

Bharat Heavy Electricals Ltd
Electronics Division
Mysore Road, Bangalore – 560 026

**Tender Documents for Design, Supply, I&C and O&M for balance of 15MW
SPV Plant at NTPC-Singrauli-MP**

RFQ Ref: HBSMM20002 RFQ Date : 25.10.2013
RFQ Due Date: 18.11.2013

This Tender Document Contains:

- (1) Request For Quotation
- (2) Technical Specifications : PS- 439-858
- (3) Enclosures B, B1 & B2 : Commercial Terms & Conditions , Unpriced Bid Format and Price Bid Format
- (4) General Terms and Conditions (Doc Ref : SCPV/BOS/01-Rev 00)
- (5) Integrity Pact

For all Technical Documents as per PS- 439-858, pls visit www.bheledn.com

Note:

Part – I: To be submitted in a separate sealed cover.

Part – II: To be submitted in a separate sealed cover.

Part-I & Part-II sealed covers should be put in outer envelope and super scribed with RFQ No., RFQ date and due date along with the Name & Address of the tenderer.

Tender document should be dropped in Tender drop box super scribed “**SC&PV-MM, Monday**”, kept in reception area of BHEL – Electronics Division, Bangalore.

For any clarification, the following may be contacted:

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REQUEST FOR QUOTATION

	BHARAT HEAVY ELECTRICALS LIMITED Electronics Division PB No. 2606, Mysore Road Bangalore - 560026 INDIA	RFQ NUMBER: HBSMM20002 RFQ DATE : 25.OCT.2013	Due Date 18.NOV.2013 Time: 13:00 HRS VENUE : NEW ENGG. BLDG
MMI:PU:RF:003			

	(for all correspondence) Purchase Executive : SRINIVAS H B Phone : 26998452 Fax : 00918026989217 E-mail: srinivasahb@bheledn.co.in
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Please submit your lowest quotation subject to our terms and conditions attached for the material mentioned below. The quotation must be enclosed in a sealed envelope / Fax superscribed with RFQ no. and due date, should reach us on or before the due date by **13.00** hours IST and will be opened on the same day at **13.30** hours at the venue mentioned above. **PLEASE DROP THE OFFER IN THE BOX PROVIDED AT RECEPTION.**

SI No.	Description	Qty	Unit	Delivery qty	Delivery Date
1	PS0679033467 Supply of MC4, Cable tie, HDPE pipe etc Supply of MC4 connectors, cable ties, HDPE conduits, cable lugs, hardware, cable trays, submersible pumps (for bore wells) etc as per clauses 5.5, 5.7, 5.9, 5.10, 5.11. of BHEL Spec PS-439-858. Test Certificate	1	ST	1	17.FEB.2014
2	PS0679033475 Supply of LT/HT/data cables, kits etc Supply of LT power cables, HT (33kV) power cables, control / instrumentation cables with cable installation accessories, hardware, termination kits etc as per clauses 5.20, 5.21 of BHEL spec PS-439-858. Test Certificate	1	ST	1	17.FEB.2014
3	PS0679033483 Supply of Materials for Inv. Room Supply of materials for construction of inverter rooms as per clause 5.14 of BHEL spec PS-439-858. (1 set = 1 inverter room) Test Certificate	5	ST	5	17.FEB.2014
4	PS0679033491 Supply of DG Set, Aux Transformer etc Supply of auxiliary transformer, ACDB / DCDB panels, battery banks, battery chargers, DG set with all related accessories and hardware as per clauses 5.27-5.31 of BHEL spec Ps-439-858 Test Certificate	1	ST	1	17.FEB.2014
5	PS0679033505 Supply of items of earthing systems 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 5.33. of BHEL spec PS-439-858. Test Certificate	1	ST	1	17.FEB.2014
6	PS0679033513 Supply items of module cleaning system Supply of items of module cleaning system such as pumps, GI pipes with fittings, valves etc, as per clause 5.36. of BHEL spec PS-439-858. Test Certificate	1	ST	1	17.FEB.2014
7	PS0679033521 Supply LA for PV array, cntrl room etc Supply of lightning arrestors for the complete solar power plant as per clauses 5.34 as per BHEL spec Ps-439-858. Test Certificate	1	ST	1	17.FEB.2014
8	PS0679033530 Supply of items of yard lighting systems Supply of items for lighting system such luminaires,	1	ST	1	17.FEB.2014

For and On behalf of BHEL.

