hardware shall be in vendor scope of supply for which details of make, part number, size etc shall be submitted for BHEL/GACL approval during detailed engineering. Shield of the RS485 cables shall be suitably earthed at SMB end.
5.16	**Identification marking of cables using cable tags** 1) Cable tags shall be provided on 1Cx300 DC cables at both ends (SMB end, PCU end) just before entering the equipment enclosure. 2) Similarly, for RS485 cables at SMB end and SCADA end. 3) Cable tags shall be of rectangular shape. 4) 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. 5) Vendor shall submit the technical details of cable tags, ID numbering scheme for BHEL/ GACL approval during detailed engineering.

5.17	**Installation of electrical panels within inverter rooms and main control room** (a) Panel installation within three inverter rooms: 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): (b) 1250 kW PCU panels along with ducts : 4 sets (c) 33kV VCB panels: 3 sets (2 incomers + 1 outgoer) (d) Distribution boards (wall mounted): SDB (AC supply), IRDB (room utilities), UPSDB AC, UPSDB DC, LDB (plant lighting): 1 No each + any extra boards as required (e) SCADA panel: 1 No (f) UPS with battery charger/ battery bank: 1 Set (g) Fire alarm system: 1 set (h) FCBC battery charger – 1 No (i) Battery bank – 1 No Panel installation within main control room: (a) 33kV VCB panels: 1 set (3 incomers + 1 outgoer + 1 Aux outgoer + 1 Bus PT) (b) ACDB main panel: 1 set (c) Distribution boards (wall mounted): DCDB, UPS DB, CR DB (room utilities), LDB (plant lighting), PDB (power DB): 1 No each + any extra boards as required (d) SCADA panel: 2 Nos (e) HMI SCADA control desk with PCs and accessories: 1 set (f) UPS with battery bank (for SCADA/emergency loads etc) – 1 No (g) FCBC battery charger – 1 No (h) Battery bank – 1 No (i) 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 vendor drawings approved by BHEL/GACL. (j) 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. (k) Panels shall be suitably grouted using welding/ bolting methods as per relevant standards. BHEL approval shall be obtained for the grouting arrangement. All necessary hardware for the same shall be within vendor scope of supply. (l) All necessary hardware like nuts, bolt washer, tie rod etc for installation of PCU ducts shall be in vendor scope of supply

5.18	**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 as per "**Cable installation methodology**" section of this specification. Cables trays shall be ladder type with horizontal corner bend pieces. 750mm minimum width, 3mm minimum thickness and appropriate height. Drawings/ make/ part number of these shall be submitted for BHEL/GACL approval. (2) Vendor shall place and fit these cable trays over steel support structure (angles, sections etc) that are provided in the cable trenches of inverter/ main control rooms 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) 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 of appropriate type, diameter and length that shall be fixed below the plinth beam of room. (2) **Such PVC conduit pipes shall be in vendor scope of supply.** Vendor shall make appropriate assessment of size of PVC pipe considering 50% max allowed filling of the pipe by the cables. Layout drawings of PVC pipes shall be submitted for BHEL/GACL approval during detailed engineering. Fixing of PVC pipes below the plinth level is in BHEL scope. (3) Cables (HT, LT, communication, control etc) shall be laid on cable trays in separate tiers with appropriate spacing as per IS: 1255. (4) 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. (5) Cables shall be dressed using appropriate cable ties at appropriate intervals to ensure firmness of their position over the trays. (6) 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. (7) All cable entry openings of conduit pipes, after laying/ termination of the cables, shall be sealed using appropriate sealant to ensure water proof tightness. (8) All cable accessories such as cable conduits/pipes, ties, trefoil clamps, sealants etc for the above purpose shall be in vendor scope of supply. (9) All the supply and installation works as mentioned above shall be as per "**Cable installation methodology**" section of this specification and as per drawings approved by BHEL/GACL during detailed engineering.
5.19	**Supply, laying, termination of LT/HT/aux supply cables in inverter/ main control rooms** (1) For all electrical panels viz PCUs/ VCB panels, UPS/ battery charger/ battery bank /DB boards and inverter transformers of the three inverter rooms, laying and termination of LT/HT/Aux power

cables shall be in vendor scope. Exception: supply, laying and termination of DC cables from SMBs to PCU DC side in BHEL scope of supply.

(2) For all electrical panels viz VCB panels/ ACDB panel/ UPS/ FCBC battery charger/ Battery bank / DB boards / aux transformer of main control room, laying and termination of LT/HT/Aux power cables within the room and up to 33kV side of 16MVA transformer shall be in vendor scope. Exception: supply, laying and termination of aux supply cables for C&R panel and 66kV switchyard shall be in BHEL scope.

(3) All cables other than those listed under section "BHEL scope" of this specification shall be in vendor scope of supply.

(4) All aux cables shall be in vendor scope of supply. Sizing shall be as per design calculations. Vendor shall submit make/ GTP etc for BHEL/ GACL approval during detailed engineering.

(a) Aux transformer 200kVA to ACDB panel in main control room: 3.5 Core, 1.1kV, Al, XLPE, armoured, PVC FRLS as per IS: 7098.

(b) ACDB panel of main control room to SDB boards of inverter rooms: 3.5 core, 1.1kV, Al, XLPE, armoured, PVC FRLS as per IS: 7098.

(c) All other aux power cables: Cu/Al, PVC, armoured, PVC FRLS, IS: 1554. Refer section "**Auxiliary AC/DC power supply system**" of this specification.

(d) Lengths of all above cables shall be assessed by vendor based on indicative layouts of inverter room/ main control room enclosed with the tender.

(5) Cable glands, cable lugs, 33kV HT cable termination kits (indoor/ outdoor types as applicable), bolts, nuts, washers etc shall be in vendor scope of supply. For power terminations of PCU AC side and Inverter transformer LV side, bimetallic (Cu/Al) lugs shall be provided by the vendor. Other lugs shall be Cu or Al as applicable.

(6) Make of cable lugs: Dowell/ 3D / Braco or any other reputed equivalent subject to approval of BHEL/GACL.

(7) Glands shall be nickel plated brass double compression for PCU/ transformer power cables. 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/ GACL.

(8) HT termination kits (indoor/ outdoor as applicable) shall be 3M/ Raychem or reputed brand subject to BHEL/GACL approval. HT termination shall be carried out by certified jointers. Credentials / certification of experience from 3M/ Raychem etc for the proposed jointers shall be submitted for BHEL/GACL approval during detailed engineering.

(9) Vendor shall make appropriate holes in the gland plates of PCUs, HT VCB panels, UPS panel, 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.

(10) 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.

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

(12) 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 such

	as technical specifications (ratings, sizes, calculations etc), cable selection, tests on cables, cable installation, cable accessories etc.
5.20	**Supply, laying and installation of Control / data / instrumentation / OFC cables** (1) BHEL shall supply the following SCADA related data communication cables (a) PCUs to SCADA panels in respective inverter/ control rooms (Ethernet/LAN cables) (b) Protection relays of VCB/C&R panels to SCADA in inverter/control rooms (Ethernet/LAN) (c) MFM meters of VCB/ACDB/FCBC/C&R panels to SCADA (RS485, 2Px0.5) (d) C&R panels, ABT meters of main control room (RS485, 2Px0.5) (e) LAN cables within SCADA network (f) OFC cable from SCADA panels of inverter rooms to SCADA panel in main control room 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. (2) All the other cables such as (i) control cables from inverter transformer marshaling boxes to relay circuits in VCB panels (transformer trip signals), (ii) control cables from inverter transformer marshalling boxes to SCADA (transformer alarm signals), (iii) control cables from SCADA panels to relay circuits in VCB panels (VCB on/off status, VCB close/open command signals), (iv) instrumentation cables from inverter transformer marshaling boxes to SCADA panels (4-20mA signals, WTI/OTI values), (v) control cables from metering CTs/ PTs of 33kV VCB outgoer panel to ABT metering panel shall be in vendor scope of supply. **(a) Control and instrumentation cables:** • Control cable shall be 2.5 sq-mm minimum, copper conductor, PVC, armoured. Instrumentation cable shall be 0.5 sq-mm minimum, copper conductor, PVC, armoured. • All the cable installation accessories such as cable trays, cable conduits, cable glands, cable lugs, bolts, nuts, washers etc shall be in vendor scope of supply. • Cable laying and cable terminations shall be in vendor scope. Make shall be reputed brands subject to BHEL/GACL approval. • Design calculations for cable selection together with GTP/datasheet particulars, make etc shall be submitted for BHEL/GACL approval. Similarly, No of cores, length requirements shall be appropriately assessed by the vendor. • All necessary resources such as labour, tools and accessories required to carry out laying and termination works etc shall be within scope of vendor. (b) **OFC cable** along with HDPE conduit, termination kits shall be in BHEL scope of supply. Vendor scope includes laying of the OFC cable underground in the conduit from inverter room SCADA panels to main control room SCADA panel. Termination of the cables at both the ends shall be in BHEL scope. (3) Vendor shall lay and terminate the **RS485 cables** to SCADA from (a) MFM meters of VCB panels, (b) MFM meters of ACDB panel, (c) MFM meters of C&R panel, (d) ABT meter for 33kV side and (e) ABT meters (3 Nos) of 66kV side, (e) Fire alarm panels, (f) Weather monitoring station. These cables shall be laid between the panels of respective inverter/ main control rooms. (4) Vendor shall lay and terminate the Ethernet cables to SCADA from (a) PCUs, (b) numerical relays of VCB panels, (c) numerical relays of C&R panels. These cables shall be laid between the panels of respective inverter/ main control rooms.

	(5) 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 such as technical specifications (ratings, sizes, calculations etc), cable selection, tests on cables, cable installation, cable accessories etc.
5.21	**Erection of 33kV transformer yards attached to inverter rooms and main control room** (1) Each of the three inverter rooms is attached to two transformer yards each having one inverter transformer. (2) Aux transformer 200kVA, 33kV/433V shall be placed at an appropriate location in 33/66kV switchyard attached to main control room. (33/66kV switchyard is in BHEL scope). (3) Vendor shall design and construct RCC foundations for the three transformers as per relevant clauses of "**General civil works**" section of this specification, geotechnical investigation report (soil report), the transformer weight / dimensions etc. In addition, following points shall be taken into account. a) Approximate total weight of 2.7MVA inverter transformer ~9,000 Kg b) Approximate total weight of auxiliary transformer ~ 500 Kg c) Soil report will be submitted to vendor prior to price bid opening. d) Foundation structure shall include appropriate layers of PCC, sand, boulders, RCC portions etc as per design requirements. e) Foundation depth shall be as per design requirements. f) Foundation pedestal height above the finished ground level 500 mm minimum. (4) Individual oil pits for the transformer, interconnectivity between the pits, oil collection pit, transformer track rails, stone gravels / fencing / gates of transformer yards, finishing works such as plastering/ painting etc shall be as per relevant clauses of the "**General civil works**" section of this specification and as per relevant IS standards / CBIP/ CEIG requirements etc. (5) Hardware arrangements (transformer track rails, angles, steel bolts, plates, nuts, washers etc), which will be part of foundation pedestal, shall be as per transformer GA drawing. GA drawing of inverter transformer shall be provided by BHEL during detailed engineering. (6) Vendor shall erect the 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. The 33KV cable from Main outgoer panel to the LV side of the 16 MVA transformer shall be laid on the Cable tray support structure. For this required material like cable trey, support structure, hardware etc is in vendor scope of supply. d) All activities applicable to oil filling and filtration including measurement of oil BDV and PPM in NABL accredited laboratory. 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. (7) 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. Also, PVC pipes shall be provided at appropriate locations along the periphery of transformer yard fencing for draining out of water from the yard. PVC of appropriate size shall be in vendor scope of supply. (8) Fencing and gate shall be provided for transformer yard as per section "**General civil works**" of this specification. All supply items shall be in vendor scope. (9) 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. (10) 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. (11) Vendor shall submit (a) GA drawings / design calculations of transformer foundations/ oil pits, (b) GA/layout/scheme of transformer yard (with appropriate overall size/ dimensions), (c) GA/BoM of fence, (e) GA/BoM of gate etc for BHEL/GACL approval, (f) GA for location/layout of aux transformer.
5.22	**Underground cable trenches and laying of HT/LT/Control/Instrumentation/OFC cables** Applicable/relevant clauses under "**Cable installation methodology**" section of this specification shall be adopted for burying the cables underground. Accordingly, following cables shall be laid underground by way of direct burying using appropriate layers of sand (75mm each layer), brick layers, refill soil etc to appropriate excavation depth below the ground level (750mm) as per relevant Indian standards (IS:1255), Indian Electricity rule, CEIG/CBIP norms etc related to cable installation practices and procedures: 1) AC aux supply cable from aux transformer (in 66kV switchyard) to ACDB panel in main control rooms. 2) AC aux supply cables from ACDB panel in main control room to SDB board in inverter rooms. 3) AC aux supply cables from DB boards of the nearest inverter/ main control room to (i) the plant lighting poles, and (ii) booster pumps. 4) AC aux supply / Instrumentation / data communication cables, as applicable, from weather monitoring station data logger to SCADA room in main control room. 5) AC aux supply / Control / instrumentation cables from inverter transformers to HT panels. 6) OFC cables (in HDPE conduits) from SCADA in main control room to SCADA panels of inverter rooms. 7) HT cables (33kV), AC aux supply cables, data communication / control / instrumentation/ SCADA cables from 33kV transformer yards to the related panels in the respective inverter/ main control rooms. 8) Any other cables (other than the above) to meet the underground cable laying requirements. **Vendor shall avoid jointing of cut pieces of LT/HT cables to form the required length between two termination ends. However, in case of unavoidable situations due to longer routes, vendor shall join the cut pieces using LT/HT straight through joints of appropriate size. Jointing shall be carried out by certified jointers for which approval shall be obtained from BHEL.** Cable trench layouts and cross section drawings shall be submitted to BHEL/GACL for approval during detailed engineering.

5.23 Specification of auxiliary transformer 200kVA, 33kV/433V, Dyn11, Outdoor, ONAN

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	200 kVA
6	No. of phases	3
7	Frequency	50 Hz, +/- 3%
8	HV winding	33kV, 3-Ph, with **Delta** connection
9	LV windings	433V, 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	4.5% 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. HV cable in BHEL scope.
18	Cable entry on LV side	Bottom entry of cables. 3.5C, 1.1kV grade, aluminum conductor, armoured, XLPE insulation, PVC sheath as per IS: 7098 will be used. Cables and accessories in BOS vendor's scope. Cable size and no. of runs shall be decided by vendor.

	19	Cables and accessories	HV & LV Cables, termination kits (for HV), cable lugs (Dowell make), double compression nickel plated brass cable glands (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 BOS vendor.
	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 at rated frequency, with IS tolerance	This shall be provided by vendor.
	28	No load current at rated voltage and rated frequency	This shall be provided by vendor. To be indicated as percentage.
	29	Efficiency at 75^0C, UPF	Minimum 98.5% at full load (100%). Efficiencies at 75% and 50% loads to be indicated by vendor.
	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 3^{rd}& 5^{th}.

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	Painting	Shade 631 of IS:5
39	Constructional features	As per relevant clause of this specification
40	Fittings and accessories	As per relevant clause of this specification

2.0 Constructional features and details of transformer components

2.0	Transformer shall be constructed in accordance with IS: 2026 and IS: 3639 or equivalent international standard. All materials / components used shall be of best quality and class most suitable for working under the conditions specified. These shall withstand the variations of temperature and atmospheric conditions, overload, over-excitation, short-circuits as per specified standards without distortion or deterioration, without development of stresses in any part and also without affecting the strength and suitability of the various parts for the work that they have to perform.

2.1 Tank

2.1.1	The transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and cover shall be of welded construction and there should be provision for lifting by crane.
2.1.2	Suitable inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
2.1.3	The exterior of tank and other steel surfaces exposed to the weather shall be thoroughly cleaned and have a priming coat of zinc chromate applied. The second coat shall be of an oil and weather-resistant nature, preferably of distinct colour from the prime and

	finish coats. The final coat shall be of a glossy, oil and weather resistant non-fading paint of specified shade.
2.1.4	The interior of the tank shall be cleaned by sand blasting and painted with two coats of heat resistant and oil insoluble paint.
2.1.5	Steel bolts and nuts exposed to atmosphere shall be galvanized. All bolted connections to the tank shall be fitted with suitable oil-tight gaskets that shall give satisfactory service under the operating conditions for complete life of the transformer, if not opened for maintenance at site.
2.1.6	The tank together with radiators, conservator, bushings and other fittings shall be designed to withstand the following conditions without permanent distortion: (i) Full vacuum of 760 mm of Hg, for filling with oil by vacuum. Internal gas pressure of 0.35 Kg/cm2 (5 Ibs/sq.in) with oil as at operating level. (ii) The transformer shall have conservator tank of adequate capacity to accommodate oil preservation system and volumetric expansion of total transformer oil. The conservator shall be bolted into position so that it can be removed for cleaning purposes. (iii) The conservator shall be of single compartment type. The top of the conservator shall be connected to the atmosphere through a transparent type silica gel breather. (iv) The tank cover shall be suitably sloped so that it does not retain rain water. The material used for gaskets shall be cork, neoprene or approved equivalent.

2.2 Core

2.2.1	The magnetic circuit shall be of core type. The core shall be constructed from non-ageing, cold rolled, super grain oriented silicon steel laminations (CRGOS) equivalenttoM4gradesteels orbetter.
2.2.2	The insulation structure of the core to clamp plates shall be such that it withstands a voltage of 2kV (rms) for one minute in air.
2.2.3	Adequate lifting lugs will be provided to enable the core & windings to be lifted.

2.3 Windings

2.3.1	Windings shall be of electrolytic grade copper free from scales and burrs.
2.3.2	Windings shall be subjected to a shrinking and seasoning process so that no further shrinkage occurs during service.
2.3.3	Windings shall have uniform insulation.

2.3.4	Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratios.
2.3.5	The completed core and coil assembly shall be dried in vacuum and shall be immediately impregnated with oil after the drying process to ensure elimination of air and moisture within the insulation.
2.3.6	Windings shall be made in dust proof and conditioned atmosphere. Vendor shall indicate those details of facilities (as available at the winding works) that will ensure meeting this requirement.

2.4 Internal earthing

2.4.1	The frame work and clamping arrangements of core and coil shall be securely earthed inside the tank by copper strip connection to the tank.

2.5 Bushings

2.5.1	Bushings shall be designed and tested to comply with the applicable standards. Bushings rated for 400A and above shall have non-ferrous flanges and hardware. Bushings shall be supplied with terminal connector clamp suitable for connecting the cables.
2.5.2	Neutral bushings of the star-connected LV winding shall be brought out to separate bushing terminals. The neutral bushings shall be provided on the tank at such a location that facilitates connecting earth conductor down to the ground level. Tank-mounted pin-type support insulators shall be provided for supporting theneutralearthing bar of specified section, along its run from the neutral bushing to ground level.

2.6 Cables boxes and disconnecting chambers

2.6.1	Cable boxes shall be supplied with gland plates having holes to suit cables provided.
2.6.2	Cable boxes / disconnecting chambers shall be provided with body earth terminals.
2.6.3	LV cable boxes shall be provided with necessary LV bushings, bus bars, bus bar supports for making cable terminations.
2.6.4	HV cable boxes shall be provided with necessary HV bushings and terminals for making cable terminations.
2.6.5	Cable boxes shall be provided with suitable gaskets to ensure the specified protection class requirement (IP55).
2.6.6	Cable boxes / disconnecting chambers shall be provided with necessary arrangements to prevent entry of rain water into the same.

2.6.7	**Disconnecting chambers:** (1) Disconnecting chambers shall be provided to enable the transformer to be removed without unsealing the cables or draining oil from the main tank. (2) Disconnecting chamber shall be air insulated and complete with seal-off bushings, removable flexible connectors / links and removable covers. (3) Phase-to-phase and Phase-to-ground clearances within the chamber shall be such as to enable either the transformer or cable to be subject separately to HV tests. Clearances shall be subject to BHEL approval.

2.7 Transformer oil

2.7.1	Transformers shall be supplied complete with transformer oil. The new insulating oil before pouring into the transformer shall conform to the requirement of IS: 335. No inhibitors shall be used in the oil. The oil samples taken from the transformer at site shall conform to requirements of IS: 1866.
2.7.2	10% extra oil, in non-returnable sealed containers, shall be sent along with main consignment to avoid any shortage of oil at the time of topping up of oil at the site. This oil quantity shall be over and above the specified mandatory spares requirement.

2.8 Fittings and accessories

Following fittings per transformer shall be provided. Vendor shall indicate compliance (Yes / No) for each line item. In case of non-compliance or deviation, vendor shall indicate and provide comments.

#	Nomenclature of fitting / accessory	Qty
1	Oil conservator with equalizer pipe and drain plug	1 set
2	HV cable box	1 set
4	LV cable box	1 set
6	Off circuit tap changing switch (OCTC) with operating knob, tap position marking and locking facility, with warning plate “Tap switch to be operated only with the transformer de-energized”.	1 set
7	Neutral bushings for earthing of LV winding	1 No
8	Earthing terminals for cable boxes, tank etc.	2 Sets
9	Radiators (detachable type) with drain value at the bottom, relief valve at the top, air plug, shut-off valves at every point of connection to the tank and lifting lugs.	4 sets
10	Silica gel dehydrating breather with oil cup	1 set
11	Prismatic / toughened glass oil level gauge for transformer and tap changer chamber with min and max markings.	1 set

12	Explosion vent (double diaphragm) with sight glasses and equalizing pipe connection to conservator	1 set
13	Inspection window with cover	1 set
14	Cover lifting lugs / eyes	2 Nos
15	Tank lifting lugs / eyes for the entire transformer	4 Nos
16	Bi-directional flat rollers	4 sets
17	Base channel with towing holes / lugs	2 sets
18	Air release hole with plug	1 No
19	Oil filling hole with cap	1 No
20	Top filter valve with threaded male adapter (blanking plug)	1 No
21	Drain cum sampling valve	1 No
22	Rating and diagram plates made of stainless steel or anodized aluminium.	1 No
23	Terminal marking plates	1 Set
24	Stem type thermometer mounted on top of tank	1 No

3.0 Inspection and testing of transformers at vendor works

3.0	Vendor shall provide inspection call to BHEL for the type and routine tests. Prior to the call, vendor shall submit the routine test results as per Manufacturing Quality Plan (MQP) for scrutiny of BHEL/GACL.

4.0 Tests

4.1	**Routine Tests: As per IS: 2026.**
4.2	**Type Tests** (a) **Temperature rise test as per IS: 2026** This test shall be performed as a type test on one sample of transformer. This is a mandatory test and shall be witnessed by BHEL/GACL. In case extra charges are required, the same shall be indicated separately in the offer on per-transformer basis. This temperature rise test shall be carried out at a tap corresponding to maximum losses as per IS: 2026. Test report shall be furnished to BHEL. (b) Valid type test report for other type tests on similar rating transformers shall be submitted during detailed engineering.

5.0 Documents to be submitted after receipt of purchase order

	5.1	Following documents shall be submitted for BHEL approval within seven days from date of purchase order. (1) GA drawings including foundation details (2) GTP (3) MQP (4) Valid type test report as above

6.0 Documents to be submitted along with consignment

	6.1	Following documents shall be submitted to BHEL at the time of delivery of the consignment: (1) As built drawings of transformer (2) Routine test reports on transformer (3) Type test reports on transformer (4) Test certificate for transformer oil (5) Operations and maintenance manual of transformer

5.24 Auxiliary AC/DC power supply system

Vendor shall establish an auxiliary AC supply system for (a) various utility power consumption purposes such as inverter / control room lamps, ceiling fans, exhaust fans, booster pumps, plant lighting, air-conditioner, other electric appliances, auxiliary power supply to PCUs, VCB panels, transformers etc and also, for (b) powering the battery chargers that in-turn charge the battery banks for 110V DC supply.

Vendor shall submit detailed SLD diagram of Aux AC/DC system with MCB types/ratings for incoming/ outgoing feeders etc for BHEL/GACL approval during detailed engineering.

The system shall comprise of following items:

(a) An **auxiliary transformer (1 No)** 200kVA, 33kV/433V, Dyn11, Outdoor, Oil-immersion / ONAN type shall be installed in the 33/66kV switchyard attached to main control room. Supply and installation of aux transformer including RCC foundation, erection of transformer, all necessary cable terminations, cable installation and cable interconnections with VCB panel (on HV side) and with ACDB panel (on LV side) shall be in vendor scope. Both the HV (33kV) and LV cables shall be in vendor scope of supply.

(b) ACDB floor-mounted panel, 1 No (fed by 3ph, 4-wire 433V auxiliary transformer supply) that distributes the AC power to various utility applications in main control room and inverter rooms shall be supplied, installed and commissioned in main control room by the vendor. The panel shall have incoming feeder supply from aux transformer and outgoing feeders for main control room utility and individually for each inverter room. Incoming as well as each outgoing feeder shall have a separate MFM meter with RS485 communication feature for SCADA connections.

(c) Battery bank, Float-cum-boost charger, UPS in main control room and Inverter room :
Vendor shall supply, install and commission 1 No each of Battery bank, Float-cum-boost charger, UPS in main control room and inverter rooms.

1. Battery bank shall be VRLA/MF stationery, sealed type, **110V DC,** at 8 hours rate of discharge, IS 1651-1979, performance as per IS:8702, nominal cell voltage 2V, 55 cells, plastic resin/ ABS/ PP container, epoxy coated exhaust fans to remove the gas emissions, suitable battery rack/stand with painted steel sections. Exact Ah sizing shall be finalized during detailed engineering for which calculations shall be submitted for BHEL/GACL approval.

Minimum rating of the battery shall be

(i) 110V, 200Ah for Control room
(ii) 110V, 100Ah for each Inverter room

2. Float-cum-boost-charger with boost current (45A) and boost voltage (135V):

Minimum Rating of Float-cum-boost-charger shall be

(i) boost current (45A) and boost voltage (135V) for control room
(ii) boost current (25A) and boost voltage (135V) for each inverter room

Battery charger as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC Batteries while supplying the DC loads. The chargers shall be designed to operate, as mentioned above, at an ambient air temperature of 50°C. Battery chargers shall have a selector switch for selecting the battery charging mode i.e. whether Trickle or Boost charging. During automatic boost charging, the Battery chargers shall operate on constant current mode.

Charger shall have load limiters which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger.

LED indications with alarm annunciation on the panel for Mains ON, Float charger AC ON, Float charger DC ON, Boost charger AC ON, Boost charger DC ON, AC Mains Fail, Float charger DC fail, Boost charger DC fail, DC earth fault, SCR fuse fail, Filter fuse fail, Blocking diode fail, Battery under-voltage, Battery over-voltage, Charger DC overload.

LED indications for various parameters: 3-ph AC input voltage, boost/float/trickle currents, charge/discharge currents, DC output voltage/current, Battery leakage current etc.

Selector switches for Float Auto/Manual, Boost Auto/Manual, Float/Boost/ Autoboost selector switches. Also, Voltmeter / Ammeter selector switches as applicable.

Charger shall have constructional features as per "**LT switchgear panels**" of this specification.

Feeders as below:
(iii) Incoming feeder – 3ph from ACDB panel in control room
(iv) Outgoing feeders min 6 feeders

- To HT Panel
- To SCADA Panel
- To DCDB
- At least three spare feeders
-

3. UPS panel, 5kVA with VRLA battery back up 1 for each control room and inverter room

- Incoming feeder – from Battery charger panel
- Outgoing feeder – To UPSDB board
- At least one spare feeder
- Make shall be Hitachi, Consul Neowatt or reputed equivalent subject to BHEL/GACL approval
- Constructional features of the panel shall be as per clause **"LT switchgear panels**"

ii. Following DB boards (wall mounted, 1 No each) for application in main control room shall be in vendor scope of supply, installation and commissioning:

1. DCDB for 110V DC supply to 33kV VCB breaker panels, 66kV SF6 breaker panel, C&R panel for 66kV switchyard, nitrogen fire protection system for 16 MVA transformer
2. UPS DB for 230V AC UPS supply to SCADA, ABT metering panel, weather monitoring system, fire alarm system, emergency loads, nitrogen fire protection system for 16 MVA transformer
3. CRDB (Control room DB) 230/415V for room utilities including SCADA room air conditioner
4. LDB (Lighting DB) 230V/415V for outdoor plant lighting system
5. PDB (Power DB) 230V/415V for submersible/ booster pumps, CCTV system, 66kV s/yard, C&R panel, 33kV HT panel

iii. Following DB boards (wall mounted, 1 No each) for each of the three inverter rooms shall be in vendor scope of supply, installation and commissioning:

1. SDB (supply DB) with incomer feeder from ACDB of main control room, outgoing feeders for PCU duct fan, UPS/BC/Battery panel, Inverter transformers (2 Nos), IRDB board, PDB board, HT panels, submersible pumps / booster pumps etc
2. IRDB (Inverter room DB) 230/415V for room utilities
3. UPSDB 230V UPS supply for PCUs (control circuits), fire alarm system panel, emergency loads
4. DCDB for 110V supply for 33kV HT panels and SCADA
5. LDB (lighting DB) for outdoor plant lighting system

Note: AC/DC DB boards shall be designed considering availability of space/ footprint requirements.

iv. Above DB boards shall also provide for any other feeders, if necessary, to meet functional requirements. In addition, at least two spare feeders shall be provided in each of the above DB boards. Further, any extra DB boards to meet functional requirements of Aux AC/DC system shall be provided by the vendor.

v. Detailed constructional specification of the panels viz: ACDB panel, UPS/FCBC, DB panels/boards etc shall be as per separate clause "**LT switchgear panels**". Where standard product is proposed for wall-mounted board, approval for the reputed brand such as Legrand, Siemens, Schneider etc shall be obtained from BHEL/GACL.

	vi. DB boards shall be provided with incoming/ outgoing ACB/ MCCB/ MCB as applicable (based on rating requirements) with spare feeders as shall be approved by BHEL/GACL. vii. Design, supply and installation of all the above items including all necessary cable terminations/ installation shall be in vendor scope. viii. Vendor shall submit the design calculations (battery, FCBC, UPS sizing etc), GA drawings, GTP particulars, Bill of materials, Make, Model / Part number etc for all the above items as per relevant IS/IEC standards for BHEL/GACL approval during detailed engineering.
5.25	**LT switchgear panels** The LT switchgear panels (ACDB, DCDB etc wherever applicable) shall be designed as per the relevant IS codes and as per the approved design for the panel. All the parts of the panels must be rated as per the relevant rated voltage level. All the panels must have multifunction meters (MFM) flushed with the surface of the panels. However, the outgoing feeder can have Tri vector meter (TVM) for the energy accounting. The ACDB panels in main control room shall be rated for the maximum output of the Aux transformer feeding the system. Similarly, ACDB/DCDB boards in inverter rooms shall be rated for the respective capacity on pro-rata basis. The short circuit withstand rating (1 sec) at rated voltage of the switchgear shall be relevant to the existing electrical system short circuit ratings. (1) LT switchgear panels (Construction) (i) Single front / compartmentalized, modular design, degree of protection IP52 with provision of extension on both sides. (ii) Incomer feeders: mains incomer - Electrically operated draw out type Air Circuit Breakers (ACBs)/ Vacuum Circuit breakers (VCBs), as applicable. (iii) Outgoing feeders: Moulded Case Circuit Breakers (MCCBs)/ electrically operated draw out type Air Circuit Breakers (ACBs) / Vacuum Circuit Breakers (VCBs), as applicable. (iv) The colour finish shade of switchgear enclosure for interior shall be glossy white & for exterior it shall be light grey, semi glossy shade 631 of IS: 5. if a different exterior shade is desired by the Employer, the same shall be intimated to the supplier. (v) The LT switchgear panel shall be fabricated out of CRGO sheet steel; 2 mm thick for the outer shall all-round. The internal walls and separators shall be of 1.6 mm thick CRGO sheet steel (vi) The gland plates shall be 3 mm thick (2) Control Circuit a) Air Circuit Breaker spring charge motor – 230 V AC, 1 phase b) Moulded Case Circuit Breakers – 230 V AC, 1 phase c) Space heater, sockets, etc. – 230 V AC, 1 phase d) Control supply for breaker closing / tripping - 110V DC e) Indications, annunciation – 110V DC (3) Bus Bar & Cable Cavity

(a) The material for main bus bars and tap off bus bars shall be electrolytic grade aluminium with properly colour coded HR PVC sleeved insulation.
(b) Bus bars shall be suitable for short circuit rating and current suitable for all connected load.
(c) Cable entry for incoming and outgoing cables shall be from Bottom.
(d) A suitable gland plate shall be supplied for termination of power, control and instrumentation cables.
(e) Whenever feeders are housed in multi-tier configuration, these tiers shall be segregated by sheet metal barriers.
(f) Earthing: Earthing bus bar shall be terminated at both ends of the switchgear to suit the connections to outside earthing conductor. All components inside the module are required to be earthed individually and are to be looped and connected to the horizontal earth bus. All the non-current carrying parts of the panels, e.g., enclosure, must be connected to earth as per the regulations.

(4) Terminals
(a) CT circuit - Isolating link type terminals with shorting facility
(b) PT circuit – clip on type terminals
(c) Spare contacts shall be wired up to terminal block. 10% spare terminals shall be provided for each module

(5) Specific requirements
(a) All ACBs/ MCBs, as applicable, shall be 4 pole, electrically operated, draw-out type, with closing coil, spring charge motor, trip coil, TNC switch for close and trip, manual closing and tripping push buttons, door I/L, test and service position micro switches, emergency P.B., safety shutters, etc. The circuit breaker shall be provided with anti-pumping feature.
(b) ACBs/ VCBs, as applicable, shall be complete with microprocessor release and shall be provided with over current, short circuit and earth fault protections.
(c) Minimum10% spare feeders of each rating shall be provided in the switchgear.
(d) All current transformers shall have 5/1A secondary and all meters shall be suitable for 5/1A operation.
(e) All indicating lamps shall be of LED cluster type. ACB feeders shall be provided with ON, OFF, AUTOTRIP, SPRING CHARGED, TEST, SERVICE, TRIP CIRCUIT HEALTHY indications
(f) All indicating instruments, including MFM, shall be flush mounting, Digital type and of standard size.
(g) Window annunciator with hooter and accept, test, reset button shall be provided.
(h) Necessary auxiliary relays for contact multiplication shall be provided in the panel.
(i) The maximum temperature of the bus bars, droppers and contacts at continuous current rating under site reference ambient temperature of 50º C shall not exceed 105º C.
(j) Instrumentation: Switchgear instrumentation shall be provided as follows:
1. Mains Incomer – Voltmeter with selector switch
2. Ammeter with selector switch
3. Power Factor meter
4. Frequency meter
5. TVM + MD meter

6. Potential indicating lamps
7. Outgoing Feeders
8. Ammeter with selector switch on all feeders

(6) General Technical Specifications (LT Switch gear Panel)

(a) The panel shall be self-supporting, free standing, floor mounted, modular type with construction having degree of protection of IP 54 as per IS 2147.

(b) The panel shall be fabricated from 14 SWG CRCA sheet steel for frame & load bearing surfaces. Partitions may be fabricated from 16 SWG CRCA if no components are mounted on them.

(c) The panel shall be painted with 2 coats of primer after pre-treatment and 2 coats of Polyurethane / epoxy paint with shade as decided by the Owner

(d) Stiffeners shall be provided at corners & between modules to make panel rugged. The stiffeners will necessarily be required for relay compartments or doors where heavy components are mounted.

(e) The openable covers will be provided with lift off type hinges, quarter turn door locks and flexible copper wire for earth connection.

(f) The panel shall be dust and vermin proof. Synthetic or neoprene gaskets shall be provided at all openings.

(g) The panel shall be of dead front construction suitable for front operated and back maintained functioning.

(h) Panel shall be provided with fluorescent lamp of 20W capacity operated by door operated limit switch. Panel shall also have space heaters and thermostat arrangement.

(i) Panel shall be provided with 3 pin switch socket combined unit of 5 Amp capacity.

(j) Lifting hooks shall be provided at the top of the panel.

(k) The hardware components used in the panel shall be hot dipped galvanized.

(l) The control components shall be fixed on mounting plate by drilling & tapping.

(m) Al anodized legend plates shall be provided for all the components. For components mounted on front face, legend plate from inside shall also be provided.

(n) Pre-treatment by 7 tank process shall be done before painting / powder coating the panel.

(o) Panel shall have provision of drawing pocket.

(p) The panel shall be designed to ensure maximum safety during operation inspection, connection of cables and maintenance. Inside panel, checking and removal of components shall be possible without disturbing other units.

(q) Cable entries will be from bottom. The opening of cable entry shall be covered by 3 mm thick gland plates.

(r) The panel shall be provided with all necessary components / devices and instruments as per the recommended schematic diagram and functional requirements.

(s) The components such as protective relays, auxiliary relays, push buttons, switches, instruments shall be flush mounted on the front side of a panel.

(t) The control wiring shall be done with PVC insulated flexible copper wire. For CT secondary circuits 2.5 sq.mm wire shall be used. For control wiring 1.5 sq.mm wire will be used.

(u) Earthing bus bar of suitable cross section shall be provided throughout the length of panel.

	(v) The panel shall be fully wired all the terminals shall be brought out for cable connections. 10% spare terminals shall be provided on each terminal block. Separate terminal block shall be provided for different voltages. All wire shall have P.V.C. ferrules as per wiring diagram. (w) Proper shrouding to incoming and outgoing terminals shall be provided to ensure safety during operation, inspection and maintenance. (x) Indicating lamps shall be with multiple LEDs & shall be suitable for the voltage specified. (y) All the components in the panel shall be properly laGACLed. The laGACLs shall be made of non-rusting metal or engraved PVC material properly fixed by screws. (z) The panel layout shall be made in such a way that it will always facilitate easy removal and reconnection of control cables without disturbing other wiring. (aa) Centre lines of control switches, push buttons and indicating lamps shall be matched so as to give neat appearance. Similarly top lines of indicating instruments and relays shall also be matched. (bb) The panel shall be provided with electrolytic grade Al bus bar of suitable cross section so as to maintain max current density of 0.8 AMP/ Sq.mm. (cc) Bus bars shall be provided with colour coded heat shrinkable insulating sleeves. (dd) Bus bars shall be supported by high quality epoxy insulators provided at specified distances so as to withstand to the given fault level. (ee) The bus bar chambers shall be provided with suitable ventilation arrangements so as to limit the maximum temperature of 85°C while carrying rated current. (ff) Proper clearance of minimum 25 mm shall be maintained between phase bus bars and between bus bars. (gg) The panel shall be inspected at manufactures works before dispatch to site at the discretion of Employer. (hh) All routine tests shall be carried out on the panel in presence of Employer or their representative or its representative. These tests shall include following: (i) Verification of components ratings and operation. (ii) High voltage measurement test. (iii) Insulation Resistance measurement. (iv) Control testing
5.26	**Supply and installation of Weather monitoring system** As part of weather monitoring system (WMS), vendor shall supply, install and commission the following measuring instruments with all necessary software and hardware such as data logger, power supply/ control/ data/ communication cables 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 etc. 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 (on the top of (or) in the vicinity of main control room) shall be decided during detailed engineering. Vendor shall submit all necessary GTP/ GA

drawings of instruments and installation arrangement, installation manual, make/ model number/ part number etc for BHEL/GACL approval during detailed engineering.

Pyranometer (2 Nos)

Vendor shall provide 2 Nos pyranometers for measuring the incidental solar radiation at horizontal and inclined plane of array.

Specification of the pyranometer shall be as follows:

1	Spectral response	0.31 to 2.8 micron
2	Sensitivity	Min 7 micro-volt / W/ m2
3	Time response (95%)	Max 15s
4	Nonlinearity	+/- 0.5%
5	Temperature response	+/- 2%
6	Tilt error	< +/- 0.5%
7	Zero off-set thermal radiation	+/- 7 W/m2
8	Zero off-set temperature change	+/- 2 W/m2
9	Operating temperature range	0 deg to +80 deg
10	Uncertainty (95% confidence level)	Hourly- Max 3%, Daily-Max 2%
11	Non stability	Max +/-0.8%
12	Resolution	Min +/- 1W/m2
13	Input power for instrument and peripherals	230V AC (if required)

Each instrument shall be supplied with necessary cables. 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. Vendor shall provide Instrument manual in hard and soft form.

Thermometers

Vendor shall provide 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. Instrument shall have arrange of 0 oC to 80 oC.The instrument shall have valid calibration certificate.

Anemometer

Vendor shall provide Ultrasonic type anemometer (wind speed and direction) (1 set)

1) Velocity range with accuracy limit	+/- 0.11 m/s up to 10.1 m/s +/- 1.1% of true when more than 10.1 m/s
2) Wind direction range with accuracy limit	0 to 360 deg with accuracy +/- 4 deg.

5.27 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 equipments at the segments as follows:

(a) String monitoring boxes (180 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 (2 No), anemometer for wind speed and direction.
(c) Power conditioning units (12 Nos): DC input / AC output parameters of inverters, grid data, fault status and events logged, etc.
(d) Inverter transformers (6 Nos): Alarm/Trip signals, WTI/OTI temperature values.
(e) 33kV VCB breaker panels (as per SLD, 15 panels): status of VCB breakers, status of protection relays of transformers, oil / winding temperatures, AC parameters at every 5MW level of the plant.
(f) ACDB multifunction meters (4 Nos): AC auxiliary utility consumption parameters
(g) ABT metering panels: one at 33kV side, Three (Main/ Check/ Standby) at 66kV side
(h) Fire alarm system (all inverter/ main control rooms): status signals

(2) BHEL scope of SCADA:

(a) 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 each inverter room.
(b) Desktop PCs (HMI control desks) provided with necessary software packages and remote monitoring features.
(c) Supply of SCADA related data / LAN cables as brought out in other clauses of this specification.