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SI No.	Description	Qty	Unit	Delivery qty	Delivery Date
	ballasts, junction boxes, conduits, fittings and accessories etc, and related accessories, hardware etc as per clause 5.35 of BHEL spec PS-439-858. Test Certificate				
9	PS0679033548 Supply of miscellaneous items Supply of miscellaneous items such as ABT metering panel, cable tags, danger boards, cable markers, hoarding board, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, tool kits, measuring instruments, office furniture, LCD display for SCADA system etc as per clauses 5.26, 5.32, 5.37-5.43.as per BHEL spec PS-439-858. Test Certificate	1	ST	1	17.FEB.2014
10	PS0679033556 Supply fire alarm sys, extinguishers etc Supply of safety related items including fire alarm system, fire extinguishers, safety gadgets etc as per clauses 5.44 of BHEL spec PS-439-858. Test Certificate	1	ST	1	17.FEB.2014
11	PS0679033564 I&C: Temp site office, storage yard etc I&C: Temporary site office, storage yard, bore wells, unloading / movement of consignments, arranging electrical power / water etc as per clauses 5.1 to 5.6 of BHEL spec Ps-439-858.	1	AU	1	20.MAR.2014
12	PS0679033572 I&C: Interconnection Modules,SMBs etc I&C: Interconnection of SPV modules, installation of string monitoring boxes including power cable terminations as per clauses 5.7 to 5.13 as per BHEL spec PS-439-858.	6	AU	6	20.MAR.2014
13	PS0679033580 I&C:Trenches,cable laying etc 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 5.22. of BHEL spec PS-439-858.	6	AU	6	20.MAR.2014
14	PS0679033599 I&C : Inverter Room I&C: Erection of inverter rooms (prefab roof / wall) with all related features such as roof, walls, floors, doors, windows, ventilators, exhaust provisions, plinth protection, electrical wiring, appliances, painting etc as per clause 5.14 of BHEL spec PS-439-858.	5	AU	5	20.MAR.2014

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SI No.	Description	Qty	Unit	Delivery qty	Delivery Date
15	PS0679033602 I&C: Elec panel instln Inverter room I&C: Erection of indoor electrical panels (PCUs, breaker panels, ACDB/DCDB panels etc) in the individual inverter rooms including grouting of panels, laying & fixing of cable trays, routing and terminations of DC/AC cables at the electrical panels up to interconnections to LV side of transformers in the switchyard as per clauses 5.18 to 5.21. of BHEL spec Ps-439-858.	5	AU	5	20.MAR.2014
16	PS0679033610 I&C: 33 KV S/yard at Inv room I&C: Erection of 33kV switchyards (attached to the five individual inverter rooms) with necessary land leveling within switchyard, laying of underground earth mat grid, foundation / erection of transformers, underground cable trenches, laying of 33kV/ LT / data / control / SCADA cables between switchyard and the inverter room panels, laying of earthing strips, earthing interconnections, stone jellies, fencing and gate for switchyard, etc. as per clauses 5.15, 5.22, 5.33. of BHEL spec Ps-439-858.	5	AU	5	20.MAR.2014
17	PS0679033629 Construction of Main Control Room (CMCS) Construction of RCC main control room (CMCS room with lounge, inverter / breaker panel rooms, store room, battery room, toilets, wash basins etc), with all RCC works, masonry works, doors, windows, glazing/ plastering works, flooring, roofing, false ceiling, ventilators, exhaust provisions, plinth protection, electrical wiring, appliances, overhead water tanks, water plumbing works, sanitary fittings, painting etc as per clause 5.16 of BHEL spec PS-439-858.	1	AU	1	20.MAR.2014
18	PS0679033637 I&C: Elec panel instln at CMCS I&C: Erection of indoor electrical panels (PCUs, VCB panels, batteries, chargers, DC/AC distribution board panels, SCADA system etc) in the main control room (CMCS) including grouting of panels, laying & fixing of cable trays, routing and terminations of DC/AC cables to the electrical panels and to 33kV side of 33/132kV transformer in switchyard etc as per clauses 5.18 to 5.21 of BHEL spec Ps-439-858.	1	AU	1	20.MAR.2014
19	PS0679033645 I&C: 33 KV S/yard at CMCS I&C: Erection of 33kV portion of the 33/132kV switchyard (attached to the main control room - CMCS) with erection of three winding transformers (including	1	AU	1	20.MAR.2014

For and On behalf of BHEL.

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	their foundations and oil soak pits), fire wall between transformers, underground cable trenches, laying of 33kV/ LT / data / control / SCADA cables between switchyard and the control room panels, laying of earthing strips for 33kV switchyard equipments, earthing connections etc as per clause 5.17, 5.22, 5.33. of BHEL spec PS-439-858.				
20	PS0679033653 I&C SCADA System 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 CMCS room as per clause 5.32 of BHEL spec PS-439-858.	1	AU	1	20.MAR.2014
21	PS0679033661 I&C : DG Set, aux Transformer, etc I&C: Installation of auxiliary transformer, ACDB / DCDB panels, Battery banks, Battery chargers, DG set including cable interconnections as per clauses 5.27-5.31. of BHEL spec PS-439-858.	1	AU	1	20.MAR.2014
22	PS0679033670 I&C: Earthing system: Array, S/yard etc 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 as per clauses 5.33, 5.34. of BHEL spec PS-439-858.	1	AU	1	20.MAR.2014
23	PS0679033688 I&C: Yard lighting system I&C of lighting system for illumination of the complete power plant including cable terminations at the yard lighting poles as well as ACDB panels of inverter room / main control room etc as per clause 5.34. of BHEL spec PS-439-858.	1	AU	1	20.MAR.2014
24	PS0679033696 I&C: Module cleaning system I&C of module cleaning system including trenches for pipelines, laying of pipelines from bore wells to solar array field, erection of pumps, valves etc as per clause 5.36. of BHEL spec PS-439-858.	1	AU	1	20.MAR.2014
25	PS0679033700 Construction of Boundary Wall Construction of boundary walls as per clauses 5.46 of BHEL spec PS-439-858. (20% of total work = 1 AU)	5	AU	5	20.MAR.2014
	PS0679033718 I&C: Misc Items fire alarm sys etc	1	AU	1	20.MAR.2014

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26	I&C of miscellaneous and safety items such as ABT metering panel, cable tags, danger boards, cable markers, hoarding board, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, office furniture, fire extinguishers, fire alarm system, LCD display for SCADA system etc as per clauses 5.26, 5.32, 5.37-5.41, 5.43, 5.44 of BHEL spec PS-439-858.				
27	PS0679033726 I&C: Commissioning, state clearances etc I&C: Pre-commissioning inspections / checks / tests, MRT tests and coordination with state / central departments / CEIG etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant as per clause 5.53 of BHEL spec PS-439-858.	1	AU	1	20.MAR.2014
28	PS0679033734 O&M of SPV Power Plant Operations and Maintenance per month (one Year) as per clause 8.0 of BHEL spec PS-439-858. 1AU = 1 Month.	12	AU	12	20.MAR.2014
29	PS0679033742 Supply of spares Supply of spare items as per clause 5.54 of BHEL spec PS-439-858. Test Certificate	180	LOT	180	20.MAR.2014
30	PS0679033866 Constn. of approach road & level crossing Construction of approach roads and railway level crossing as per clauses 5.49, 5.50 of BHEL spec PS-439-858.	1	AU	1	19.NOV.2013
31	PS0679033874 Construction of Pathways Construction of pathways as per clauses 5.47 of BHEL spec PS-439-858.	1	AU	1	19.NOV.2013
32	PS0679033882 Construction of Drainage System Construction of drainage system as per clause 5.48 of BHEL spec PS-439-858. (20% of total work = 1 AU)	5	AU	5	19.NOV.2013
33	PS0679033890 Constn. of Security cbn, watch tower etc Construction of security cabin, watch tower, landscaping as per clauses 5.45, 5.51 and 5.52 of BHEL spec PS-439-858.	1	AU	1	19.NOV.2013


Total Number of Items - 33

Please note that 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.

For and On behalf of BHEL.