(3) Vendor scope of supply and installation of SCADA system:

(a) Vendor shall install the BHEL supplied SCADA system in the air-conditioned SCADA room in main control room. Vendor shall also install SCADA panels in each of the three inverter rooms.
(b) Control / instrumentation cables as mentioned in other clauses of this specification.
(c) Cable laying/ terminations of all SCADA cables at respective panels / equipments shall be in vendor scope of supply. BHEL will provide the necessary cabling schedule during detailed engineering.
(d) Vendor shall supply, install and commission necessary provisions/ equipments (Modem/ Router/ WiFi etc, broadband connection (BSNL etc)) to enable **remote monitoring of SCADA** from offices of BHEL/ GACL. Also, periodic payments (rental and usage charges) towards broadband connections shall be borne by the vendor until completion of 10 years of O&M.
(e) Vendor shall supply following **furniture sets** at SCADA room and office room of main control room at SPV plant end:
- PC table: 2 Nos
- Printer table: 1 No
- Executive table complete with draws/ side racks:3 Set
- Chair, industry standard, revolving type, with wheels, arm rest, provisions for adjustment of height (hydraulic/ gas lift):8 Nos
- Storage almirah: 2 No
- Filing cabinet: 2 No

	(4) Data signals for SCADA integration are described as below: Following is the list of signals from the five major segments of the power plant as above. **4.1 String monitoring boxes in solar array field – 180 Nos** (a) RS485 Modbus (RTU) cables from string monitoring (combiner) boxes of solar photovoltaic array field, whereby each box provides data signals viz. max 16 string currents, 1 box voltage, 1 box temperature, 1 load break switch status, 1 SPD status. And, 1 SPV module temperature shall be from any one of the string monitoring boxes. (b) Vendor shall draw appropriate number of such RS485 Modbus communication cables from solar array field to SCADA room, based on the daisy-chain grouping of string monitoring box RS485 Modbus (RTU) outputs. **4.2 Weather monitoring equipment – 6 Nos** Analog signals from the weather monitoring equipment viz. pyranometer (2 Nos), anemometer (1 No) and ambient temperature sensor (1 No), Module temperature sensor (1No). **4.3 Power conditioning units (PCUs) 1250kW: 12 Nos** RS485 modbus (RTU) signals from these PCUs comprising of DC /AC side / grid parameters such as current, voltage, frequency, phase, power factor, power (VA, Watt, Var), energy (VA-h, Watt-h, Var-h), fault details, other event logs with dates and times etc. **4.4 LT and HT equipments (Transformers, VCB panels, ACDB panel, C&R panel, ABT metering panels etc)** a) 2.7MVA inverter transformer oil temperature value: 4-20mA analog signal. b) 2.7MVA inverter transformer winding temperature value: 4-20mA analog signal. c) 2.7MVA inverter transformer protection fault signals: Buchholz alarm, Low oil level alarm, PRD alarm, OTI alarm, WTI alarm: potential free NO contact, Digital. d) HT Panels: VCB On/Off status, open/command signals: potential free NO contact, Digital. e) Numerical relays of VCB panels of three inverter rooms: Ethernet cables from relays to SCADA panel f) HT VCB panels: multifunction meters: RS485 data g) ACDB panel multifunction meters: RS485 data h) Aux transformer (1 No): OTI value, WTI value, Buchholz alarm, low oil level alarm, PRD alarm, OTI alarm, WTI alarm: potential free NO contact, Digital. i) C&R panel: Multifunction meters, Relays: RS485 data j) ABT meter at 33kV side (1 No): RS485 data (AC energy generation parameters) k) ABT meters at 66kV side (1 Nos): RS485 data (AC energy generation parameters) l) Fire alarm system: Status signals
5.28	**Plant Lighting System** Vendor shall supply, install and commission plant lighting system (for areas listed below) that includes all necessary items such as luminaires, LED lamps, GI poles, bend pipes, junction boxes with MCBs/TBs/ glands/ provisions for earthing, conduit pipes for aux supply cables above ground level up to junction box for street light poles, conduit pipes for cables above ground level up to luminaire for wall mounted lighting, casing/capping wherever applicable, GI earth wires, aux supply cables (multicore, 1.1kV, Al/Cu, PVC, armoured, PVC FRLS as per IS:1554, appropriate sizing) up to junction box, cables (1.1kV, Al/Cu, PVC, unarmoured, unsheathed, as per IS: 694, appropriate sizing) from junction box to luminaires, cable glands, cable lugs, termination hardware etc. Scope also includes civil foundation works for street lighting poles.

Cables shall be laid underground as per IS: 1255 with reference the section "**cable installation methodology**" of this specification. Cables shall be terminated at both the lighting end and LDB board end in respective inverter rooms.

Spacing between poles/lamps shall satisfy the lux requirements of the respective areas. AC supply shall be from the LDB distribution boards from the three inverter rooms/ main control room.

Vendor shall submit lux calculations, lighting layout, single line diagram for aux supply from LDB boards, GA drawings of lighting poles/ wall-mounted/ column-mounted/ fence-mounted systems, GA drawings of civil foundation for street light poles, bill of materials with make/ GTPs/ model number/ part number/ rating/ applicable IS standards/ quantity etc for BHEL/GACL approval during detailed engineering. For all the items, reputed brand shall be procured after approval from BHEL/GACL. Cable schedule shall also be submitted.

Vendor shall also supply 15-20W (230V) LED lamps for emergency purpose: (a) 4 Nos in electrical panel room of main control room, (b) 1 No each in battery room, office area, corridor.

Areas of plant lighting systems for vendor scope:

1. Street lighting poles (20 lux minimum)
   (a) By the side of peripheral boundary fencing of SPV power plant
   (b) By the side of pathways from inverter rooms to main control room

2. Street lighting poles/ wall mounted/ column-mounted/ fence-mounted systems as applicable (20 lux minimum)
   (a) on pillars of main entrance gate of power plant
   (b) in front of main control room (from main gate to control room)
   (c) for 33kV transformer yards of the three inverter rooms
   (d) for 66kV switchyard (~ 25m x 50m) attached to main control room

General technical requirements:

(1) All LED luminaires shall be supplied with proper diffuser to avoid direct visibility of LED with proposer thermal management for longer life.

(2) 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.

(3) LED luminaires shall meet the following parameters

1	Input voltage	170-260V
2	Input frequency	50 +/- 1 Hz
3	Power factor	0.95 minimum
4	Power efficiency	>96%
5	LED efficacy	>130 lumens per watt
6	Dispersion angle	Minimum 120 deg

7	Usage hours	Dusk to dawn
8	Total harmonic distortion	<15%
9	Working temperature	-5 deg to +50 deg C
10	Working humidity	10% - 90% RH (preferably hermetically sealed unit)
11	Index of protection level	Minimum IP65
12	Lamp casing	Powder coated metal/ Aluminium
13	Life	> 50,000 Hrs
14	LED type	Power LEDs from reputed make
15	Colour temperature	2800 deg K / 3000 deg K
16	Colour rendering	>75
17	Junction temperature	< 60 deg C
18	Electrical connector	Lead wire with 2m long (or) as required by customer at site
19	Expected life of components	Passive electronic components life greater than > 1,00,000 hrs
20	Moisture protection in case of casing damage	IP 65 (preferably totally encapsulated)

(4) Control gear specification

EN 61347-2-13: Particular requirements for DC/AC supplied electronic control gear for LED module
EN 62384: DC/AC supplied electronic control gear for LED modules

(5) Luminaire EMC specification

EN 61000-3-2: Electromagnetic compatibility (EMC). Limits for harmonic current emissions (Equipment input current < 16 A per phase)
EN 61000-3-3: Limitation of voltage fluctuation and flicker in low voltage supply systems for equipment with rated current < = 16 A

(6) Additional information for LED luminaire

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

The LED luminaire 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 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.

The luminaire should be provided with in built power unit and electronic driver. The luminaire should be should be so constructed to ensure that the gear and LED modules are replaceable, if required.

The luminaire should be suitable for both standard street light poles with a typical pole diameter of 50 mm – 60 mm and should be suitable for both side entry and bottom entry (post top).

(7) Junction Boxes, Conduits, Fitting & Accessories

Junction boxes for street lighting poles, lighting mast, wall-mounted, fence-mounted as applicable shall

	be deep drawn or fabricated type made of min 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55. All switches and receptacles up to 16A shall be modular type. These shall be provided with pre-galvanized/ galvanized modular switchbox & plate. Conduits, Pipes and Accessories Galvanized heavy duty steel conduits for normal area and galvanised heavy duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy duty steel conduits may be offered. Rigid steel conduits shall be heavy duty type, hot dip galvanized conforming to IS: 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside. Flexible conduit shall be water proof and rust proof made of heat resistant lead coated steel. Pull out boxes shall be provided at suitable interval in a conduit run. Boxes shall be suitable for mounting on Walls, Columns, Structures etc. Pull-out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes used outdoor shall be weather proof type suitable for IP55 degree of protection and those used indoor shall be suitable for IP52 degree of protection. Pull out box & its cover shall be hot dip galvanized. **(8) Lighting Poles** Street Light system and peripheral lighting shall be designed generally in line with design guidelines. Height of the poles should be chosen so as not to affect working of Solar panels. The maximum height of pole shall be 8 mtrs. The poles shall be hot-dip galvanized as per relevant IS: 2629/ IS: 2633/ IS: 4759. The average coating thickness of galvanizing shall be min 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS: 875 considering prevailing soil/ site condition considering all accessories mounting on pole. Street light poles shall have loop-in/ loop-out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB. Lighting fixtures shall generally be controlled from switchboxes of each area and not directly from lighting panel. **(9) Earthing** Lighting poles etc shall be earthed by two separate and distinct connections with earthing system. Distribution boards, junction boxes, lighting fixtures etc shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the ends.
5.29	**Earthing for solar array structures and SMBs** The solar array MMS structures, SMBs and various electrical equipments installed by the vendor shall be provided with appropriate earthing for protection against faults as guided by IEC 60364. The earthing system shall be designed with consideration of the soil resistivity of the project site. Unless otherwise

	specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed. The permissible system fault power level also shall be kept in consideration while designing the earthing system. Each array structure of solar PV yard, string monitoring boxes, other electrical equipments of module cleaning system viz pumps/ switchboards etc and all other metallic bodies shall be grounded properly as per IS 3043-1987 and Indian electricity act / IE Rules. The earthing electrodes for solar array shall be of 3m minimum long, 40 mm minimum diameter, perforated GI pipe, chemical compound filled, double walled. Each electrode shall be connected to the solar array earth mat grid. For each electrode, earth chamber shall be constructed using brick masonry. Electrodes shall be of reputed brand such as Ashlok, Balaji Metacast Industries or any other equivalent subject to BHEL/ GACL approval during detailed engineering. **Earth chamber shall have features as follows:** (a) Square sized with 450 x 450mm minimum inner opening. Exact size shall be chosen to ensure ease of maintenance operation using spanners etc. (b) Brick wall thickness all around = 230mm minimum (c) Depth of chamber = 500 mm minimum below FGL. (d) Projection of chamber above FGL = 150mm minimum (e) Top of electrode shall have minimum clearance of 100 mm below cover plate. (f) Cover plate, cast iron of 5mm minimum thickness, square shaped to fit the opening of chamber, painted with red oxide and two coatings of black paint. (g) Cover plate shall have suitable lifting hooks and padlocking arrangement. (h) Both the outer and inner walls of the brick wall shall be plastered and painted as per relevant civil works clauses of this specification. Supply and installation of all materials shall be in vendor scope. **Earth mat grid shall have following dimensions:** (1) Earth mat grid 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) Outer grid shall be with GI flat 65x8 mm minimum (3) Inner branches (along the solar array rows) with GI flat 25x3mm minimum (4) Inner branches shall be welded to outer grid (5) Electrode shall be bolted to a horizontal GI flat 25x6 that in turn bolted (M10 minimum) to two GI flat 25x6 raisers on either side of horizontal flat. Raisers shall be connected to outer grid of earth mat by way of welding. (6) Number of electrodes for solar array shall be decided based on earth mat design to obtain interconnected grid earth resistance less than 1 Ohm. (7) Earth mat design/ calculations as per IS: 3043 and IEEE 80, Indian Electricity Rules along with layout drawing for complete solar array shall be submitted for BHEL/GACL approval during detailed engineering. **Earthing of MMS structures shall be as follows:** (a) Solar array MMS structure shall be connected to Inner branch of earth mat using GI flat 25x3 mm minimum; Bolting on structure (M10 minimum), Welding on earth mat end.

	(b) Adjacent structures shall be connected to one another using GI flat 25x3 mm minimum. Both ends shall be bolted (M10 minimum). **Earthing of SMBs shall be as follows:** (a) Body of SMB structure shall be earthed using GI flat 50x6 mm minimum; Bolting on SMB structure end (M10 minimum) and welding on inner branch of earth mat grid. (b) SPD earth point shall be earthed using 1Cx16 flexible copper (unarmoured) green cable. Both ends of cable shall be suitably lugged and connected using matching hardware. (c) Data card of the SMB shall be earthed using 1Cx2.5 flexible copper (unarmoured) green cable. Both ends of cable shall be suitably lugged and connected using matching hardware. **General points:** (a) All items related to earthing viz electrodes, GI flats, hardware etc shall be in vendor scope of supply. (b) GI bolts, nuts, plain washers shall be used. Spring washers shall be zinc/epoxy coated. (c) 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) Welds shall be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection. (f) 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. (g) Other applicable standards: - IS: 2629: Recommended practice for hot dip galvanizing of iron and steel - IS: 2633: Method for testing uniformity of coating on zinc coated articles - IS: 6745: Methods for determination of mass of zinc coating on zinc coated iron and steel articles. - IS: 513: Cold rolled low carbon steel sheets and strips - IS: 3063: Fasteners single coil rectangular section spring washers 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, 33kV transformer yards** (1) Vendor shall supply, install and commission appropriate earthing for protection against faults as guided by IEC 60364 for the inverter rooms, main control room, 33kV transformer yards. (2) Earthing system shall be designed with consideration of the soil resistivity of the project site. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed. Permissible system fault power level also shall be kept in consideration while designing the earthing system. (3) Design calculations and layout of the earth mat grid with electrodes, to achieve earth mat grid resistance value of less than 1.0 Ohm for the individual rooms, shall be submitted for BHEL/GACL approval during detailed engineering. (4) Earthing electrodes shall be of 3m minimum long, 40 mm minimum diameter, perforated GI pipe, chemical compound filled, double walled. Bore holes of appropriate diameter shall be made on the earth for insertion of such chemical earthing electrodes with filling of mix of chemical

compound and water around. Number of earth electrodes per room, spacing between them, GI flat layout etc shall be based on design calculation. Make of electrode shall be Ashlok, Balaji Metacast or any other reputed equivalent subject to BHEL/GACL approval.

(5) Inverter rooms and main control room shall be provided with separate earth mat grids:
   (a) GI flats 65x8 minimum shall be laid underground cutting across the room from one end to the other and extending outward from both sides. These flats shall be at bottom level of internal cable trench.
   (b) GI flats 65x8 minimum shall be laid underground around the room and interconnected to the above cutting-across flats. The interconnection shall be by way of welding with full width overlapping.

(6) Earthing connections to electrical panels within the inverter room/ main control room:
Flats GI 65x8 minimum shall be provided for double earthing of PCUs, 33kV VCB panels, SCADA, UPS/ FCBC/ Battery banks, C&R panel, ABT metering panels, cable trays. However, if design calls for copper flats for PCUs, Cu flats 50x6 minimum shall be provided. For all DB boards and any other metallic bodies within the inverter room, earthing shall be by way GI flats or PVC insulated copper cables of appropriate size. GI/Cu flats shall be bolted on panel end and overlap welded to earth mat grid running internally. In case of cables, both ends shall be bolted for which the earth mat grid shall be drilled with matching holes.

(7) Earthing of inverter transformers in the transformer yards of inverter rooms/ Aux transformer in 66kV switchyard near main control room:
   (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 minimum.
   (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 using 50x6 copper conductor.
   (e) Neutral of aux transformer shall be connected to two earth pits using GI flat 65x8 minimum.
   (f) For both shield earthing and neutral earthing, heat-shrinkable insulation sleeve shall be provided around the earthing conductor.

(8) Transformer yard fencing shall be earthed at two different locations using GI flats 65x8 minimum. Gate shall be looped to the fencing mesh by way of GI wire of suitable size.

(9) Earth mat grid shall be buried underground up to a depth of 600mm minimum from FGL. 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) Earth chambers shall be constructed around electrodes as per relevant IS standards.
   a) Square sized with 450 x 450mm minimum inner opening. Exact size shall be chosen to ensure ease of maintenance operation using spanners etc.
   b) Brick wall thickness all around = 230mm minimum
   c) Depth of chamber = 500 mm minimum below FGL.
   d) Projection of chamber by 150mm minimum above FGL (for outside transformer yard) and, by 100mm minimum above stone jelly level (inside transformer yard).
   e) Top of electrode shall have minimum clearance of 100 mm below cover plate.

	f) Cover plate, cast iron of 5mm minimum thickness, square shaped to fit the opening of chamber, painted with red oxide and two coatings of black paint. g) Cover plate shall have suitable lifting hooks and padlocking arrangement. h) Both the outer and inner walls of the brick wall shall be plastered and painted as per relevant civil works clauses of this specification. i) Supply and installation of all materials shall be in vendor scope. (11) 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. **(12) Interconnection of earth mat grids of individual inverter rooms, main control room and solar array:** • Vendor shall interconnect each of the three inverter room earth mat grids to solar array earth mat grid at least at two nearest locations. • Vendor shall also interconnect the main control room earth mat grid to solar array earth mat grid at least at two nearest locations. **General points:** (a) All items related to earthing viz electrodes, GI flats, hardware etc shall be in vendor scope of supply. (b) GI bolts, nuts, plain washers shall be used. Spring washers shall be zinc/epoxy coated. (c) 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) Welds shall be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection. (f) 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. (g) Other applicable standards: - IS: 2629: Recommended practice for hot dip galvanizing of iron and steel - IS: 2633: Method for testing uniformity of coating on zinc coated articles - IS: 6745: Methods for determination of mass of zinc coating on zinc coated iron and steel articles. - IS: 513: Cold rolled low carbon steel sheets and strips - IS: 3063: Fasteners single coil rectangular section spring washers
5.31	**Lightning arrestor (ESE) system for protection of solar array/ inverter/control rooms** Supply, installation and commissioning of lightning arrestor (ESE) system for protection coverage of solar array, inverter rooms and the main control room shall be in vendor scope. **A. Lightning arrestor (ESE) with mast, counter and test link** 1) Solar array shall be protected from direct lightning stroke with Early Streamer Emission (ESE) air terminal as per NF C 17-102 (latest revision). Vendor scope of lightning protection coverage shall also include inverter rooms and control room. 2) Location and layout of ESE terminal (mounted on masts of appropriate size/height) shall be in such a manner that it does not cast shadow on the PV Modules during 08:30 AM to 04:30 PM. Quantity and locations of ESE air terminals (masts) shall be decided during detailed engineering. Make shall be ABB or other reputed equivalent subject to approval of BHEL/GACL approval. Design calculations for

	protection coverage, drawing showing layout with arrestor locations/ protection coverage/ bill of materials for the complete system shall be submitted for BHEL/GACL approval. 3) ESE air terminal shall be type tested in any national/international approved lab for advance triggering time (ΔT). Lightning Impulse current test and type test report shall be submitted for BHEL/GACL for approval. Each ESE air terminal shall be provided with separate earthling termination and test link for equipotential bonding of lightning protection system as per OEM guidelines/ NFC 17 - 102. Each ESE air terminal shall be equipped with lightning stroke counter to be fixed at suitable height in serial on the down conductor. 5) Mast of ESE air terminal shall be erected on isolated RCC foundation. Suitable guy wires shall be used to support the mast of ESE terminal against the wind. Drawing of foundation with design load calculations shall be submitted for BHEL/GACL approval. **B. Down Conductors** 1) Down conductors shall be as straight as practicable and shall follow a direct path to earth electrode. 2) Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be inaccessible to interference. Other than the direct connection to the earth electrode, no other connections shall be made below a test point. 3) All joints in the down conductors shall be welded type. 4) Lightning conductors shall not pass through or run inside GI Conduits. 5) Testing link shall be made of galvanized steel of size 25x6 mm. 6) Pulser system for lightning shall not be accepted. **C. Earth chambers for lightning arrestors:** 1) Three earth chambers shall be provided for each lightning arrestor. 2) Each down conductor shall be connected to individual earth pit as per required Standards. 3) Earth chamber shall be of brick masonry enclosure with cast iron cover plate (minimum 5mm thick) and having locking arrangement. 4) Earth electrode shall be of chemical earthing type of Ashlok or Balaji metacast or any other equivalent. These electrodes shall be the same type as those used for solar array earthing. **D. General points:** 1) The lightning conductor must ensure three zone protection level
5.32	**Water washing system for SPV modules (Module cleaning system)** 1) Vendor shall supply, install and commission permanent arrangement for module washing in the SPV Plant taking into account all related site conditions. 2) Vendor shall estimate the water requirements for cleaning the SPV modules at least once in every week at the rate of 1.5L consumption per module during every cleaning cycle. 3) The system shall essentially include the following minimum components: a) GACL will install a water pipeline for the water requirement during the O&M period of the plant for cleaning and other utilities purpose. b) Vendor shall install one of PVC water tank of reputed make for each Inverter room. The capacity of each tank shall not be less than 5000 L. The supply of these tanks shall be in vendor scope. The tank shall be installed on the RCC pedestal. The drawing of the pedestal shall be submitted for BHEL/GACL approval.

	c) Vendor shall connect the water pipeline laid by GACL (near the plant boundary) to these water tanks. Surface pump (booster pump) with pressure regulating tank of appropriate size/ rating shall be installed at every tank location. Suitable RCC civil pedestal and housing chamber shall be constructed for this arrangement. Chamber shall have necessary canopy (for prevention of water entry), door/lock provision, steel sections/ steel sheets to withstand wind load etc, corrosion protection painting, fasteners etc. Vendor shall submit drawings for BHEL/GACL approval during detailed engineering. d) Vendor shall employ armoured electrical cables of suitable size/rating for all electrical connections. Cables with cable accessories (glands/ lugs/ termination hardware etc) shall be in vendor scope of supply and installation. Cabling to the pumps shall be from DB panels in the nearest inverter/control rooms. Cables shall be laid underground as per IS: 1255. All cable terminations including the ones at DB panels shall be in vendor scope. e) In addition to operating from inverter/control rooms, outdoor type switch box with MCB etc shall also be provided to switch ON/OFF the pump directly from solar field. Such components shall be suitably mounted within the housing chamber. f) Water pressure gauge of appropriate size/rating shall be installed at every tank location. g) UPVC pipes as per relevant IS standards, heavy duty, 6 Kg/sqcm: pump suction/ header pipes (40NB minimum), Feeder pipes (25NB minimum). h) UPVC elbows, Tees, bends, couplers as applicable, as per relevant IS standards, for jointing and leak-proof pressurized pipe fittings. i) UPVC pipes shall be directly buried in ground at least 300mm below FGL. GI/ Hume pipes (75NB minimum) shall be used at road and drain crossings. j) UPVC raiser pipes with ball valves (25NB minimum, metal body, IS marked) and reducer nozzles for fitting hose pipes, at every delivery point. Every raiser pipe shall be fixed in the soil using concrete (PCC) pedestal construction with foundation depth of 200mm minimum. k) Delivery points shall be made available in the space between every two rows of solar array with max 30m spacing between delivery points. Accordingly, number of delivery points shall be provided for cleaning of the entire solar array. m) Air release valve fittings (metal body, IS marked) for feeder pipes at appropriate locations. n) Control gate valve for header pipes; for maintenance (IS marked) at appropriate locations. o) Control gate valve for feeder pipes; for maintenance (IS marked) at appropriate locations. p) Non-returnable valves (NRV) shall be provided wherever applicable. q) Hose pipes, heavy duty 25NB minimum: 10 rolls each of 50m (minimum) long r) All necessary hardware items such as GI clamps/ screws/ bolts/ nuts/ plain washers/ spring washers etc wherever applicable. s) Any other items as required to complete the technical/ operational requirements of module washing system. t) At road crossings and wherever heavy/impact load applicable, UPVC pipes shall be covered with higher diameter GI pipes for protection against such loads. u) Vendor shall design and submit the piping and instrumentation diagram P&ID of water washing arrangement including the physical sequence of branches, reducers, valves, pressure gauge, delivery points and location of pumps and water storage tanks for BHEL/GACL approval during detailed engineering. The diagram shall show locations of pipelines, valves, delivery points etc as superimposed on the solar array layout, Bill of materials (item-wise description, type / rating, make, model number / part number,

quantity) of water washing arrangement with necessary calculations of water flow / pressure / discharge etc for BHEL/GACL approval during detailed engineering.

15) All necessary labour, machinery, tools, instruments shall be in vendor scope.

5.33 Firefighting / detection/ alarm systems

a) 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. Make shall be Safex/ Ceasefire/ Vintex/ Unicare fire safety or any other reputed equivalent subject to BHEL/GACL approval.

- DCP type (ABC) 10 Kg designed/tested IS 15683 with safety release valve, NRV and CE approved valve. Dry powder IS 14609 with standard accessories.
- CO2 type Hand 9 Kg with wheel. Designed/tested IS 2878 complete with hose, screw valve, CO2 gas IS 1522, cylinder IS 7285, valve IS 3224. Tested at 250 Kgf/cm2.
- Foam type hand 9Kg, squeeze grip CO2 cartridge type, throw period 35s, range of Jet 6m, designed/tested IS:15683, Gas cartridge IS:4947.
- Hand portable pressurized water CO2 9 Ltr designed/tested IS: 15683, rubber hose, safety release valve, NRV and CE approved valve, throw of jet 6m.
- 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.

Quantity requirements:

	DCP type (ABC) 10 Kg	CO2 type Hand 9 Kg	Foam type hand 9 Kg	Hand portable pressurized water CO2 9 Ltrs	Sand buckets
Main control room CMCS	1	4	2	-	4
Each inverter room	1	2	2	-	2
Each transformer yard of inverter room	1	1	1	-	2
66kV Switchyard	1	2	2	-	4
Security room	-	-	-	2	2

b) Microprocessor based fire alarm system for inverter/ main control rooms

Vendor shall provide intelligent microprocessor-based main fire alarm panels of modular construction complete with central processing unit, input and output modules, power supply module, supervision control and isolator modules with 10% spare provisions.

Fire detection alarm system shall include but not limited to the following items:

(a) Fire alarm control panel
(b) Multi sensor smoke detector
(c) Hooter cum strobe
(d) Manual call point

(e) Hooter
(f) Fault isolation modules
(g) Control modules
(h) Cables from sensors to fire panels
(i) Digital output from fire detection system shall be integrated with SCADA (RS485 compatible)

Multi sensor type smoke detectors shall be provided below false ceiling areas of control room and inverter rooms. One sensor shall be provided for each 25 sqm of area.

Fire Alarm Control Panel Indication

(a) Alarm conditions shall be immediately displayed on the control panel. Alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged, LED shall remain lit. A subsequent alarm received from another zone after acknowledgement shall illuminate the alarm LED and the panel display shall show the new alarm information.
(b) During alarm condition, an alarm tone shall sound within the control panel until the alarm is acknowledged.
(c) If the audible alarm signals are silenced for any reason, they shall automatically resound if another zone is activated.
(d) All alarm signals shall be automatically "locked in" at the control panel until the operated device is returned to its normal condition and the control panel is manually reset.

Vendor shall submit integrated layout of fire detection/alarm system in the three inverter rooms and main control room along with Bill of Materials (make, mode number/ part number, quantity) etc for BHEL/GACL approval during detailed engineering. Make of the system shall be Hochiki/ Notifier or any other reputed brand subject to BHEL/GACL approval.

(1) Supply of all items (including cables, earthing items, hardware, miscellaneous items) in vendor scope.

5.34 Other safety related items

Vendor shall supply the following safety related items. Make / part number of each item shall be submitted to BHEL/GACL for approval prior to procurement.

1	Gas Mask	5 Nos
2	First Aid Box with essential medicines and bandage cotton, antibiotic cream, Dettol, etc.	1 set
3	Hand Gloves 33 KV for GOS operation	10 sets
4	Hand Gloves 1KV for Maintenance of SMB	10 sets
5	Discharge rod	5 Nos
6	Safety Helmet	20 Nos
7	Safety shoes	10 pairs

5.35 CCTV system/ cameras

a. CCTV cameras shall be supplied, installed and commissioned at main entry gate (covering all the entry/exit round the clock 24 hours), along plant perimeter (covering complete perimeter of plant area to capture all possible intrusions), inverter rooms/control rooms (covering entry/exit and activities within the rooms). Accordingly, to meet this requirement, number of cameras shall be

	proposed by vendor. Whereas the monitoring screen shall be installed in control room office, the cameras shall be provided at exact locations that will be finalized by BHEL/GACL during detailed engineering. b. 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. c. Camera shall be colour, suitable for day and night surveillance (even under complete darkness) and network compatible. d. It shall be possible to control all cameras i.e., PTZ auto/ manual focus, selection of pre-sets, 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. e. The system shall support video analytics in respect of the following: 1. Video motion detection 2. Object tracking 3. Object classification f. 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. g. Details of make, model number, part number, GTP, layout drawings showing camera locations, electrical scheme etc for BHEL/GACL approval during detailed engineering.
5.36	**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/GACL approval during detailed engineering for the following. (1) Solar array structures: 2715 Nos (2) String monitoring boxes: 180 Nos (3) Size/ source/ destination of DC cable 1Cx300 with arrow mark (power flow direction) to be painted on SMBs and PCUs (4) PCUs front side: PCU ID number (1-12) with rating 1250kW, AC chamber/ DC chamber, Danger text/symbol. (5) PCUs DC chamber back side: SMB ID numbers, cable size (1Cx300 +,-) with upward arrow mark, danger text/symbol (6) PCUs AC chamber back side: Inv Trnfmr ID, cable size (8Rx1Cx300 / 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/ N2 fire protection panel, ID number shall be painted. Cable size/ destination/ arrow marks not required to be painted as cable tags shall be adequate. (9) For all the plant lighting poles of power plant, ID numbers shall be painted. (10)For earth chambers of inverter rooms and main control room, ID number shall be painted. (11)All switchboards shall be painted with ID number. (12)Lightning arrestors (ESE)

5.37 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.

Vendor shall submit the respective schemes of marking and tagging for BHEL/GACL approval during detailed engineering.

5.38 Display boards and sign boards

1	Board displaying instruction chart for restoration from Electric Shock	4 Nos
2	Board displaying instruction chart for artificial respiration	4 Nos
3	Board displaying dos and don'ts.	4 Nos
4	Board displaying fire extinguishers details and operations	4 Nos
5	"No smoking" board	8 Nos
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	2 Nos
8	Danger boards: 33000V with danger symbol in Hindi, Gujrati, English	10 Nos
9	Identification boards, of suitable sizes, within and outside control room such as Inverter room 1, Inverter room 2, Inverter room 3, Main control room, Executive lounge, Store room, Gents toilet, Ladies toilet, SCADA room, Battery room, Pantry room etc. BHEL will provide list.	15 Nos

(a) 5mm thick sun board with LG make vinyl sticker (computerized cutting and pasting) shall be used for Sl Nos 5, 8 and 9.

(b) For others, flex banner with design & printing shall be used.

Note: In addition to the above, hoarding board for the overall power plant shall be fabricated in consultation with BHEL/GACL and installed at a suitable location near the main entrance gate of the plant.

5.39 Electrical insulation mat

(1) Vendor shall supply electrical insulating mats as follows:

- (a) Reputed make as shall be approved by BHEL/ GACL
- (b) As per IS: 15652:2006
- (c) Class B
- (d) Thickness 2.5 mm minimum
- (e) Size = 2m x 1m minimum, exact size shall be as approved by BHEL/GACL during detailed engineering.
- (f) Colour: to be approved by BHEL/GACL
- (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.

5.40 Checkered plates

Vendor shall supply and install checkered plates made of MS for closing the cable trenches (a) behind/ in front, as applicable, of the panels such as PCUs, LT panels, ACDB panels etc in inverter rooms / main control room to cover up the cable trench and also (b) all other open trench areas.

(1) MS plates shall have a suitable handle (welded to the plate) to facilitate ease of lifting and movements.
(2) Plate thickness = 6 mm minimum
(3) Width and length of checkered plates shall be selected so that the cable trenches are neatly sealed without any gaps.
(4) Plates shall be red oxide coated followed by black painting.
(5) BHEL/GACL approval shall be obtained for overall arrangement of checkered plate.

5.41 Air conditioner

(1) Air conditioner (3Nos) of split type for SCADA room, supervisor room,
(2) Size / capacity shall be selected based on the room size and shall be approved by BHEL/GACL.
(3) It shall be of reputed make as shall be approved by BHEL / GACL/

5.42 Tool kits and instruments

Vendor shall supply the following tool kits and measuring instruments:

A. Measuring instruments

1	Digital Earth Resistance Tester	Cambridge Instruments	DET-2000	2 Nos
2	Digital multimeter	Reputed make		2 Nos
3	AC-DC Clamp Meter Amp range	Lutron	DM-6506	2 Nos
4	AC-DC clamp meter mA range	Lutron		2 Nos
5	Thermometer, Laser Beam	Fluke	62 Mini	2 Nos
6	Digital thermometer (wall hanging)	Reputed Make		2 Nos
7	Digital megger – 5KV type	Reputed Make		2 Nos
8	Electrical Tester	Reputed Make		2 Nos

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

B. Tool kits

1	Double ended spanner Set of sizes 10-11, 12-13, 14-15, 16-17, 17-18	2 Nos each
2	Screwdriver Set	1 Set
3	Crimping tool with Dye range 50-400sq-mm cable, mechanical gear power, hand operated	1 Set
4	Crimping tool up to 6 sq-mm cable	1 set
5	Drilling machine AC, hand operated, with bit size up to 20 mm	1 set
6	Measuring Tape, 5m	2 Nos
7	Measuring Tape, 50 m	2 Nos
8	Allen Key set	1 Set
9	Adjustable spanner 2-inch size	1 No
10	Hammer	2 Nos
11	Rough file kit	1 Set

	12	Platform balance, 50Kg range, 100g accuracy	1 No
	13	Cutting Pliers	2 Nos
	14	Nose Pliers	2 Nos
	15	Vacuum cleaner, of industrial type, for control room sweeping / cleaning.	1 No
	16	Blowers for cleaning the panels	2 Nos

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

5.43 General specification of LT cables

(1) LT power and control cables

LT Power & control cables shall be of minimum 1100 volts grade XLPE / PVC insulated conforming to IS 1554 for utilization voltages less than equal to 415 V.

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 the cables shall conform to the requirements of the following standards and codes:

IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltagesupto and including 1100V.
IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.
IEC-332	Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

(2) LT power cables

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.

All cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

If cables are to be laid underground, laying shall be as per latest relevant IS code.

Copper/aluminium conductor used in power cables shall have tensile as per relevant standards. Conductors shall be stranded.

XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C.

PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

For single core armoured cables, armouring shall be of copper/aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanised steel as follows:

Sl	Calculated nominal dia of cable under armour	Size and Type of armour
i)	Upto 13 mm	1.4mm dia GS wire
ii)	Above 13 upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii)	Above 25 upto 40 mm	0.8mm thick GS formed wire / 2.0 mm dia GS wire
iv)	Above 40 upto 55mm	1.4 mm thick GS formed wire/ 2.5 mm dia GS wire
v)	Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
vi)	Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm mm^2 per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel.

The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wire / formed wire.

Outer sheath shall be of PVC as per IS: 5831 & black in colour for power cables. In addition to meeting

all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

(a.) Oxygen index of min. 29 (as per IS 10810 Part-58).

(b.) Acid gas emission of max. 20% (as per IEC-754-I).

(c.) Smoke density rating shall not be more than 60 % (as per ASTMD-2843).

Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue and Black

For reduced neutral conductors (in case of power cable), the core shall be black.

In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

(a) Cable size and voltage grade - To be embossed

(b) Word 'FRLS' at every 5 metre - To be embossed

(c) Sequential marking of length of the cable in metres at every one metre -To be embossed / printed

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum, over the declared value in the technical data sheets.

Repaired cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

Cable selection & sizing

Cables shall be sized based on the following considerations:

(a) Rated current of the equipment

(b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage

(c) Short circuit withstand capability

This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the letout energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the

system fault current level for total breaker tripping time inclusive of relay pickup time.

De rating Factors

De rating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

a) Variation in ambient temperature for cables laid in air

b) Grouping of cables

c) Variation in ground temperature and soil resistivity for buried cables.

Cable lengths shall be considered in such a way that straight through cable joints are avoided.

Cables shall be armoured type if laid in switchyard area or directly buried.

All LT power cables of sizes more than 120 sq.mm shall be XLPE insulated.

CONSTRUCTIONAL FEATURES for LT Power Cables

1.1 KV grade XLPE power cables shall have compacted aluminium/ copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), armoured/ unarmoured, PVC outer-sheathed conforming to IS:7098. (Part-I). Cables which are directly buried shall be armoured.

1.1KV grade PVC power cables shall have aluminium/ copper conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) armoured/ unarmoured, PVC outer-sheathed conforming to IS:1554 (Part-I).

CONSTRUCTIONAL FEATURES for LT control cables

1.1 KV Grade Control Cables shall have stranded copper conductor and shall be multicore PVC insulated, PVC inner sheathed, armoured / unarmoured, FRLS PVC outer sheathed conforming to IS: 1554. (Part-I).

1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene PropylineRubber(EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathedwith heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968. Minimum conductor size shall be 2.5 sqmm.

TESTS

Indicative list of tests / checks, routine and acceptance tests shall be as per Quality Assurance and Inspection table of LT power cables enclosed at relevant section.

All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the cable price.

All cables to be supplied shall be of type tested design.

During detailed engineering, the contractor shall submit for BHEL/GACL approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to BHEL either at third party lab or in presence of BHEL/GACL representative and submit the reports for approval.

The type test reports once approved for any projects shall be treated as reference. Minor changes if any shall be highlighted on the endorsement sheet.

The reports for following type tests shall be furnished:

Sl	Type Test	Remarks
	Conductor	
1.	Resistance test	
	For Armour Wires / Formed Wires	
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	
5.	Torsion test	For round wires only
6.	Wrapping test	
7.	Resistance test	
8(a)	Mass & uniformity of Zinc Coating tests	For GS wires/formed wires only.
8(b)	Adhesion test	For GS wires/formed wires only
	For XLPE insulation & PVC Sheath	
9.	Test for thickness	

10.	Tensile strength and elongation test before ageing and after ageing	
11.	Ageing in air oven	
12.	Loss of mass test	For PVC outer sheath only.
13.	Hot deformation test	For PVC outer sheath only.
14.	Heat shock test	For PVC outer sheath only
15.	Shrinkage test	
16.	Thermal stability test	For PVC outer sheath only
17.	Hot set test	For XLPE insulation only
18.	Water absorption test	For XLPE insulation only
19.	Oxygen index test	For PVC outer sheath only
20.	Smoke density test	For PVC outer sheath only
21.	Acid gas generation test	For PVC outer sheath only
22	Flammability test as per IEC-332 Part-3 (Category -B)	For completed cable only
23	Insulation resistance (volume resistivity method)	
24	High voltage test	

(3) LT control cables

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.

All cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

Conductor of control cables shall be made of stranded, plain annealed copper.

Outer sheath shall be of PVC as per IS: 5831 & grey in colour for control cables.. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

(a) Oxygen index of min. 29 (as per IS 10810 Part-58).

(b) Acid gas emission of max. 20% (as per IEC-754-I).

(c) Smoke density rating shall not be more than 60 % (as per ASTMD-2843).

Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue and Black

For control cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.

In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

(a) Cable size and voltage grade - To be embossed
(b) Word 'FRLS' at every 5 metre - To be embossed
(c) Sequential marking of length of the cable in metres at every one metre -To be embossed / printed

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

All cables except module inter-connecting DC cable shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

Repaired cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

Cable selection & sizing

Control cables shall be sized based on the following considerations:

(a) The minimum conductor cross-section shall be 1.5 sq.mm.

(b) The minimum number of spare cores in control cables shall be as follows:

No. of cores in cable	Min. No. of spare cores
2C, 3C	NIL

	5C	1
	7C-12C	2
	14C & above	3

CONSTRUCTIONAL FEATURES for LT control cables

1.1 KV Grade Control Cables shall have stranded copper conductor and shall be multicore PVC insulated, PVC inner sheathed, armoured / unarmoured, FRLS PVC outer sheathed conforming to IS: 1554. (Part-I).

(4) Cable Drums

(a) Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. However, for single core cables up to 6 sqmm size, supplier can do alternative packaging of whole drum/spool to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

(b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stenciled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

5.44 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 galvanising 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 upto 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 alongwith 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, hardwaresfitings 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.

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

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

c) 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.

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

e) 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, H.T. 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.

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

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

h) 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.

i) 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.

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

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

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

m) 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

b. Segregation means physical isolation to prevent fire jumping.

c. All cables associated with the unit shall be segregated from cables of other units.

d. 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.

e. 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.

	f) All cable terminations shall be appropriately tightened to ensure secure and reliable connections.
5.45	**General civil works** This section describes the technical requirements of various civil works related to this specification such as design mix for concrete, brick masonry/ plastering/ painting etc for earth chambers, RCC foundation for transformers, foundation for security room/ watchman cabin/ street lighting poles, , transformer yard fencing works / gate etc. **1) Concrete/ RCC Works** All RCC works shall be with design mix as per IS: 456 and the materials used viz. Cement, coarse & fine aggregate, Reinforcement steel etc. shall conform to relevant BIS standards. The contractor shall carry out concrete mix design well in advance prior to construction through NABL accredited laboratory/ Reputed Engineering Institute (IITs/NITs/ Government Engineering Institutes only). The minimum grade of RCC shall be M25 except for underground (UG) water tank where the grade of concrete shall be minimum M30. PCC shall be of min. grade M10 (equivalent nominal Mix – 1:3:6) unless otherwise specified. Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383. Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116 Reinforcement steel shall be of high strength TMT bars of grade Fe500 D conforming to IS: 1786. Ductile detailing in accordance with IS: 13920 shall be adopted for superstructure and sub-structure of all RCC buildings and structures. For grouting works anti shrink ready mix grout of approved make or cement mortar (CM) grout with non-shrink additive shall be used. The grout shall be high strength grout having min. characteristic strength of 30 N/ mm2 at 28 days. Foundation system shall be made to transfer loads safely to the soil for structures such as lightning arrestors etc, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. No foundation allowed on back filled soil and the foundation depth to reach up to NGL.

All loads shall be considered in line with IS: 875. Seismic loads for design shall be in accordance with IS: 1893 and relevant Standards.

IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete

IS: 5525 and SP: 34 shall be followed for reinforcement detailing.

A minimum 75 mm thick PCC shall be provided below RCC wherever RCC is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS: 456.

2) Masonry Works

Brick work shall be in cement mortar (CM) 1:6 & 1:4 for 230 mm and 115 mm thick brick wall respectively.

Bricks shall be of class designation 7.5 conforming to IS: 1077, IS: 2212 & IS: 3495.

All concrete blocks shall be of min. compressive strength of 7.5 N/mm2 and shall be of Grade-A conforming to IS: 2185.

Bricks/blocks required for masonry work shall be thoroughly soaked in clean water tank for approximately two hours. Brick shall be laid in English bond style. Green masonry work shall be protected from rain. All masonry work shall be kept moist on all the faces for a period of seven days.

Suitable damp proof course (DPC) shall be provided.

The DPC shall be with PCC (1:2:4) using 6 down coarse aggregate and water proofing admixture. The min. thickness of DPC shall be 40mm

3) Plastering, Pointing & Coping Works

All brick masonry work shall be provided with plaster.

Wall and ceiling plaster shall be in cement mortar (CM) – 1:6 and 1:3 respectively. Thickness of plaster shall be 18mm and 12mm for rough and smooth surface of the brick wall respectively. The ceiling plaster shall be 6mm thick.

All joints in stone masonry shall be raked and pointed in cement mortar (CM) – 1:3 except specified otherwise. Exposed top surface of brick or stone masonry shall be provided with 50 thick plain cement concrete (PCC) coping (1:2:4) with trawl finish. All exposed coping shall be provided with suitable slope and projection for easy drainage of water.

4) Foundation calculations

The foundation system shall be made to transfer loads safely to the soil for the various structures, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope

stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. No foundation allowed on back filled soil and the foundation depth to reach up to NGL.

All loads shall be considered in line with IS: 875. Seismic load for design shall be in accordance with IS: 1893 and relevant Standards.

IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete
IS: 5525 and SP: 34 shall be followed for reinforcement detailing.

A minimum 75 mm thick PCC shall be provided below RCC wherever RCC is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS: 456.

5) Design Loads

Unless otherwise specified elsewhere, Dead load, Live load, Wind load and Seismic load for buildings and structures shall be considered as per provisions of relevant IS standards.

The following minimum imposed load as indicated for some of the important areas shall, however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered.