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REQUEST FOR QUOTATION

 MMI:PU:RF:003	BHARAT HEAVY ELECTRICALS LIMITED Electronics Division PB No. 2606, Mysore Road Bangalore - 560026 INDIA	RFQ NUMBER: HBSMM20002 RFQ DATE : 25.OCT.2013	Due Date 18.NOV.2013 Time: 13:00 HRS VENUE : NEW ENGG. BLDG
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Preference will be given to vendors who accepts our standard payment terms i.e.100% payment - 30 days after receipt of material at our works subject to acceptance. 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 rejected.The list of banned firms is available on BHEL web site www.bhel.com			
i). This is only RFQ not an order. ii). In all correspondence quote RFQ No. & due date. iii). In Quotation BHEL material code / RFQ Sl. No. should be mentioned clearly. iv). Quotation Envelope / Fax not superscribed with RFQ No.and due date is liable for rejection. v). Quotation should remain valid for a minimum peiod of 90 days from due date. vi). In case of non-receipt of Quotation or regret letter for 3 consecutive RFQs you are liable to be removed from our vendors list. vii). All Prices should be written in words and numbers. viii). Excise Chapter Heading should be mentioned for all items where VAT is applicable .			

For and On behalf of BHEL.



PURCHASE SPECIFICATION; GROUP: PHOTOVOLTAICS
DESIGN, SUPPLY, I&C, O&M OF BALANCE OF SYSTEM ITEMS
FOR 15MW SPV POWER PLANT AT NTPC-SINGRAULI, MP

PS-439-858

Rev No: 00

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Specification for

Design, Supply, I&C, O&M of Balance of System items
for 15MWp Solar Photovoltaic Grid-connected Power plant
at

NTPC-Singrauli, MP

Revision details : R 00	Prepared:	Approved:	Date:
	Varun Jain	N Harihara krishnan	24-May-2013



**PURCHASE SPECIFICATION; GROUP: PHOTOVOLTAICS
DESIGN, SUPPLY, I&C, O&M OF BALANCE OF SYSTEM ITEMS
FOR 15MW SPV POWER PLANT AT NTPC-SINGRAULI, MP**

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FOR 15MW SPV POWER PLANT AT NTPC-SINGRAULI, MP**

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	PURCHASE SPECIFICATION; GROUP: PHOTOVOLTAICS DESIGN, SUPPLY, I&C, O&M OF BALANCE OF SYSTEM ITEMS FOR 15MW SPV POWER PLANT AT NTPC-SINGRAULI, MP	PS-439-858
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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 15 MWp solar photovoltaic (SPV) power plant at NTPC-Singrauli with the overall project scope comprising of three major portions as follows:

(A) Solar power plant at Singrauli, MP

- (a) The SPV modules employed at the power plant generates DC electricity that in turn is inverted to AC in the range 300-400V. The voltage is further stepped up to 33kV using 1.6MVA transformers. Twelve such transformers are employed to achieve 15MWp. Further, the combined output is stepped up to 132kV level using 16MVA transformer to facilitate energy export to 132kV grid.
- (b) String monitoring boxes (SMBs) are employed to monitor the DC parameters of the strings of solar array. The DC power outputs from the SMBs are fed to 24 Nos of 630kW grid-interactive power conditioning units (inverters) that are housed in a distributed manner among 5 inverter rooms and one central monitoring and control station (CMCS) room. The inverter rooms, each generating 2.5MWp, are placed at different locations of the power plant. Each room is associated with a 33kV transformer yard (switchyard), employing two oil-immersion transformers of 1.6MVA, 33kV/xxx-xxxV (one HV and two LV windings), xxx in the range 300-400V. The vacuum circuit breaker (VCB) protection indoor panels (2 incomers, 1 outgoer) are also placed in each inverter room. Thus, all these five inverter rooms, put together, generate 12.5MWp. The balance 2.5MWp is generated at CMCS end, using one similar set of 4x630kWp inverters, 2x1.6MVA transformers.
- (c) The 6 sets of 2.5MWp outputs are combined at CMCS using another set of indoor VCB panels placed within CMCS. This set has 6 incomer and 1 outgoer panel. Further, this combined power output (33kV, 15MWp) is fed to an oil-immersion type 16MVA, 33/132kV transformer.
- (d) The CMCS is, thus, attached to a 33/132kV switchyard. The portion on the 132kV side of transformer comprises of outdoor-mounted equipment viz. SF6 breaker, CTs, PTs, surge arrestors, GOS isolators, earth switches, support structures / gantry towers / beams etc that facilitate relay protection (line as well as transformer) and metering. The metering and relay protections are supported by a separate Control and Relay (C&R) panel placed in the CMCS room.
- (e) The solar power plant is monitored using SCADA system that is placed in CMCS room.
- (f) All the switchyards are supported by underground earthmat grid system that provides earthing for all the switchyard equipments.