#	Area	Imposed Load
a	Roof	150 kg/ Sqm
b	Building floors	1000 kg/ Sq
c	RCC Floors (General)	500 kg/ Sqm
d	Outdoor platforms, Stairs, Landing/ Balconies, Walkway, Chequred plate & Grating floor	500 kg/ Sqm
e	Road	As per IRC Standard
f	Road culverts & allied structures over drain & pipe crossings	Design for class -'AA' loading (Wheeled & Tracked both) and check for Class – 'A' loading as per IRC Standard
g	Underground structures such as Sumps, Pits, Trench, Drain etc.	In addition to Earth pressure and Ground water table at FGL, a surcharge of 1 T/Sqm shall also be considered
h	Pre-cast cover over cable trench	400 kg/ Sqm

Primary Loads

1. Dead Load (DL)
2. Live Load (LL)
3. Wind Load (WL) – Both along X & Z directions
4. Seismic Load (EL) – Both along X & Z direction

Design Load combinations

1. DL+LL
2. DL+LL ± WLx
3. DL +LL± WLz
4. DL+LL ± ELx
5. DL+LL ± ELz

All buildings, structures and foundations shall be designed to withstand loads corresponding to worst design load combinations. Unless otherwise specified elsewhere in the specifications, the DL, LL, WL and EL shall be estimated as per provisions of relevant BIS standards.

Wind Load Factors K2, K2 and K3 – As per IS 875 (Part-3). However, minimum value for K1, K2 and K3 shall be 1.0.

Unless otherwise specified elsewhere in the specifications, the Seismic Load shall be considered corresponding to Earth quake zone at site as per IS: 1893 – (Part- 4)

6) Structural Steel

All structural steel shall design shall carried out as per IS 800. Structural steel shall conform IS 2062, Pipe shall be as per medium/high grade of IS 1161, Chequered plates shall conform to 3502 and Hollow steel sections for structural use shall conform to IS: 4923.

7) Grouting

Cement mortar (1:2) grout with non-shrink additives shall be used for grouting below base plate of column. The grout shall be high strength grout having a minimum characteristic compressive strength of min 30 N/mm2 at 28 days. The grout shall be chloride - free, cement based, free flowing, non-metallic grout.

8) Transformer yards / transformer foundations / oil pits / fencing / gate

i. Transformer and equipment foundations shall be founded on piles/isolated spread footings depending on the final geotechnical investigation report.
ii. Transformer foundations shall have its own pit which would cover the area of the transformer and cooler banks, so as to collect any spillage of oil or oil drainage in case of emergency. The oil pit shall be filled with granite stone gravel of 40 mm size uniformly graded. The retention capacity of the transformer pit shall be min. 1/3 volume of the transformer oil which is filled with gravel with 300mm free space above gravel fill. The individual transformer oil pit shall be connected to an oil collection pit which shall be sized to accommodate full oil volume of the transformer connected to it, without backflow. The oil collection pit shall be connected to oily water drainage system. Dimensions of the discharge pipe shall consider rainfall intensity also. The water shall be discharged into the nearest drain by gravity flow or pumping. Both, the transformer pit and the oil collection pit shall be of RCC. The oil collection pit shall be provided with RCC cover.
iii. Transformer track rails shall conform to IS: 3443.
iv. The switchyard area around the transformer and other equipment shall be covered with gravel.

v. Transformer yard fencing / gate

a) The area shall be provided with galvanized chain link fence of height min 1.8 m with gate. The fencing shall be of GI chain link mesh fabric, max. mesh size 40x40mm (minimum wire gauge 3.15mm), both ends twisted conforming to IS 2721 with suitable internal, corner and stay posts of GI angles along with 230 thick brick/ 300 thick RR masonry toe wall, 150mm height above GL.

b) The brick masonry toe wall shall be plastered with 15 thick CM (1:4) plaster on both faces and shall have min. 50 thick PCC (1:2:4) coping finished smooth and projecting 40mm on either side of the wall and top sloping inwards.

c) Minimum size of angle for internal, corner and stay post shall be 50x50x6 mm. Spacing of intermediate posts shall not be more than 2.5m. Every 10th intermediate post shall be provided with a stay post along fence and every corner post shall be provided with two stay posts along either side fence. The Main entry gate shall of rugged design with GI steel sections. The gate shall be complete with MS flat guide track, castor wheel(s), all fittings and fixtures like hinges, aldrop, locking arrangement, posts etc.

d) The Gate of size (width) 3.5m shall be of MS pipe frame with welded wire fabric mesh including all accessories and fittings. MS angle posts shall conform to IS: 2062. The portion of the fence covering towards rail track shall be made of removable type for movement of transformer during erection /removal.

e) In addition, a small gate, 1.2 m wide shall be provided for main entry for maintenance purpose. The transformer yard/ switchyard fencing work shall conform to CEIG requirements.

5.46 Pre-commissioning inspections/ checks/tests, MRT tests, coordination/liaison with state /central departments/CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning:

#	Scope description
1	Pre-commissioning inspections / checks / tests, MRT tests and coordination / liaison activities with state / central departments / Transco/ DISCOM/ CEIG 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 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, ABT metering panel, 33kV VCB panels, 33kV LV side of 16MVA transformer, SCADA panels.. 2) Terminations of Control/ Instrumentation/ Data/ Communication cables wherever applicable. 3) Terminations of earthing at all electrical equipments/ 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 (6 Nos, 2.7MVA) and Aux transformer (1 No, 200kVA)
					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. 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	Indoor CTs 33kV
					1) IR tests (all cores): Pri-Sec, Sec-Sec, Pri-E, Sec-E 2) Ratio tests / primary injection
				B4	Indoor PTs 33kV including Bus PTs
					1) IR tests (all cores): Pri-Sec, Sec-Sec, Pri-E, Sec-E 2) Voltage ratio test 3) Polarity test

				B5	Indoor VCB breakers 33kV
					1) IR tests 2) Contact resistance measurement (CRM) 3) Timing test: close/ open/ close-open 4) Functional checks: breaker open/close, spring-charged motor 5) Remote operation from SCADA panels: open/close, command/status, lamp indications
				B6	Numerical relays at VCB 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 STU 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. ABT meters iii. Protection relays
				B8	ACB breaker settings (with the help of PCU service engineer at site)
					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 bank
					1) All functional checks: battery charging/ discharging, FCBC/ battery output parameters etc as per OEM checklists
			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 66kV 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 above approvals rests with the above said upstream contractor of BHEL. However, wherever technical clarifications are required by the approving agencies with regard to SPV portions (including solar array) up to 33kV side of 16MVA 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 vendor.

					3) For solar array details including earth mat grid, module cleaning system, lightning arrestors etc, vendor shall suitably coordinate with the respective downstream contractor of BHEL for mobilization of inputs from them necessary for the approval process. 4) Following are the areas of approval, as applicable, for the SPV-side portions including solar array and up to 33kV side of 16MVA transformer. (a) Schemes/ layouts/ calculations such as earth mat design, solar array layout, lighting arrestor layout, module cleaning system, cable trench layout, plant lighting system, fire alarm system etc. (b) GTP/ datasheets/ GA drawings/ Bill of materials, MQP etc of supply items. (c) GA drawings of installation such as foundation/ oil pits of inverter transformers / auxiliary transformer etc. (d) Factory test reports of supply items including BHEL-supplied items. (e) Site test reports of transformers, transformer oil, VCB breakers, CTs, PTs, ABT meters, resistance of earth mat grids etc (f) 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. (g) Interaction/ coordination with customer (GACL) in the above process as and when required. (h) 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. (i) Subsequent to site inspection by the concerned agency, vendor shall support the 66kV contractor in following-up with them to obtain their clearance for line charging/ grid synchronization. (j) Vendor shall implement all the observations of CEIG related to SPV-side portion including solar array and up to 33kV side of 16MVA transformer.
			E	Commissioning of power plant	
					1) Vendor shall organize presence of an electrical consultant at site at the time of commissioning with no additional charges to BHEL. The consultant shall have adequate expertise in the form of knowledge/ experience in this field. He shall be able to guide the site team on the steps/ procedure/ precautions to be adopted during commissioning. Also, he shall be cable of extempore trouble-shooting in case of any technical problems encountered on SPV portions up to 33kV side of 16MVA transformer. Vendor shall submit credentials of the proposed consultant for BHEL/GACL approval prior to awarding of work/ availing their service.

						2) Vendor shall organize all necessary tools/ measuring instruments required to operate the various electrical equipments 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). 3) It is the responsibility of the vendor to interact technically with upstream/ downstream contractors for successful charging of 66kV grid line followed by charging of 33/66kV transformer at SPV plant end and grid synchronization of inverters/ plant commissioning. 4) Vendor shall participate actively in the commissioning until it is established that there is successful export of power from all the PCUs and through the 66kV transmission line/ switchyards of power plant.

5.47 Spares required to be supplied along with main consignment:

1) 33kV termination kits: 5 Nos each type
2) 33kV straight through jointing kit: 3 Nos each type
3) Fuses of all types: 10% of total population of respective items
4) MCCB, MCB of all types: 10% of total population of respective items
5) Indicating lamp set of all types: 10% of total population of respective items
6) Surge protection devices/ MOV: 10% of total population of respective items
7) Plant lighting LED lamps: 5% each type.
8) 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

Notes:
(a) 1 set refers to total quantity of the item used in one transformer.
(b) In case percentage is a decimal figure, it shall be rounded up to next higher integer.

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

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 300 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. List of instruments shall be mentioned in the offer.
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	65% of the jobs created due to the project in the supervisory and managerial cadres & 80% 0f the jobs that will be created in other cadres shall be filled in by employing local persons. "the expression Local person shall mean a person domiciled in Gujarat State for 15 years prior to applying for employment to vendor
6.14	Before engaging the labour in to work, vendor should get the NOC from labours' native police station as well as NOC from Santhalpur, Gujarat police station
6.15	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.
6.16	No child labour shall be employed for execution of the present contract.
6.17	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.
6.18	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.
6.19	BHEL/GACL 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/GACL for procurement of the item from dealers.
6.20	Field Quality Plan / Quality control system 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/GACL. 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/GACL 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/GACL.
6.21	Any deviations shall be discussed with BHEL/GACL site engineers and implementation shall be taken up only after approval from BHEL /GACL.
6.22	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.
6.23	Vendor shall, as and when required by BHEL/GACL, participate in the review meetings conducted by BHEL/GACL at project site, BHEL-EDN (Bangalore), BHEL-Corporate office (New Delhi), GACL office (Vadodara) etc.
6.24	**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.

7.0 Operations and Maintenance

7.1	**Date of commencement of operations and maintenance** Zero date for O&M shall be the actual date on which the power plant is commissioned with synchronization of PCUs to grid / export of power for full 15MW (AC). O&M shall be for 10 years with scope of SPV portions on the solar plant end including solar array up to 33kV side of 16MVA transformer.
7.2	O&M personnel 1. Vendor shall deploy following minimum personnel: (a) Technical / administrative / office personnel • One technical-cum-administrative in-charge having graduation in electrical/ electronics engineering and experience with overall responsibility for complete plant operations. The in-charge shall have competence to deftly handle technical and operational / crisis problems. • Six working level staff with ITI / diploma level qualifications in engineering with competence for operating electrical/ electronics/ mechanical equipment, taking measurements, data logging / maintaining registers, preparation of reports in computer. • Eight unskilled persons for regular house-keeping (cleaning / mopping etc) and water cleaning of SPV modules. • **Note:** At least one among the technical personnel shall essentially be a certified / licensed person for HT operations (33kV minimum). This is a mandatory requirement. (b) Security personnel • Minimum 6 security guards with competence to handle tough situations and safeguard the plant from miscreants. • Among these, two shall be deployed during night shift,two during morning shift and two during evening shift.

2. Vendor shall provide uniforms for the O&M staff.

3. Similarly, O&M personnel shall be provided with raincoats, toolsets, earthing rods, safety gloves, safety goggles, gumboots, helmets and all other personal protective equipment (PPE) that will be relevant to ensure human safety.

4. Names, qualification, work responsibility of personnel shall be listed on a display board within control room.

5. Attendance register shall be maintained for both the teams.

6. Vendor shall ensure statutory requirements such as ESI, PF and labour license for their O&M personnel posted at site.

7. BHEL/GACL shall have right to disallow any O&M employee, if found unfit to perform. BHEL instructions issued in writing shall be binding on vendor who shall replace the person.

8. O&M personnel at site shall conform to general regulations in force at site and to any special instructions from GACL administration.

9. O&M personnel at site shall be deemed to be aware of damages and risks incidental to conditions of ordnance factory (OFMK) land & works from time to time and BHEL/GACL shall not be responsible for any injury to personnel arising there from.

10. Training to O&M personnel
    It is the absolute responsibility of vendor to ensure imparting of necessary training to their O&M personnel to get them acquainted with the operations of various electrical and mechanical equipment of the power plant. For this purpose, vendor shall identify the O&M personnel well in advance and involve them during installation and commissioning stages so that they become well versed with various functional aspects of the power plant.

11. Availability of O&M personnel at power plant
    (a) Vendor shall ensure that operating staff are present in the power plant during 7:30 AM – 6:30 PM every day.
    (b) Vendor shall ensure that certain minimum operating staff are present at the power plant even on festivals, public holidays and any other unique occasions so that the plant is run under competent supervision on all days.

12. O&M personnel shall, strictly, not use any part of the power plant for their personal / residential purposes. Their presence at the plant shall, strictly, be meant only for the purpose of operation and maintenance of plant.

7.3	Responsibility of vendor during PG test Vendor shall, in addition to the O&M activities (as per this specification), carry out the Performance Guarantee test (PG test) that commences on a date (as mutually decided by BHEL/GACL) after successful completion of initial acceptance test that is carried out for 7 continuous days and evaluated with reference to performance ratio (PR). PG test is the final acceptance test (conducted for a period of 30 days as decided by GACL within the O&M period) to prove the performance of the power plant with reference to PR Vendor shall carry out the following activities during this period: 1. O&M activities as per this specification 2. Monitoring of power plant parameters as per SCADA reports 3. Reporting power plant parameters to BHEL/GACL on daily basis
7.4	O&M operations – daily basis (1) Water cleaning of SPV modules (2) Inverter room / main control room cleaning – dry sweeping, wet mopping (3) Water wash cleaning of toilets, urinals (4) Gardening of landscaping areas: watering of plants, trimming of plants as applicable and necessary. (5) Logging of DC, AC, grid parameters (current, voltage, power, energy) at PCUs & VCB panels, transformer temperatures, equipment tripping/ breakdown, grid outage etc as per BHEL formats. (6) SCADA data station / PC operations for daily monitoring of weather parameters, trend graphs and urgent reporting to BHEL/GACL in case of any problems / anomalies observed with any of the parameters. (7) Drinking water to be arranged for O&M personnel at site.
7.5	O&M activities – weekly basis (1) Removal of garbage from solar array field, switchyard, roads, drains, pathways, sand buckets; logging in registers with signatures of operating persons and in-charge. (2) Monitoring and logging of fire extinguisher levels / pressures as per BHEL formats
7.6	O&M activities – monthly basis (1) Inspection of fire extinguishers (weight, pressure indication, physical status etc) followed by refilling actions, if necessary, based on indications. Report to be submitted as per BHEL approved recording formats. (2) Earthing resistance measurements for solar array structures, control room equipment, switchyard equipment, lightning arrestors: measured values shall be recorded in registers and reported to BHEL as per BHEL approved recording formats. (3) Submission of values / status of plant parameters and events for the corresponding month, as below, as per BHEL approved formats: a. Daily values of solar array strings (SMB parameters) b. Daily values of weather parameters (solar energy, wind speed, ambient temperature) c. Daily energy generation d. Events (with date, time) of faults / tripping / breakdown of equipment e. Events (with date, time) of grid outage f. Events (with date, time) of equipment damages, accidents and thefts

	g. Activities of module cleaning (4) Monthly reports shall be submitted to BHEL for all the above data. (5) Energy generation / meter reading report to be prepared and submitted to the concerned department. Signatures from GACL representatives shall be obtained wherever required.
7.7	O&M activities - quarterly basis (1) Cleaning of PCUs, LT panels, VCB panels, UPS panels etc to remove accumulated dust. (2) Monitoring and status review, followed by rectification/ calibration/ replenishment/ replacement actions as necessary and applicable for following: (a) Spare items of all electrical equipment (b) First aid box items - medicines and accessories (c) Safety gadgets (d) Tool kits and measuring instruments (e) Yard lights (f) Pumps, starters (g) Control room appliances: air conditioners, lights, fans, exhaust fans, switch boards etc (3) Pest control for control room (rats, snakes etc) – sprays, chemicals, medicines etc to be applied wherever required. (4) Submission of quarterly report on above activities to BHEL.
7.8	O&M activities – half yearly basis (1) Cleaning of water storage tanks (2) Tilting of Module mounting structures at specified angles
7.9	O&M activities – yearly basis (1) BDV measurements for oil samples from all transformers and submission of report to BHEL/ GACL. (2) Filtration of oil to be arranged, if required, based on BDV measurement report. (3) Lubrication of moving contacts (VCBs etc) with appropriate grease etc (4) Cleaning of sewerage lines, septic tanks (if found necessary) (5) Painting of main gate, switchyard gate / fencing, earthing chambers, other steel structures within control room and switchyard if required based on conditions of rusting etc. (6) Checking tightness of hardware in solar array structures and tightening wherever required. (7) Checking tightness of power cable terminations in SPV modules (MC4), SMBs, electrical panels of control room and switchyard.
7.10	O&M activities - as and when required (contextual basis) (1) Monitoring and operation of plant electrical equipment as and when required: (a) VCB on/off: local operations from outdoor VCB panel and remote operations from SCADA system. (b) Settings of numerical relays in VCB panels: review and revision in consultation with BHEL. (c) ACB and MCCB on/off operations on LT side (d) PCU operations: emergency close, LCD displays (selection of settings, monitoring the DC/AC/event/fault status parameters), operation of duct fans (e) UPS panels and Battery bank operations (f) Booster pump operations to fill the water storage tanks

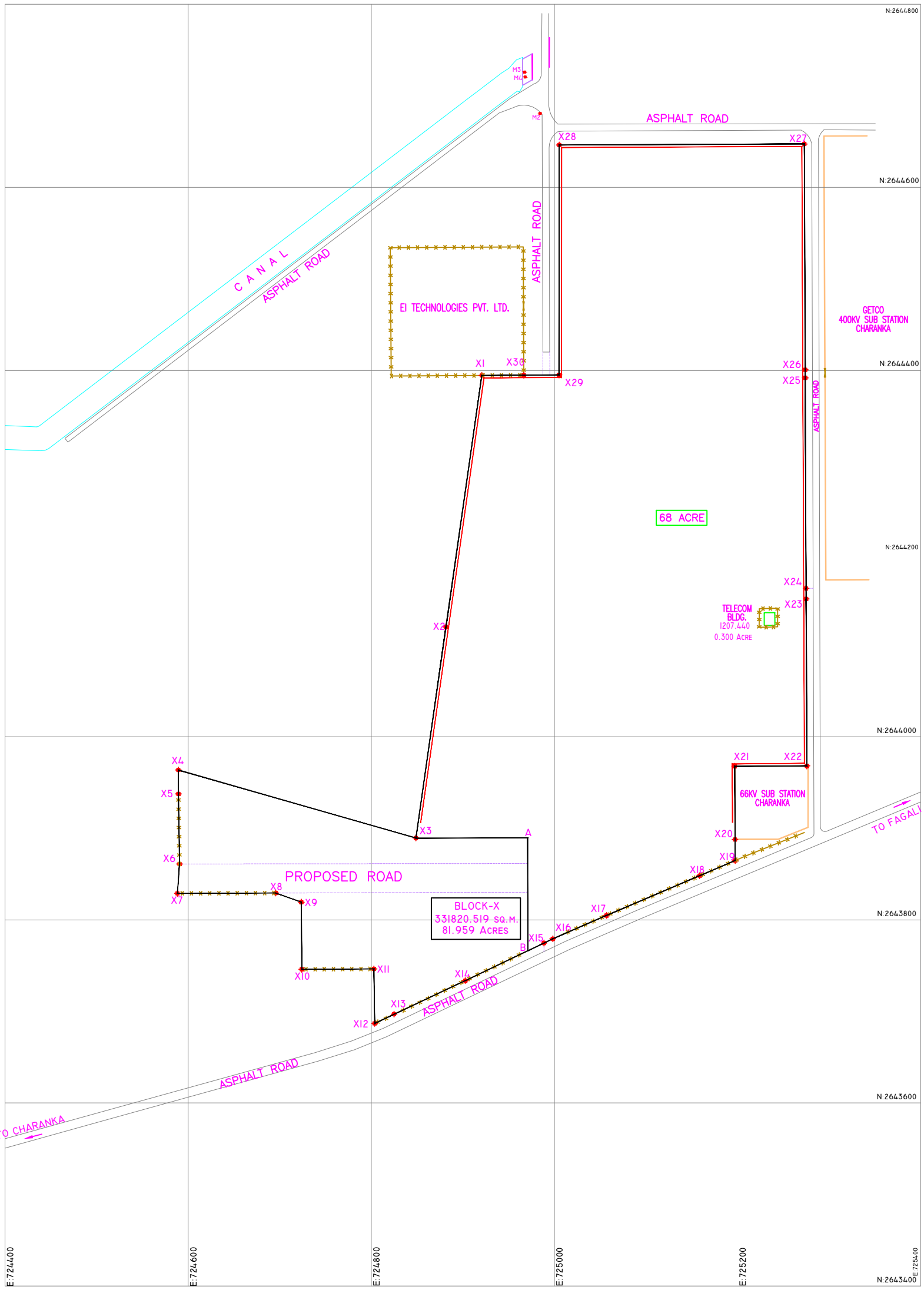
	(2) Coordinating, on behalf of BHEL, and obtaining renewal of statutory licenses, clearances and approvals from state departments such as electricity boards, CEA/CEIG etc. (3) Repair and replacement of vendor supplied items, by vendor, with urgent action plans and implementation, when the items are found non-working / damaged. The same shall be reported to BHEL within 12 hours from time of observation. (4) Reporting, on an immediate basis (within max 2 hours) of functional problems / damages in BHEL supplied items to facilitate repair / replacement by BHEL. Further, vendor shall correspond / coordinate with respective equipment vendors / service centers, on behalf of BHEL, for getting the service engineers to the site. Later, coordinating with the service engineers during their visit to site, and assisting them in the trouble shooting process until the problem is resolved. Vendor shall report to BHEL (within max 2 hours) immediately after the problem is resolved. (5) Vendor shall keep updating the spares inventory at the site every time there is consumption of spare items towards replacement. In case of shortage of spares, the same shall be reported on an urgent basis (with max 2 hours) to BHEL. (6) Coordinating with sub-station upon grid failures, line problems etc and implementing the needful steps to restore the plant to normal operation. (7) Theft incidents: immediate reporting to BHEL, filing FIRs with police stations on behalf of BHEL, coordination for site inspection by insurance companies and clearance of insurance claims, logging of events (date, time) and maintaining records. (8) Accidents: immediate reporting to BHEL, coordinating with hospitals, logging of events (data, time) and maintaining records.

8.0 Documents to be submitted for BHEL/GACL approval during detailed engineering

8.1	BHEL/GACL 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).
8.2	Name of vendor/ make, model number/ part number, specification/ sizes/ dimensions/ drawings/ datasheets shall be submitted for all the vendor supplied items.
8.3	Design calculations/ general arrangement drawings/ single line diagrams/ GTP particulars/ datasheets/ schemes/ layouts/ bill of materials etc, as applicable, shall be submitted for the following: (1) GI cable trays for internal cable trench, cable ties (for dressing on cable trays of internal cable trench), HDPE DWC conduits for control/ communication cables from transformer marshaling box to SCADA/ HT panels etc, 33kV termination kits, 33kV straight through jointing kits, cable glands, cable lugs, (2) All cables within vendor scope of supply. (3) Underground trench for 1Cx300 33kV cables, Aux AC cables, OFC cable: routing layout/ cross sections etc (4) Earth mat grid for inverter room: design calculations, layout, BoM etc (5) Earth mat grid for main control room: design calculations, layout, BoM etc.

	(6) Earth chambers of solar array/ inverter/ main control rooms: GA, cross section, BoM with GTP/ datasheets etc (7) UPS/ FCBC/ Battery bank sizing calculations for main control room and inverter rooms. (8) Plant lighting system: lux calculations, lighting layouts, GA drawings of street light pole/ wall-mounted/ column-mounted/ fence-mounted systems, SLD, BoM with GTP/ datasheets etc. (9) Fire detection/ alarm system: layout in inverter room, layout in main control room, overall layout with zones/ sensor/ hooter/ control panel locations, BoM with GTP/ datasheets etc. (10) Any other designs/ schemes/ layouts etc as per BHEL/GACL requirements that will be discussed during detailed engineering.
8.4	Manufacturing Quality Plans for all the vendor supplied items
8.5	Field quality plan for the field work: civil works, electrical works
8.6	Detailed activity-time chart for project implementation
8.7	Detailed manpower deployment schedule
8.8	Installation manuals for chemical earthing electrodes, fire alarm system etc.

Annexure - 1



NORTH

SCALE

20 0 20 40 60 80 100

METERS

NOTE :

1). THE GRID IS CONSIDERED AS BASE POINTS M3 & M4 AS UTM (UNIVERSAL TRAVERSE MERCATOR) GRID WHICH ARE GIVEN BY THE CLIENT.

2). THE AREA BOUNDE BY BOUNDARY CORNERS X1,X2,X3....X30, X1 FOR BLOCK-X.....81.959 Acres, 331820.519 sq.m.
DEDUCT TELECOM BLDG. & ROAD..... 0.300 Acres, 1207.440 sq.m.
NET AREA.....81.659 Acres, 330613.079 sq.m.

3). THE AREA BOUNDE BY BOUNDARY CORNERS X1, X2, X3, A, B, X15, X16,....X30 = 68 ACRE.

LEGEND :

- GRID
- PEG-I — STATION POINT
- N : 2643200 / E : 725400 — CO-ORDINATES
- X1 — X-BLOCK BOUNDARY
- 68 ACRE BOUNDARY

LIST OF BOUNDARY CORNERS (BLOCK-X)

BOUNDARY CORNER	CO-ORDINATES N :	CO-ORDINATES E :	DISTANCE IN METRE.	INCLUDED ANGLE ° ' "
X1	2644394.621	724920.818	277.518	98-29-05
X2	2644119.890	724881.586	232.860	179-58-23
X3	2643889.352	724848.775	269.941	277-53-12
X4	2643963.274	724589.274	26.122	73-53-15
X5	2643937.577	724589.331	76.576	179-11-05
X6	2643861.012	724590.590	32.160	185-07-11
X7	2643828.937	724588.247	107.473	85-37-14
X8	2643829.315	724695.719	29.596	199-55-32
X9	2643819.326	724723.578	73.263	249-49-29
X10	2643746.065	724724.155	78.795	90-12-36
X11	2643746.397	724802.950	59.443	269-34-38
X12	2643686.958	724803.638	23.475	65-25-54
X13	2643696.965	724824.873	86.086	180-00-00
X14	2643733.663	724902.747	95.170	179-43-02
X15	2643774.656	724988.635	10.700	180-03-44
X16	2643779.256	724998.297	63.957	181-55-44
X17	2643804.783	725056.939	110.731	180-24-35
X18	2643848.236	725158.746	42.156	179-59-57
X19	2643864.786	725197.518	23.023	112-50-58
X20	2643887.809	725197.412	79.943	180-00-00
X21	2643967.751	725197.041	78.806	269-58-34
X22	2643968.149	725275.847	182.451	90-03-10
X23	2644150.599	725275.094	11.535	179-23-32
X24	2644162.132	725274.960	229.925	180-25-22
X25	2644392.055	725273.992	8.793	180-37-05
X26	2644400.847	725274.049	246.593	179-23-32
X27	2644647.438	725273.055	267.694	89-59-14
X28	2644646.300	725005.364	251.153	90-18-20
X29	2644395.147	725005.092	38.491	269-34-49
X30	2644394.907	724966.602	45.784	180-00-00
X1	2644394.621	724920.818		58-29-05
X3	2643889.352	724848.775	122.152	81-53-29
A	2643889.371	724970.927	123.157	270-00-00
B	2643766.214	724970.945		

DEMARCATION SURVEY

CLIENT : GUJARAT ALKALIES & CHEMICALS LIMITED
RANOLI, VADODARA

WORK : DEMARCATION SURVEY
AT CHARANKA, TALUKA RADHANPUR, PATAN

SCALE :- RF. 1 : 2000
1 CM. = 20 M.

DRG. NO.
GACL/CHARANKA/DEMARCATION/2017

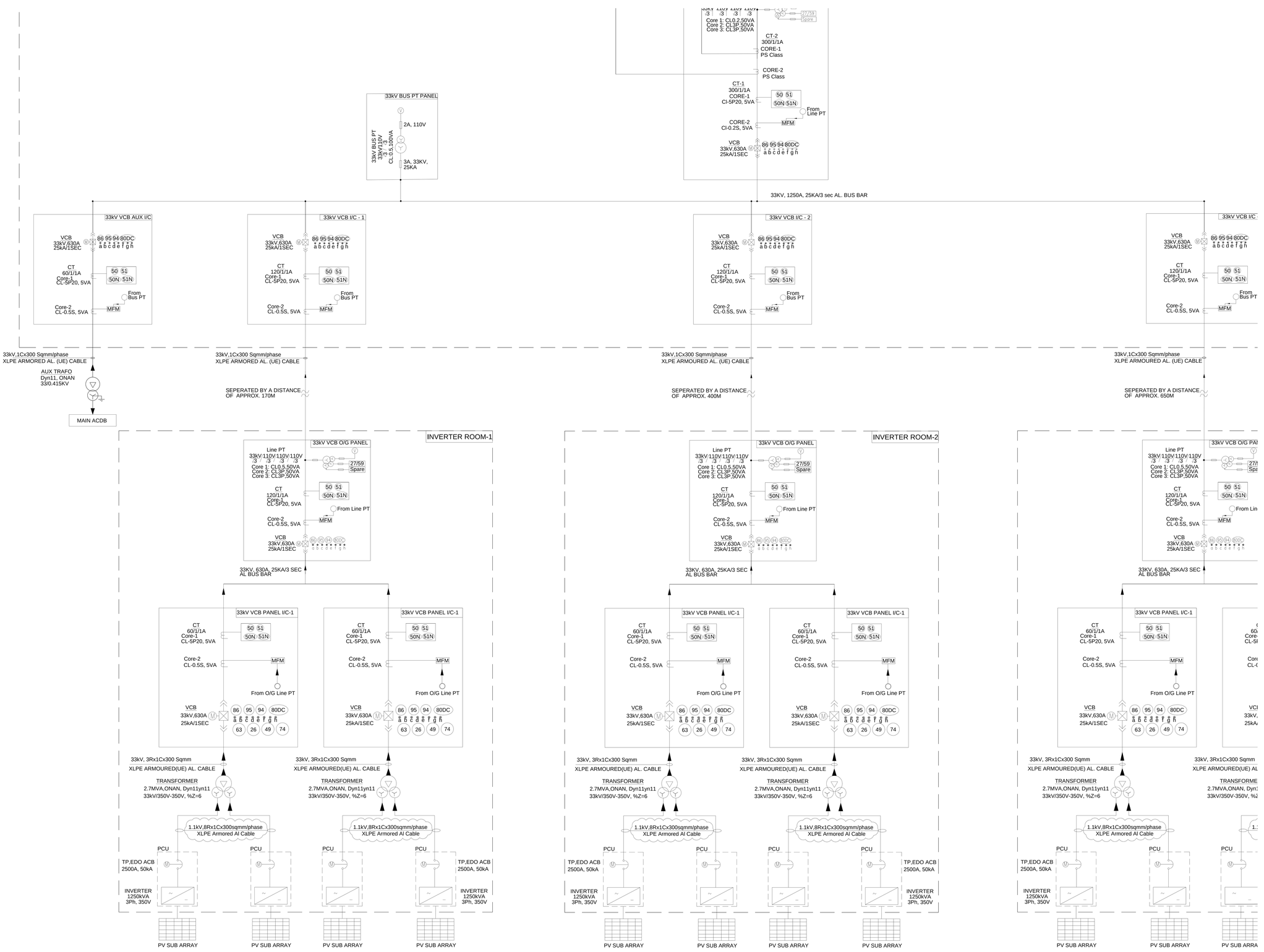
JUNE.2017

SURVEYED & PREPARED BY: CHETAN ENGINEERS

LAND & HYDROGRAPHIC SURVEYOR & MAPPER
10, Ravinagar, B/h. Harinagar Water tank,
Gotri Road, Vadodara 390 007.
Ph. 2314171 Fax. 2339304.
Email : chetan_rs@yahoo.com

FOR CHETAN ENGINEERS,

Annexure - 2



NOTE: 1. CABLE SIZES SHOWN ARE TENTATIVE AND FINAL CABLE SIZED SHALL BE AS PER APPROVED CABLE SIZING DOCUMENT

2. DETAILS OF 66KV BAY AT GETCO STU SHALL BE AS PER THE APPROVAL OF GETCO

DEPT.	SC&PV
STATUS	CONTRACT
DISTRIBUTION	

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD
01	30.06.17	RA	PR	NHK

SLD revised as per MITCON comments dtd. 29.06.2017

REV.	DATE	DRWN	CHD	APPD
00	24.06.17	RA	PR	NHK

First issue.

GACL Promoting Green Technology

15MW(AC) SOLAR
CHARANKA SOLAR F

BHEL

BHARAT HEAVY ELEC
ELECTRONICS DIVISION,

CUSTOMER'S CONSULTANT :

MITCON CONSULTANCY & ENGIN
SERVICES LTD.

TITLE

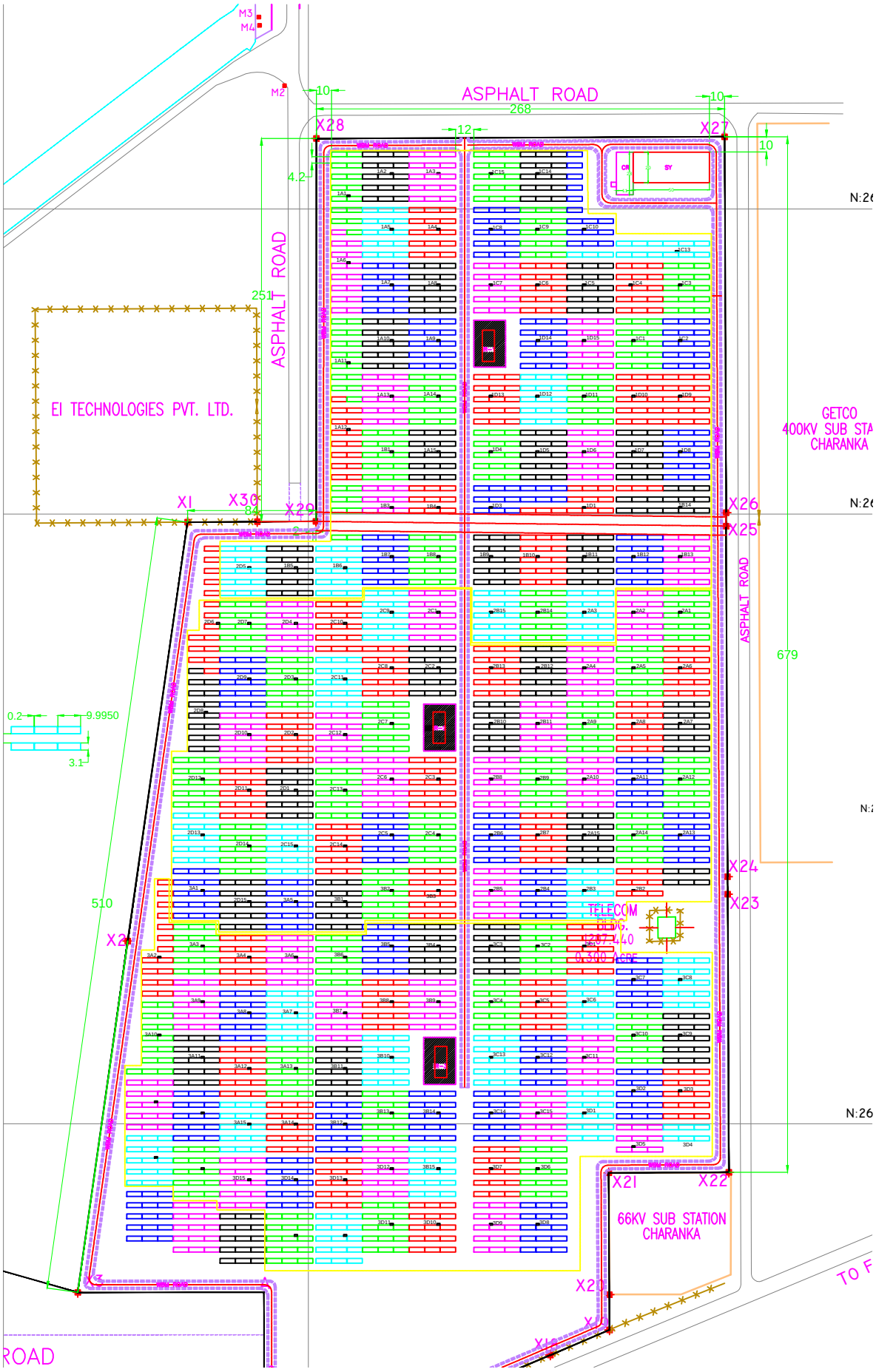
AC SINGLE LINE DIAGRAM

SCALE :

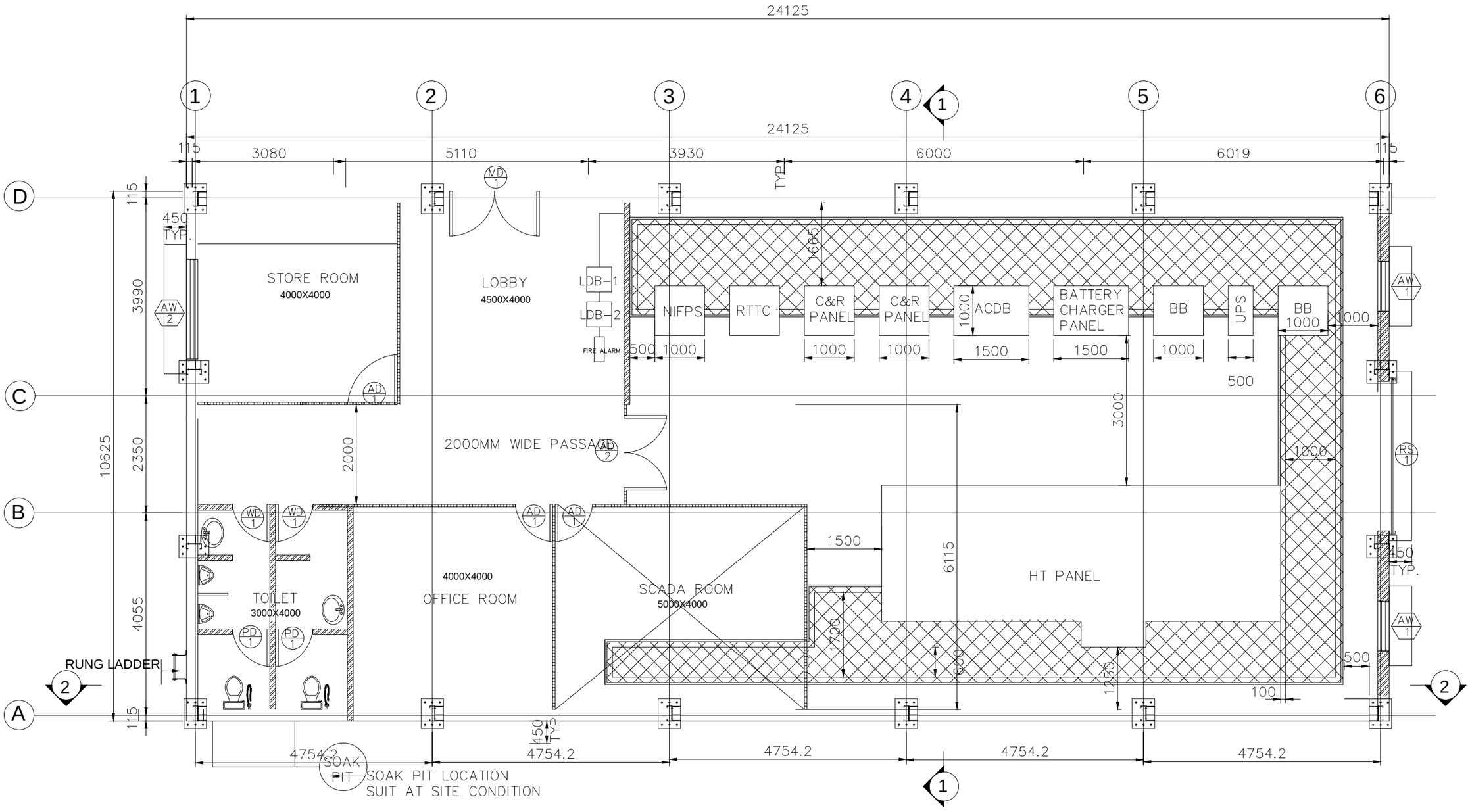
DF

SH

Annexure - 3

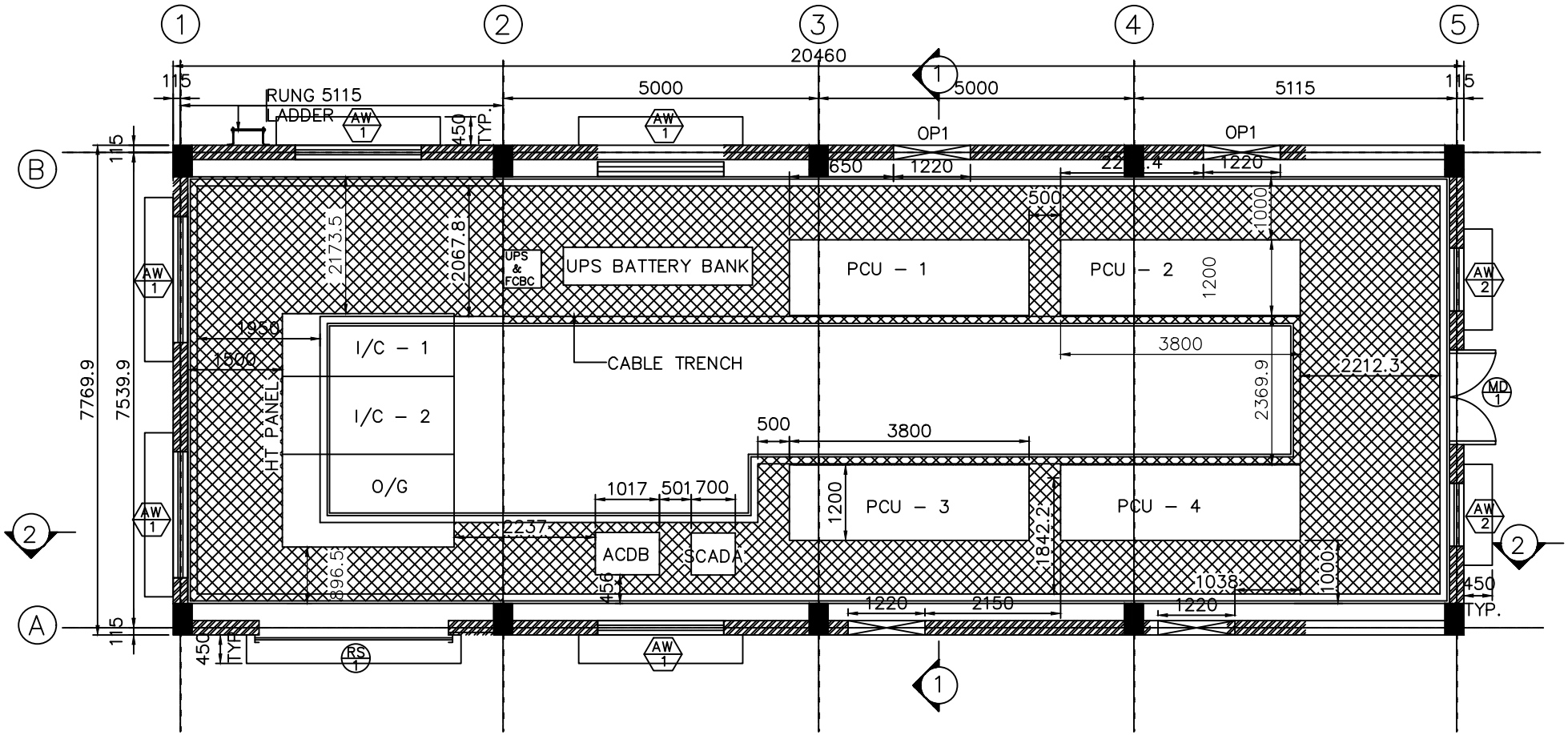

ASPHALT ROAD
268
10
12
4.2
251
ASPHALT ROAD
EI TECHNOLOGIES PVT. LTD.
GETCO
400KV SUB STA
CHARANKA
679
ASPHALT ROAD
510
9.9950
0.2
3.1
TELECOM
66KV SUB STATION
CHARANKA
X1
X2
X20
X21
X22
X23
X24
X25
X26
X27
X28
X29
X30
N:26