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- (g) DC supply (220V), required for various electrical equipment such as protection relays, indication lamps etc is provided by a set of DC battery banks and chargers that are in turn charged by the auxiliary supply (433V) deduced from 33kV bus using an oil-immersion type 200kVA, 33kV/433V auxiliary transformer placed at CMCS end.
- (h) The plant has several other infrastructural support systems such as bore wells (for water supply), underground water pipeline network system for cleaning of SPV modules, lighting system for illumination of plant, fire alarm system for the inverter / CMCS rooms, fire extinguishers, tools and instruments for operations and maintenance etc.
- (i) The plant is provided with an all-around boundary wall with a gate. Each switchyard is provided with chain link fencing and gate. Approach roads, pathways, drainage system are also part of project scope.
- (j) The SPV power plant has one ABT energy meter that monitors energy generation at 33kV side of 16MVA, 33/132kV transformer and one another meter at 132kV side.

BHEL drawings viz (a) single line diagram of SPV power plant up to power export to 132kV grid and (b) solar array layout are enclosed with tender.

(B) Transmission line between SPV plant and Singrauli Super Thermal Power Station (SSTPS)

The power generated at SPV plant is transported to SSTPS using 132kV overhead (OH) transmission line (supported by transmission towers). Wherever OH line is not feasible due to practical conditions en route, underground cables are laid. The distance between SPV plant and SSTPS is 10 Km approximately.

NTPC drawing showing transmission line route is enclosed herewith.


(C) 132kV switchyard at SSTPS, UP

The transmission lines / cables get terminated at 132kV switchyard (SSTPS end) that comprises of equipments such as SF6 breaker, CTs, PTs, surge arrestors, GOS isolators, earth switches, support structures / gantry towers / beams, IPS tubes etc. The control and relay panel is kept within control room of the power plant.

BHEL drawing showing single line diagram of 132kV bay at SSTPS is enclosed with tender.

1.2 Vendor scope

The vendor scope is of design, supply, installation, commissioning, operations and maintenance that includes activities but not limited to design, engineering, drafting of drawings, obtaining BHEL/NTPC approvals for the design / drawings, manufacture / testing / inspection at manufacturer's works, packing, supply, transportation, transit insurance, delivery to site, unloading, storage and equipment

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erection including associated civil and structural works for the SPV power plant (as per clause 1.1 (A) above) portion of the project excluding certain portions of 33/132 kV switchyard and certain items that will be directly supplied by BHEL.

Additionally, the scope includes various coordination / liaison activities (related to clearance / approval) with concerned state / central authorities such as CEIG etc and also operations and maintenance of the complete 132kV portion of the project for a period of one year after successful trial run for cumulative 72 hours of trouble-free operation following successful commissioning of the plant (export of generated power to 132kV grid, transporting the same to SSTPS substation and hooking it up to 132kV buses at SSTPS) as certified by concerned authorities.

Note: The above is only a broad outline of vendor scope for the sake of introduction. The detailed vendor scope, together with BHEL scope, are listed under section 3.0 and elaborated under section 5.0 onwards.

1.3 Address particulars of the power plant


Vendor shall note that the SPV power plant is located at MP, whereas the Singrauli Super Thermal Power Station (SSTPS) is at UP.