Annexure - 4 Main Control Room Layout



GROUND FLOOR PLAN

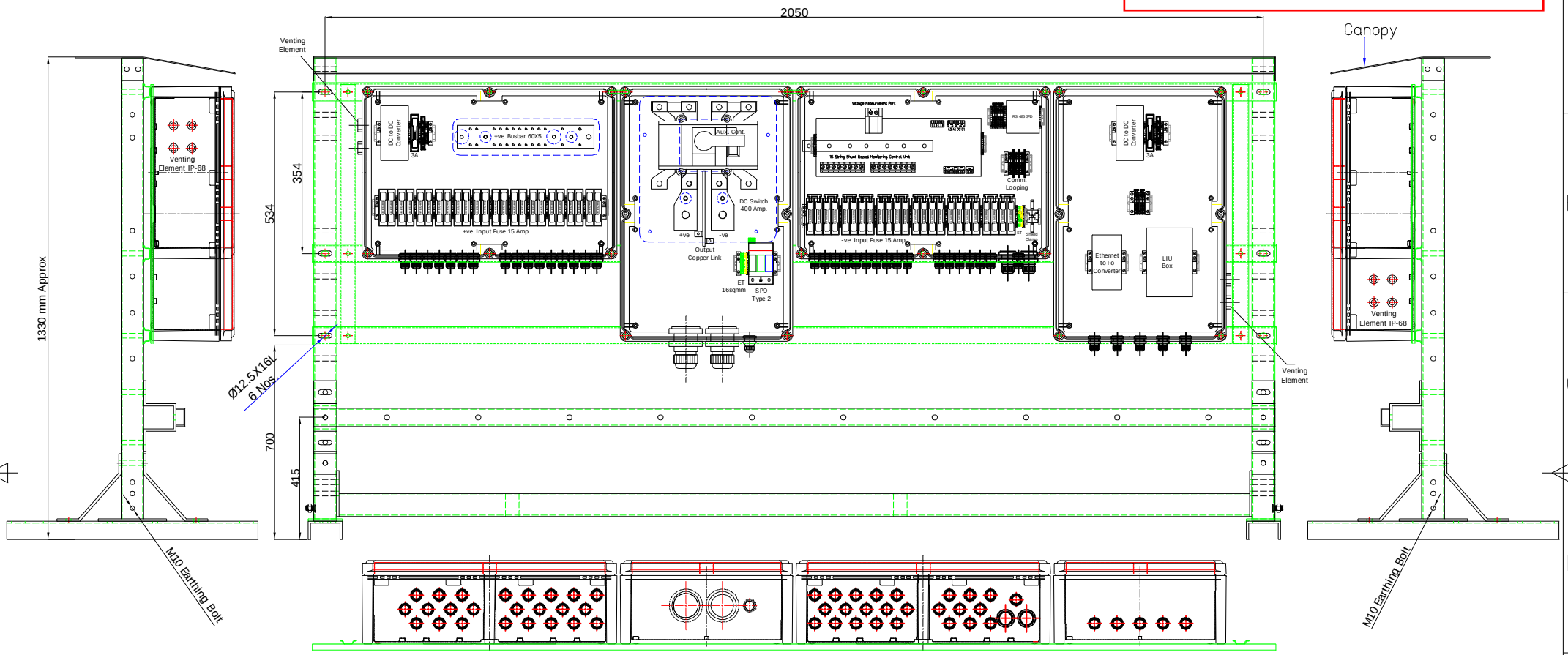
Annexure - 5 Inverter Room Layout



GROUND FLOOR PLAN
(SCALE 1:75)

Annexure - 6:
Contact BHEL for
Soil Test Report

Annexure - 7a SMB with FO



NOTE :-

1. Complete structure galvanizing thickness minimum 80 microns.
2. Nut, bolt & plain washer material SS-304 & Spring washer with zinc epoxy coating.

Enclosure Size : 560X380X180, 4 Nos. (Transparent Cover)
Cable Gland-1 : PG-11, Suitable Wire Dia. 5-10 mm (54 Nos.)
Cable Gland-2 : PG-13.5, Suitable Wire Dia. 6-12 mm (1 No.)
Cable Gland-3 : PG-21, Suitable Wire Dia. 13-18 mm (2 Nos.)
Cable Gland-4 : PG-42, Suitable Wire Dia. 30-38 mm (2 Nos.)

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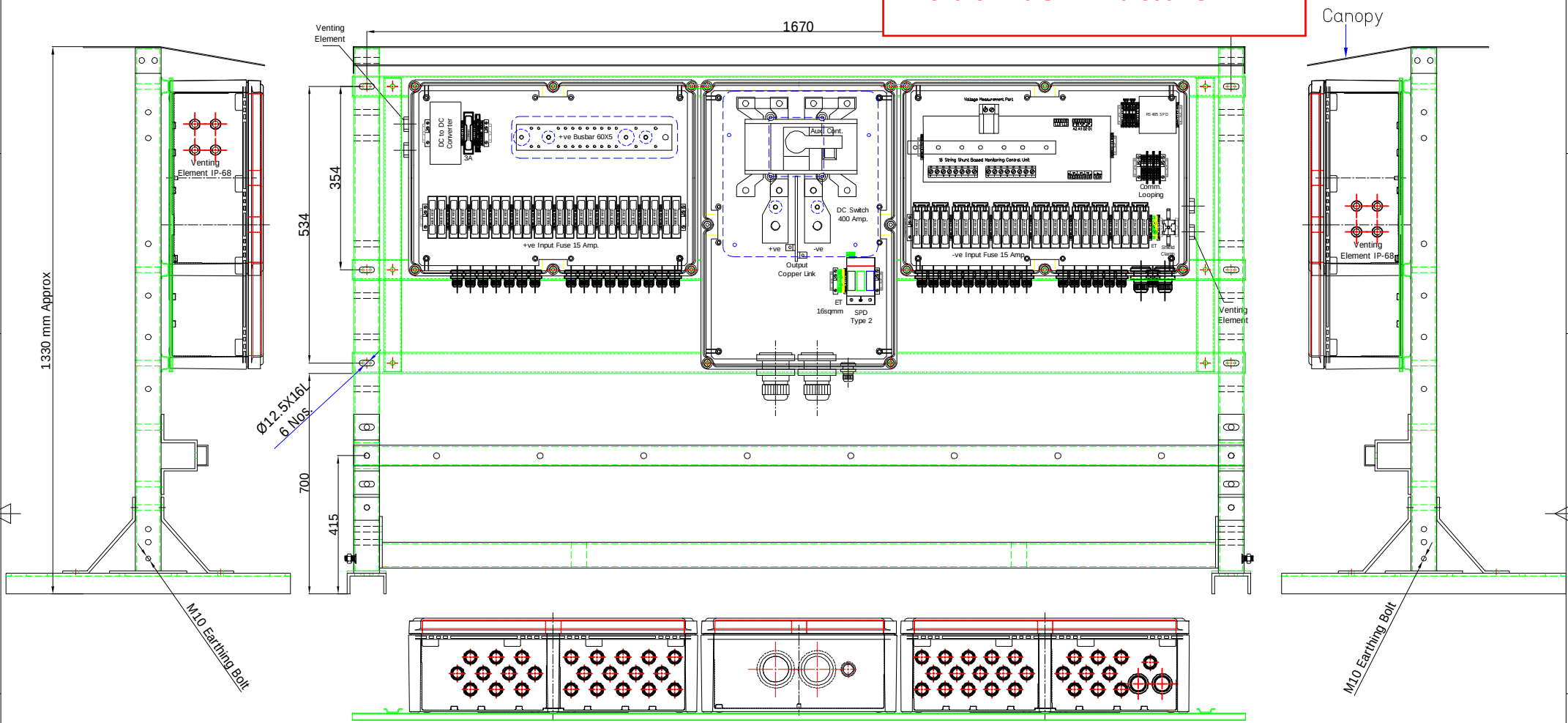
QTY	REV	CHANGE DETAIL	APPD. BY	DATE

TOLERANCE :

1. ±20 FOR MOUNTING ARRANGEMENT
2. +2 for Hole Dia
3. ±1.5 for Hole Position Dimension

PART NAME/TITLE :	SCB for 24 in 1 out			ALL DIMENSION ARE IN MM	
SUB-TITLE :	M/S BHEL			Dwg. No. :- G4087	
MATERIAL :	Polycarbonate	FINISH :	VISUAL		
ANGLE PROJN			NAME	SIGN	DATE
PAGE	1 OF 1	DRN. BY	GAURAV		06/03/2017
SCALE	N.T.S.	CKD. BY			
D:\GS\TTPL logo.jpg		APP. BY	P.SANDHU		
Article No. :-					Rev :- 00

Annexure - 7b SMB without FO



NOTE :-

1. Complete structure galvanizing thickness minimum 80 microns.
2. Nut, bolt & plain washer material SS-304 & Spring washer with zinc epoxy coating.

Enclosure Size : 560X380X180, 3 Nos. (Transparent Cover)
Cable Gland-1 : PG-11, Suitable Wire Dia. 5-10 mm (49 Nos.)
Cable Gland-2 : PG-13.5, Suitable Wire Dia. 6-12 mm (1 No.)
Cable Gland-3 : PG-21, Suitable Wire Dia. 13-18 mm (2 Nos.)
Cable Gland-4 : PG-42, Suitable Wire Dia. 30-38 mm (2 Nos.)

TOLERANCE :	PART NAME/TITLE : SCB for 24 in 1 out				ALL DIMENSION ARE IN MM
	SUB-TITLE : M/S BHEL				Dwg. No. :- G4088
1. ±20 FOR MOUNTING ARRANGEMENT	MATERIAL : Polycarbonate		FINISH : VISUAL		
	ANGLE PROJN			NAME	SIGN	DATE
	PAGE	1 OF 1	DRN. BY	GAURAV		06/03/2017
	SCALE	N.T.S.	CKD. BY			
2. +2 for Hole Dia			APP. BY	P.SANDHU		
3. ±1.5 for Hole Position Dimension			Article No. :-			Rev :- 00

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QTY	REV	CHANGE DETAIL	APPD. BY	DATE

4	Power Transformer	Bharat Bijlee
		Transformers & Rectifiers
		Electrotherm
		PETE-Hammond
		Voltamp
		Raychem RPG
		Prime Meiden Any reputed make based on reference and credentials approved by GACL.
5	HT Panel /HT Breaker	Siemens
		L & T
		ABB/System house of ABB
		Schneider
		CGL Any reputed make based on reference and credentials approved by GACL.
6	Control and relay panel	ABB
		Siemens
		Avana
		Schneider
		Alstom Any reputed make based on reference and credentials approved by GACL.
7	LT Switchgear component	L & T
		Siemens
		ABB
		Schneider Any reputed make based on reference and credentials approved by GACL.
8	Auxiliary Transformer	Voltamp
		Transformers & Rectifiers
		Kotson
		Jayesh Electricals
		Any reputed make based on reference and credentials approved by GACL.
9	Cables	Polycab Cables
		LAPP
		Siechem
		KEI Cables
		UniFlex Cables
		Ravin Cables Any reputed make based on reference and credentials approved by GACL.
10	HT termination kits	Raychem
		3M
11	Optical Fiber Cable	Finolex
		D-Link

		Any reputed make based on reference and credentials approved by GACL.
12	Earthing Pit Materials	Ashlok
		Powertrac
		ERICO
13	SCB	Hensel Electric Pvt Ltd
		Trinity Solar
		Eaton
		ABB
14	Lugs	Dowell
		Comet
		3D
15	Cable Glands	Comet / 3D
16	SCADA System	Rockwell
		Siemens
		Schneider
		Mitsubushi
17	Weather Sensors	a. Pyranometer: i) Keep & Zone ii) IngenIeurbüroMencke & Tegtmeyer GmbH iii) ADOLF THIES Gmbh & Co. b. Temperature Measurement: i) Met One Inc ii) Climatronics
		c. Wind Speed & direction : i) Met One Inc
		d. Tripod Stand: i) Met One Inc ii) Climatronics
		Any reputed make based on reference and credentials approved by GACL.
18	Batteries	Exide/ HBL Niap power system Ltd
19	UPS	Hitachi HI-REL
		Eaton
		Emerson
20	Battery Charger	Chhabi Electrical
		Caldyne
		HBL Niap power system Ltd
		Servilink
21	Lightning Arrestor (ESE type)	Erico
		Nimbus
		AT, Spain
		Ingesco
		Indelec
22	ABT Energy Meter (subject to approval from GETCO)	SEMS
		EDMI
23	HT Isolator (Upto 66 kV Outdoor type)	Siemens
		ABB
		CGL
		GR Power switchgear
24	HT CT & PT (Upto 66 kV Oil Filled type)	ABB
		CGL
		Pragati
25	LA (Upto 66 kV Outdoor Type)	CGL
		Oblum

		Elpro
26	66kV Cable	Approved vendors of GETCO
27	Disc and post insulator	BHEL
		Birla
28	GI structure for the switchyard	Sujana Towers
		Kalpatru Power transmission
		Approved vendors of GETCO
29	Insulator hardware	3M
		ITIPL
		Approved vendors of GETCO
30	Clamps and connectors	Klemenn engineering corporation
		Approved vendors of GETCO
31	Numerical Relay	Siemens
		Areva
32	Switch fuse unit	Siemens
		L & T
33	PLCC equipments	ABB
34	Lighting fixture / system	Philips / CGL/Bajaj/Havells
35	LED Lighting	CGL
		Wipro
		Bajaj
		Panasonic
		Philips
36	MCCB	SIEMENS
		ABB
		Schneider
		L & T
37	RMU (Ring Main Unit)	ABB
		Schneider
		Siemens
		CGL
		L & T
38	Steel Structure for MMS	TISCO
		SAIL
		JINDAL
		RINL
		ESSAR
39	Submersible/Sump Pump	Kirlosker
		KSB
		CGL
		CRI
		Jyoti
40	CCTV Camera & Monitoring System	Sony /Honeywell/Milestone

NOTE:
Procurement of BOS items is to be carried out from vendors specified as per above customer's approved vendor list.

However, BOS items can be procured from vendors different from specified above; subject to submission of required credentials and prior approval from BHEL and GACL.

SPECIAL COMMERCIAL CONDITIONS OF CONTRACT (SCC) - for foreign vendors				
RFQ No. SPKSCPV002 Dtd.19.07.2017 Due Date (Tech Bid): 02.08.2017				
Sl. No.	**Terms**	**BHEL Term**	**Confirmation**	**Deviation/Remarks**
1	**Pre-Qualification Criteria (PQC)**	a) Vendor should have carried out electrical installation and commissioning of minimum cumulative of 15MWp solar photovoltaic power plants in India in last 3 years from RFQ date, with individual power plant projects of 5MW and above. Evidence in form of PO copies/ completion certificates from clients shall be submitted for the same along with technical offer. (b) The bidder should have achieved average annual financial turnover of Rs. 10 Cr. in the last three years ending 31st March of the previous financial year. The bidder shall submit the following details along with the bid: a) Audited balance sheets for last three years	Complied	
2	**Bidding**	**(a)** Bid has to be submitted as Two Part – Techno Commercial Bid (Part-1) & Price Bid (Part-II).**Bids shall be submitted through e-Procurement portal https://bheleps.buyjunction.in of M/s. Mjunction Services Limited.**	Complied	
		(b) SCC & Annexure A1 to be submitted along with technical bid (Part-I) & **Annexure A2** to be submitted along with Price bid (Part-II).	Complied	
		(c) Clause-wise compliance to BHEL Purchase specification along with all documents as called in Technical specification to be submitted along with technical bid(Part-1).	Complied	
3	**Price basis:**	Firm i.e., from the date of PO to completion of supply if I&C is not applicable. If I&C is in supplier's scope,then the prices shall remain firm till commissioning & handing-over of the complete system. (PVC clause not acceptable).	Complied	
4	**Terms of Delivery:**	CIF Seaport/ CIF Airport/ FCA Airport (Indicate name of Seaport/Airport)	Complied	
5	**Delivery Period:**	**Supply :** 8 (Eight) weeks from drawing approval. **Drawing Submission :** 1 (One) week from the date of Purchase Order. **I&C:** Within 4 (Four) weeks from supply **O&M**: 10 (Ten) years commencing from commissioning date	Acceptable / Not acceptable	
6	**Payment Term:**	**(a) Supply:** 1) 80% of the basic value (excluding I&C charges) will be paid with 45 days credit, against Sight draft, from the date of AWB/BOL on submission of complete set of documents as in PO. 2) 10% of basic supply value will be paid on completion of I&C against submission of supplementary invoice along with proof of completion of I&C along with I&C charges (if any). 3) Balance 10% (retention money) against submission of supplementary invoice along with PBG valid for Warranty Period+3 months Claim Period from BHEL Consortium Bank. **(b) I&C:** 100% on completion of I&C/Supervision and certification line item wise on pro-rata basis. **(c) O&M:** 100% O&M charges shall be done in monthly basis against report certified by BHEL. **Note :** In exceptional cases, if vendor fails to submit PBG after supplies, vendors can also accept for the final 10% payment, payable after the warranty period + 3 months of claim period against supplementary invoice subject to the completion of commissioning (if applicable) as PBG is linked to Warranty period.	Acceptable / Not acceptable	
		(b) For any deviation in payment term, the offer will be liable for loading as per Clause G of ITB.	Acceptable / Not acceptable	
7	**Evalution of L1 vendor**	Over all L1 of Supply + I&C + O&M on "FOR" basis to site will only be considered.	Complied	
8	**Warranty :**	**Warranty for Supply :** 18 months from supply, 12 months from I&C whichever is earlier. **Warranty/Guarantee for Workmanship & I&C :** 12 months from I&C.	Acceptable / Not acceptable	
9	**Pre Shipment Inspection**	**(a)** Pre Shipment Inspection will be carried out by BHEL/Customer for which test report shall be sent one week in advance.	Acceptable / Not acceptable	
		(b) Pre Shipment Inspection charges , if any, shall be considered while evaluating your offer to arive at "Total Cost to BHEL".The charges for the same shall be informed to you before Price Bid Opening/Reverse Auction.	Acceptable / Not acceptable	
10	**Penalty**	**(a) Supply:** Penalty of 0.5% per week at the basic price of the good for undelivered quantity of supply portion, subject to a maximum of 10%. For Supply, Pre Shipment Inspection Call Letter Date (Receipt of test report) will be treated as delivery for purpose of penalty.	Acceptable / Not acceptable	
		(b) For any deviation in penalty term, the offer will be liable for loading as per Clause No. G, Point No.(b) of ITB.	Acceptable / Not acceptable	

11	**PBG**	PBG shall be furnished in the BHEL prescribed format.	Acceptable / Not acceptable	
12	**Validity:**	Quotation should remain valid for a period of 90 days from the due date.	Acceptable / Not acceptable	
13	**Bank charges (If applicable):**	**(a)** All Bank charges to seller's account	Acceptable / Not acceptable	
		(b) Deviation will be liable for loading as per Cl.G of ITB	Acceptable / Not acceptable	
14	**Reverse Auction:**	BHEL reserves the right to conduct Reverse auction.Procedure for the same will be informed by BHEL .	Acceptable / Not acceptable	
15	**DUN No.**	Please mention Dun & Bradstreet No.(DUN No.)		
16	**Consignment Details**	Weight and Dimension of consignment with packing.	Furnished / To be furnished	
17	**Despatch Documents:**	Despatch documents include Air Waybill/Bill of Lading, Invoice, Packing list, PSI letter copy and Warranty certificate. One copy of Invoice, Packing list and Air Way Bill /Bill of Lading shall be faxed/emailed immediately after despatch. Also one copy of packing list to be kept inside each box for easy identification of material at site.	Acceptable / Not acceptable	
18	**Other terms & conditions**	For any other Terms and Conditions, kindly refer to the following: A: ITB (document ref :SCPV: BOS: ITB - Rev 02) B: GCC (document ref: SCPV: BOS: GCC - Rev 02)	Acceptable / Not acceptable	
19	**Integrity Pact**	(a) IP is a tool to ensure that activities and transactions between the Company and its Bidders/Contractors are handled in a fair, transparent and corruption free manner. A panel of Independent External Monitors (IEMs) have been appointed to oversee implementation of IP in BHEL. The IP as enclosed with the tender (total 7 sheets) is to be submitted (duly signed by authorized signatory who signs in the offer) along with technocommercial bid. Only those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this Pact would be a preliminary qualification. Details of IEM for this tender is furnished below: Shri D.R.S Chaudhary, IAS (Retd.), Flat No. L-202 & L-203 (1st Floor) Ansal Lake View Enclave Shamla Hills Bhopal- 462 013 (M.P.) Ph: +91 755 4050495 dilip.chaudhary@icloud.com (b) Please refer Section-8 of the IP for Role and Responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to the IEM mentioned in the tender. No routine correspondence shall be addressed to the IEM (phone/post/email) regarding the clarifications, time extensions or any other administrative queries, etc. on the tender issued. All such clarification/issues shall be addressed directly to the tender issuing (procurement) department."	Acceptable/Not acceptable	
20	**BOS %**	The percentage of Supply, I&C and O&M for values shall be in the range indicated below(approximately,with overall tallying to 100%) : (a) Supply : 30-35% (b) I&C :22-26% (c) O&M :42-45%	Complied	

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Annexure-A1

TECHNICAL BID ENCLOSURE FOR COMPLIANCE OF QUOTE : UNPRICED BID (Foreign Vendors)							
RFQ No. SPKSCPV002 Dtd.19.07.2017 Due Date (Tech Bid): 02.08.2017							
Sl No.	**Material Code**	**DESCRIPTION**	**Quantity**	**Unit**	**Quoted**	**HSN/SAC CODES**	**Currency**
1	PS0679062742	Supply of MC4 ,Cable tie,HDPE pipe etc.	1	ST	Yes / No		
2	PS0679062750	Supply of Array earthing items	1	ST	Yes / No		
3	PS0679062769	Supply of Array LA items	1	ST	Yes / No		
4	PS0679062777	Supply of Module cleaning system items	1	ST	Yes / No		
5	PS0679062823	I&C: Array earthing works	1	AU	Yes / No		
6	PS0679062858	I&C: Module cleaning system works	1	AU	Yes / No		
7	PS0679062874	I&C: Inteconnection of Modules,SMB etc.	3	AU	Yes / No		
8	PS0679062882	Supply of control cable, kits etc.	1	ST	Yes / No		
9	PS0679062890	Supply of Aux Trf, ACDB,DCDB,UPS etc	1	ST	Yes / No		
10	PS0679062912	Supply of Plant lighting system	1	ST	Yes / No		
11	PS0679062920	Supply of Misc items	1	ST	Yes / No		
12	PS0679062939	Supply: Fire alarm sys, Extinguisher etc	1	ST	Yes / No		
13	PS0679062947	Supply of CCTV system	1	ST	Yes / No		
14	PS0679062955	Supply of spare items	1	ST	Yes / No		
15	PS0679062963	I&C: Cable Trench works	4	AU	Yes / No		
16	PS0679062971	I&C : Panel installation in IR rooms	3	AU	Yes / No		
17	PS0679062980	I&C: 33kV Trf yards	3	AU	Yes / No		
18	PS0679062998	I&C: CMCS	1	AU	Yes / No		
19	PS0679063005	I&C: switchyard attached to CMCS	1	AU	Yes / No		
20	PS0679063013	I&C: SCADA System	1	AU	Yes / No		
21	PS0679063021	I&C: Earthing	1	AU	Yes / No		
22	PS0679063030	I&C: Plant lighting system	1	AU	Yes / No		
23	PS0679063048	I&C: Misc items	1	AU	Yes / No		
24	PS0679063056	I&C: CCTV system	1	AU	Yes / No		
25	PS0679063064	I&C: Pre-Commissioning checks etc.	1	AU	Yes / No		
26	PS0679063072	O&M : Monthly basis	120	AU	Yes / No		
27	PS0679063137	Supply of Weather monitoring system	1	ST	Yes / No		

Please refer RFQ/Tender for detailed description of items.

Note:

The above format is to be used for Unpriced bid.

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ANNEXURE A2

PRICE BID (Foreign Vendors)							
RFQ No. SPKSCPV002 Dtd.19.07.2017 Due Date (Tech Bid): 02.08.2017							
Sl No.	**Material Code**	**DESCRIPTION**	**Quantity**	**Unit**	**Quoted**	**HSN/SAC CODES**	**Currency**
1	PS0679062742	Supply of MC4 ,Cable tie,HDPE pipe etc.	1	ST	Yes / No		
2	PS0679062750	Supply of Array earthing items	1	ST	Yes / No		
3	PS0679062769	Supply of Array LA items	1	ST	Yes / No		
4	PS0679062777	Supply of Module cleaning system items	1	ST	Yes / No		
5	PS0679062823	I&C: Array earthing works	1	AU	Yes / No		
6	PS0679062858	I&C: Module cleaning system works	1	AU	Yes / No		
7	PS0679062874	I&C: Inteconnection of Modules,SMB etc.	3	AU	Yes / No		
8	PS0679062882	Supply of control cable, kits etc.	1	ST	Yes / No		
9	PS0679062890	Supply of Aux Trf, ACDB,DCDB,UPS etc	1	ST	Yes / No		
10	PS0679062912	Supply of Plant lighting system	1	ST	Yes / No		
11	PS0679062920	Supply of Misc items	1	ST	Yes / No		
12	PS0679062939	Supply: Fire alarm sys, Extinguisher etc	1	ST	Yes / No		
13	PS0679062947	Supply of CCTV system	1	ST	Yes / No		
14	PS0679062955	Supply of spare items	1	ST	Yes / No		
15	PS0679062963	I&C: Cable Trench works	4	AU	Yes / No		
16	PS0679062971	I&C : Panel installation in IR rooms	3	AU	Yes / No		
17	PS0679062980	I&C: 33kV Trf yards	3	AU	Yes / No		
18	PS0679062998	I&C: CMCS	1	AU	Yes / No		
19	PS0679063005	I&C: switchyard attached to CMCS	1	AU	Yes / No		
20	PS0679063013	I&C: SCADA System	1	AU	Yes / No		
21	PS0679063021	I&C: Earthing	1	AU	Yes / No		
22	PS0679063030	I&C: Plant lighting system	1	AU	Yes / No		
23	PS0679063048	I&C: Misc items	1	AU	Yes / No		
24	PS0679063056	I&C: CCTV system	1	AU	Yes / No		
25	PS0679063064	I&C: Pre-Commissioning checks etc.	1	AU	Yes / No		
26	PS0679063072	O&M : Monthly basis	120	AU	Yes / No		
27	PS0679063137	Supply of Weather monitoring system	1	ST	Yes / No		

Please refer RFQ/Tender for detailed description of items.

Note:

The above format is to be used for Unpriced bid.

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SPECIAL COMMERCIAL CONDITIONS OF CONTRACT (SCC) - for indigenous vendors				
RFQ No. SPKSCPV002 Dtd.19.07.2017 Due Date (Tech Bid): 02.08.2017				
Sl No.	**Terms**	**BHEL Term**	**Confirmation**	**Deviation / Remarks**
1	**Pre-Qualification Criteria (PQC)**	a) Vendor should have carried out electrical installation and commissioning of minimum cumulative of 15MWp solar photovoltaic power plants in India in last 3 years from RFQ date, with individual power plant projects of 5MW and above. Evidence in form of PO copies/ completion certificates from clients shall be submitted for the same along with technical offer. (b) The bidder should have achieved average annual financial turnover of Rs. 10 Cr. in the last three years ending 31st March of the previous financial year. The bidder shall submit the following details along with the bid: a) Audited balance sheets for last three years	Complied	
2	**Bidding**	**(a)** Bid has to be submitted as Two Part – Techno Commercial Bid (Part-1) & Price Bid (Part-II).**Bids shall be submitted through e-Procurement portal https://bheleps.buyjunction.in of M/s. Mjunction Services Limited.**	Complied	
		(b) SCC & Annexure B1 to be submitted along with Technical bid (Part-I) & **Annexure B2** to be submitted along with Price bid (Part-II).	Complied	
		(c) Clause-wise compliance to BHEL Purchase specification along with all documents as called in Technical specification to be submitted along with technical bid(Part-1).	Complied	
3	**Price Basis**	Firm i.e., from the date of PO to completion of supply if I&C is not applicable. If I&C is in supplier's scope,then the prices shall remain firm till commissioning & handing-over of the complete system.(PVC clause not acceptable).	Complied	
4	**Terms of Delivery**	Free On Road Basis to Project site : 15MW SPV Plant GACL at Charanka Solar Park, Gujarat	Complied	
5	**Delivery Period**	**Supply :** 8 (Eight) weeks from drawing approval. **Drawing Submission :** 1 (One) week from the date of Purchase Order. **I&C:** Within 4 (Four) weeks from supply **O&M**: 10 (Ten) years commencing from commissioning date	Acceptable / Not acceptable	
6	**Payment Term**	**(a) Supply:** 1) 80% of basic Supply value + 100% of taxes, duties and freight charges will be paid with 45 days credit from the receipt of material at site or 15 days credit from the date of submission of complete set of documentation whichever is later. 2) 10% of basic supply value will be paid on completion of I&C against submission of supplementary invoice along with proof of completion of I&C along with I&C charges (if any). 3) Balance 10% (retention money) against submission of supplementary invoice along with PBG valid for Warranty Period+3 months Claim Period from BHEL Consortium Bank. **(b) I&C/Supervision:** 100% on completion of I&C/Supervision and certification line item wise on pro-rata basis. **(c) O&M:** 100% O&M charges shall be done in monthly basis against report certified by BHEL. **Note** : In exceptional cases, if vendor fails to submit PBG after supplies, vendors can also accept for the final 10% payment, payable after the warranty period + 3 months of claim period against supplementary invoice subject to the completion of commissioning (if applicable) as PBG is linked to Warranty period.	Acceptable / Not acceptable	
		(b) For any deviation in payment term, the offer will be liable for loading as per Clause G of ITB.	Acceptable / Not acceptable	
7	**GST**	**(a)** Kindly provide the tax structure (CGST, SGST, IGST) with current rate applicable.	CGST: ……..% SGST: ……..% IGST: ……..%	
		(b) Kindly furnish your GST No.	GST no……..	
8	**Evalution of L1 vendor**	Over all L1 of Supply + I&C + O&M on "FOR" basis to site will only be considered.	Complied	
9	**Warranty**	**Warranty for Supply :** 18 months from supply, 12 months from I&C whichever is earlier. **Warranty/Guarantee for Workmanship & I&C :** 12 months from I&C.	Acceptable / Not acceptable	

10	**Pre Shipment Inspection**	**(a)** Pre Shipment Inspection will be carried out by BHEL/Customer for which test report shall be sent atleast one week in advance.	Acceptable / Not acceptable	
		(b) Pre Shipment Inspection charges , if any, shall be considered while evaluating your offer to arive at "Total Cost to BHEL".The charges for the same shall be informed to you before Price Bid Opening/Reverse Auction.	Acceptable / Not acceptable	
11	**Penalty**	**(a) Supply:** Penalty of 0.5% per week at the basic price of the good for undelivered quantity of supply portion, subject to a maximum of 10%. For Supply, Pre Shipment Inspection Call Letter Date (Receipt of test report) will be treated as delivery for purpose of penalty.	Acceptable / Not acceptable	
		(b) For any deviation in penalty term, the offer will be liable for loading as per Clause No. G, Point No.(b) of ITB.	Acceptable / Not acceptable	
12	**Road Permit**	Road permit if applicable will be given by BHEL before Dispatch of ordered Items.However, vendor shall give request for road permit 24 hours in advance.	Complied	
13	**PBG**	PBG shall be furnished in the BHEL prescribed format.	Acceptable / Not acceptable	
14	**Despatch Documents**	Complete set of despatch documents in 3 sets shall be forwarded to BHEL directly. Despatch documents include Invoice, Lorry receipt (L/R), Packing list, PSI letter Copy, Proof of delivery such as MRC (Material Receipt Certificate)/ original acknowledged LR, Insurance intimation letter and Warranty certificate. One set of Invoice, Packing list and L/R shall be emailed immediately after despatch to BHEL-EDN, Bangalore.	Complied	
15	**Reverse Auction**	BHEL reserves the right to conduct Reverse auction.Procedure for the same will be informed by BHEL .	Acceptable / Not acceptable	
16	**Other terms & conditions**	For any other Terms and Conditions, kindly refer to the following: A: ITB (document ref :SCPV: BOS: ITB - Rev 02) B: GCC (document ref: SCPV: BOS: GCC - Rev 02)	Acceptable / Not acceptable	
17	**Validity**	Quotation should remain valid for a period of 90 days from the due date.	Acceptable / Not acceptable	
18	**Shipment**	Kindly indicate the state from where the shipment will take place.	State/Place	
19	**Integrity Pact**	(a) IP is a tool to ensure that activities and transactions between the Company and its Bidders/Contractors are handled in a fair, transparent and corruption free manner. A panel of Independent External Monitors (IEMs) have been appointed to oversee implementation of IP in BHEL. The IP as enclosed with the tender (total 7 sheets) is to be submitted (duly signed by authorized signatory who signs in the offer) along with technocommercial bid. Only those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this Pact would be a preliminary qualification. Details of IEM for this tender is furnished below: Shri D.R.S Chaudhary, IAS (Retd.), Flat No. L-202 & L-203 (1st Floor) Ansal Lake View Enclave Shamla Hills Bhopal- 462 013 (M.P.) Ph: +91 755 4050495 dilip.chaudhary@icloud.com (b) Please refer Section-8 of the IP for Role and Responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to the IEM mentioned in the tender. No routine correspondence shall be addressed to the IEM (phone/post/email) regarding the clarifications, time extensions or any other administrative queries, etc. on the tender issued. All such clarification/issues shall be addressed directly to the tender issuing (procurement) department."	Acceptable/Not acceptable	
20	**BOS %**	The percentage of Supply, I&C and O&M for values shall be in the range indicated below(approximately,with overall tallying to 100%) : (a) Supply : 30-35% (b) I&C :22-26% (c) O&M :42-45%	Complied	

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ANNEXURE B1

TECHNICAL BID ENCLOSURE FOR COMPLIANCE OF QUOTE : UNPRICED BID (Indigenous Vendors)								
RFQ No. SPKSCPV002 Dtd.19.07.2017 Due Date (Tech Bid): 02.08.2017								
Sl No.	**Material Code**	**DESCRIPTION**	**QUOTED**	**QTY**	**UNIT**	**HSN/SAC CODES**	**BREAK UP OF TAX STRUCTURE (CGST/SGST/IGST/Service Tax etc) WITH CURRENT RATES**	**Remarks**
1	PS0679062742	Supply of MC4 ,Cable tie,HDPE pipe etc.	YES/NO	1	ST			Taxes Inclusive
2	PS0679062750	Supply of Array earthing items	YES/NO	1	ST			Taxes Inclusive
3	PS0679062769	Supply of Array LA items	YES/NO	1	ST			Taxes Inclusive
4	PS0679062777	Supply of Module cleaning system items	YES/NO	1	ST			Taxes Inclusive
5	PS0679062823	I&C: Array earthing works	YES/NO	1	AU			Taxes Inclusive
6	PS0679062858	I&C: Module cleaning system works	YES/NO	1	AU			Taxes Inclusive
7	PS0679062874	I&C: Inteconnection of Modules,SMB etc.	YES/NO	3	AU			Taxes Inclusive
8	PS0679062882	Supply of control cable, kits etc.	YES/NO	1	ST			Taxes Inclusive
9	PS0679062890	Supply of Aux Trf, ACDB,DCDB,UPS etc	YES/NO	1	ST			Taxes Inclusive
10	PS0679062912	Supply of Plant lighting system	YES/NO	1	ST			Taxes Inclusive
11	PS0679062920	Supply of Misc items	YES/NO	1	ST			Taxes Inclusive
12	PS0679062939	Supply: Fire alarm sys, Extinguisher etc	YES/NO	1	ST			Taxes Inclusive
13	PS0679062947	Supply of CCTV system	YES/NO	1	ST			Taxes Inclusive
14	PS0679062955	Supply of spare items	YES/NO	1	ST			Taxes Inclusive
15	PS0679062963	I&C: Cable Trench works	YES/NO	4	AU			Taxes Inclusive
16	PS0679062971	I&C : Panel installation in IR rooms	YES/NO	3	AU			Taxes Inclusive
17	PS0679062980	I&C: 33kV Trf yards	YES/NO	3	AU			Taxes Inclusive
18	PS0679062998	I&C: CMCS	YES/NO	1	AU			Taxes Inclusive
19	PS0679063005	I&C: switchyard attached to CMCS	YES/NO	1	AU			Taxes Inclusive
20	PS0679063013	I&C: SCADA System	YES/NO	1	AU			Taxes Inclusive
21	PS0679063021	I&C: Earthing	YES/NO	1	AU			Taxes Inclusive
22	PS0679063030	I&C: Plant lighting system	YES/NO	1	AU			Taxes Inclusive
23	PS0679063048	I&C: Misc items	YES/NO	1	AU			Taxes Inclusive
24	PS0679063056	I&C: CCTV system	YES/NO	1	AU			Taxes Inclusive
25	PS0679063064	I&C: Pre-Commissioning checks etc.	YES/NO	1	AU			Taxes Inclusive
26	PS0679063072	O&M : Monthly basis	YES/NO	120	AU			Taxes Inclusive
27	PS0679063137	Supply of Weather monitoring system	YES/NO	1	ST			Taxes Inclusive
28	**Freight Charge including Service Tax on Freight		YES/NO	Lumpsum			NA	**Freight : Free of Cost/Extra

Please refer RFQ/Tender for detailed description of items.

Note:

1. The quoted prices shall be on "FOR" basis to project sites.
2. Please indicate taxes clearly applicable as on date.
3. The above format only shall be used for compliance.No changes are acceptable.
4. Taxes-inclusive rates for Supply, I&C and O&M to be quoted for Sl No.1-27.
5. Indicate whether freight charges and insurance charges are free of cost or will be charged extra.In absence of clarity, these charges shall be considered free of cost from vendor.(If the offer contains the freight value at actuals, it will be considered as free of cost).
6. SUCCESSFUL VENDOR SHALL SUBMIT THE BILLING BREAK UP FOR SUPPLY & I&C FOR APPROVAL AND IMPLEMENTATION.Successful vendor to furnish HSN/SAC codes against each item for billing break-up implementation.

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ANNEXURE B2

PRICED BID (Indigenous Vendors)								
RFQ No. SPKSCPV002 Dtd.19.07.2017 Due Date (Tech Bid): 02.08.2017								
Sl No.	Material Code	DESCRIPTION	QTY	UNIT	Unit Rate (Rs.)	Total Value (Rs.) (Rate X Qty)	BREAK UP OF TAX STRUCTURE (CGST/SGST/IGST/Service Tax etc) WITH CURRENT RATES	Remarks
1	PS0679062742	Supply of MC4 ,Cable tie,HDPE pipe etc.	1	ST				Taxes Inclusive
	Unit rate in words :							
2	PS0679062750	Supply of Array earthing items	1	ST				Taxes Inclusive
	Unit rate in words :							
3	PS0679062769	Supply of Array LA items	1	ST				Taxes Inclusive
	Unit rate in words :							
4	PS0679062777	Supply of Module cleaning system items	1	ST				Taxes Inclusive
	Unit rate in words :							
5	PS0679062823	I&C: Array earthing works	1	AU				Taxes Inclusive
	Unit rate in words :							
6	PS0679062858	I&C: Module cleaning system works	1	AU				Taxes Inclusive
	Unit rate in words :							
7	PS0679062874	I&C: Inteconnection of Modules,SMB etc.	3	AU				Taxes Inclusive
	Unit rate in words :							
8	PS0679062882	Supply of control cable, kits etc.	1	ST				Taxes Inclusive
	Unit rate in words :							
9	PS0679062890	Supply of Aux Trf, ACDB,DCDB,UPS etc	1	ST				Taxes Inclusive
	Unit rate in words :							
10	PS0679062912	Supply of Plant lighting system	1	ST				Taxes Inclusive
	Unit rate in words :							
11	PS0679062920	Supply of Misc items	1	ST				Taxes Inclusive
	Unit rate in words :							
12	PS0679062939	Supply: Fire alarm sys, Extinguisher etc	1	ST				Taxes Inclusive
	Unit rate in words :							
13	PS0679062947	Supply of CCTV system	1	ST				Taxes Inclusive
	Unit rate in words :							
14	PS0679062955	Supply of spare items	1	ST				Taxes Inclusive
	Unit rate in words :							
15	PS0679062963	I&C: Cable Trench works	4	AU				Taxes Inclusive
	Unit rate in words :							
16	PS0679062971	I&C : Panel installation in IR rooms	3	AU				Taxes Inclusive
	Unit rate in words :							
17	PS0679062980	I&C: 33kV Trf yards	3	AU				Taxes Inclusive
	Unit rate in words :							
18	PS0679062998	I&C: CMCS	1	AU				Taxes Inclusive
	Unit rate in words :							
19	PS0679063005	I&C: switchyard attached to CMCS	1	AU				Taxes Inclusive
	Unit rate in words :							

20	PS0679063013	I&C: SCADA System	1	AU				Taxes Inclusive
	Unit rate in words :							
21	PS0679063021	I&C: Earthing	1	AU				Taxes Inclusive
	Unit rate in words :							
22	PS0679063030	I&C: Plant lighting system	1	AU				Taxes Inclusive
	Unit rate in words :							
23	PS0679063048	I&C: Misc items	1	AU				Taxes Inclusive
	Unit rate in words :							
24	PS0679063056	I&C: CCTV system	1	AU				Taxes Inclusive
	Unit rate in words :							
25	PS0679063064	I&C: Pre-Commissioning checks etc.	1	AU				Taxes Inclusive
	Unit rate in words :							
26	PS0679063072	O&M : Monthly basis	120	AU				Taxes Inclusive
	Unit rate in words :							
27	PS0679063137	Supply of Weather monitoring system	1	ST				Taxes Inclusive
	Unit rate in words :							
28	**Freight Charge including Service Tax on Freight		Lumpsum				NA	**Freight : Free of Cost/Extra
	Freight charge in words :							

Please refer RFQ/Tender for detailed description of items.

Note:

1. The quoted prices shall be on "FOR" basis to project sites.
2. Please indicate taxes clearly applicable as on date.
3. The above format only shall be used for compliance.No changes are acceptable.
4. Taxes-inclusive rates for Supply, I&C and O&M to be quoted for Sl No.1-27.
5. Indicate whether freight charges and insurance charges are free of cost or will be charged extra.In absence of clarity, these charges shall be considered free of cost from vendor.(If the offer contains the freight value at actuals, it will be considered as free of cost).
6. SUCCESSFUL VENDOR SHALL SUBMIT THE BILLING BREAK UP FOR SUPPLY & I&C FOR APPROVAL AND IMPLEMENTATION.Successful vendor to furnish HSN/SAC codes against each item for billing break-up implementation.

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