(1) Address of SPV Power plant

NTPC Ltd,
Singrauli Solar PV Power Project,
Near Nehru Shatabdi Hospital
PO Jayant
District Singrauli
MP 486890

(2) Address of SSTPS

NTPC Ltd,
Singrauli Super Thermal Power Station
PO Shaktinagar
District Sonebhadra
UP 231222


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1.4 Enclosures to this specification

1	Single line diagram of overall SPV power plant - 36790500658
2	Tentative site layout with locations of solar array, inverter rooms, switchyards - 36790500654
3	Drawing of SPV module L20220 type - 36700200370
4	GA assembly drawing of module mounting structure - BH-NT-SI-DWG-004 (22 pages)
5	Sketch showing panel positions in inverter room - 36790500656
6	Sketch showing inside layout of central monitoring control station (CMCS) 36790500657
7	Tentative drawing of boundary wall – 0000-000-POC-A-001
8	Tentative drawing of watch tower
8	Tentative drawing of security cabin 36790500653
9	Geo technical (soil) study report 81 Pages
10	NTPC approved vendor lists – 31 Pages
11	Indicative field quality plan of NTPC – 16 Pages

2.0 Pre-Qualification Criteria (POC) for vendors

- (a) Vendor should have carried out design, supply, installation and commissioning (or EPC contract) of minimum cumulative of 10MWp solar photovoltaic power plants in India, with individual power plant projects of 1MW and above. Evidence of completion certificates from clients shall be submitted for the same along with technical offer.
- (b) Vendor shall submit a declaration that materials for the present project shall be procured from NTPC-approved “A” or “N” category sub-vendors, for whichever the items NTPC has approved the sub-vendors. Sub-vendors with “DR” category status as on the day of tender opening shall not be considered.

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3.0 Scope of work

3.1 Vendor scope of work (brief outline)

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, cable lugs, hardware, cable trays, submersible pumps (for bore wells) etc as per clauses 5.5, 5.7, 5.9, 5.10, 5.11.	1 set
2	Supply of LT power cables, HT (33kV) power cables, control / instrumentation cables with cable installation accessories, hardware, termination kits etc as per clauses 5.20, 5.21.	1 set
3	Supply of materials for construction of inverter rooms as per clause 5.14. (1 set = 1 inverter room)	5 sets
4	Supply of auxiliary transformer, ACDB / DCDB panels, battery banks, battery chargers, DG set with all related accessories and hardware as per clauses 5.27-5.31.	1 set
5	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 5.33.	1 set
6	Supply of lightning arrestors for the complete solar power plant as per clauses 5.34.	1 set
7	Supply of items of module cleaning system such as pumps, GI pipes with fittings, valves etc, as per clause 5.36.	1 set
8	Supply of items for lighting system such luminaires, ballasts, junction boxes, conduits, fittings and accessories etc, and related accessories, hardware etc as per clause 5.35.	1 set
9	Supply of miscellaneous items such as ABT metering panel, cable tags, danger boards, cable markers, hoarding board, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, tool kits, measuring instruments, office furniture, LCD display for SCADA system etc as per clauses 5.26, 5.32, 5.37-5.43.	1 set
10	Supply of safety related items including fire alarm system, fire extinguishers, safety gadgets etc as per clauses 5.44.	1 set
11	Supply of spare items as per clause 5.54.	1 set
12	I&C: Temporary site office, storage yard, bore wells, unloading / movement of consignments, arranging electrical power / water etc as per clauses 5.1 to 5.6	1 AU
13	I&C: Interconnection of SPV modules, installation of string monitoring boxes including	1 AU



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	power cable terminations as per clauses 5.7 to 5.13	
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 5.22.	5 AU
15	I&C: Erection of inverter rooms (prefab roof / wall) with all related features such as roof, walls, floors, doors, windows, ventilators, exhaust provisions, plinth protection, electrical wiring, appliances, painting etc as per clause 5.14.	5 AU
16	I&C: Erection of indoor electrical panels (PCUs, breaker panels, ACDB/DCDB panels etc) in the individual inverter rooms including grouting of panels, laying & fixing of cable trays, routing and terminations of DC/AC cables at the electrical panels up to interconnections to LV side of transformers in the switchyard as per clauses 5.18 to 5.21.	5 AU
17	I&C: Erection of 33kV switchyards (attached to the five individual inverter rooms) with necessary land leveling within switchyard, laying of underground earth mat grid, foundation / erection of transformers, underground cable trenches, laying of 33kV/ LT / data / control / SCADA cables between switchyard and the inverter room panels, laying of earthing strips, earthing interconnections, stone jellies, fencing and gate for switchyard, etc. as per clauses 5.15, 5.22, 5.33.	1 AU
18	Construction of RCC main control room (CMCS room with lounge, inverter / breaker panel rooms, store room, battery room, toilets, wash basins etc), with all RCC works, masonry works, doors, windows, glazing/plastering works, flooring, roofing, false ceiling, ventilators, exhaust provisions, plinth protection, electrical wiring, appliances, overhead water tanks, water plumbing works, sanitary fittings, painting etc as per clause 5.16.	1 AU
19	I&C: Erection of indoor electrical panels (PCUs, VCB panels, batteries, chargers, DC/AC distribution board panels, SCADA system etc) in the main control room (CMCS) including grouting of panels, laying & fixing of cable trays, routing and terminations of DC/AC cables to the electrical panels and to 33kV side of 33/132kV transformer in switchyard etc as per clauses 5.18 to 5.21.	1 AU
20	I&C: Erection of 33kV portion of the 33/132kV switchyard (attached to the main control room - CMCS) with erection of three winding transformers (including their foundations and oil soak pits), fire wall between transformers, underground cable trenches, laying of 33kV/ LT / data / control / SCADA cables between switchyard and the control room panels, laying of earthing strips for 33kV switchyard equipments, earthing connections etc as per clause 5.17, 5.22, 5.33.	1 AU
21	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 CMCS room as per clause 5.32.	1 AU




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22	I&C: Installation of auxiliary transformer, ACDB / DCDB panels, Battery banks, Battery chargers, DG set including cable interconnections as per clauses 5.27-5.31.	1 AU
23	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 as per clauses 5.33, 5.34.	1 AU
24	I&C of lighting system for illumination of the complete power plant including cable terminations at the yard lighting poles as well as ACDB panels of inverter room / main control room etc as per clause 5.34.	1 AU
25	I&C of module cleaning system including trenches for pipelines, laying of pipelines from bore wells to solar array field, erection of pumps, valves etc as per clause 5.36.	1 AU
26	Construction of boundary walls as per clauses 5.46 (20% of total work = 1 AU)	5 AU
27	Construction of approach roads and railway level crossing as per clauses 5.49, 5.50.	1 AU
28	Construction of pathways as per clauses 5.47.	1 AU
29	Construction of drainage system as per clause 5.48. (20% of total work = 1 AU)	5 AU
30	Construction of security cabin, watch tower, landscaping as per clauses 5.45, 5.51 and 5.52	1 AU
31	I&C of miscellaneous and safety items such as ABT metering panel, cable tags, danger boards, cable markers, hoarding board, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, office furniture, fire extinguishers, fire alarm system, LCD display for SCADA system etc as per clauses 5.26, 5.32, 5.37-5.41, 5.43, 5.44	1 AU
32	I&C: Pre-commissioning inspections / checks / tests, MRT tests and coordination with state / central departments /CEIG etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant as per clause 5.53.	1 AU
33	Operations and Maintenance per month (one Year) as per clause 8.0	12 Mon

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3.2 BHEL scope of work

For the sake of clarity to the vendor, the items and activities that are within the scope of BHEL are listed below. The receipt, unloading, storage, handling, erection of the supply items are within the scope of vendor. However, insurance for the BHEL-supplied items is within BHEL scope.


1	Jungle clearance (removal of bushes, cutting of trees etc)	-
2	Site leveling / grading, soil testing, topography survey	-
3	Supply of solar PV Modules (240Wp)	~ 62,640 Nos
4	Supply, foundations and installation of solar array structures with modules mounted on the structures	2610 structures
5	Supply of cable, 1Cx 6 sq-mm (for connection of PV modules to string monitoring boxes)	required length
6	Supply of cable, 1C x 240 sq-mm (for connection from solar arrays up to PCUs in inverter rooms and main control room CMCS)	required length
7	Supply of control / instrumentation / OFC cables for SCADA interconnections	required length
8	Supply of string monitoring boxes with mounting fixtures	120 sets
9	Supply and installation of weather monitoring equipments (pyranometers – 2 Nos, ambient temperature sensor – 1 No, module temperature sensor – 1 No, anemometer – 1 No)	1 set
10	Supply of power conditioning units (PCUs) of 630 kW with ACB panels	24 sets
11	Supply of transformers 1.6 MVA, 33kV/xxx V-xxx V (1 HV winding, 2 LV windings), Dyn11yn11, ONAN (oil immersion type)	12 Nos
12	Supply of transformer 16MVA, 33/132kV, Dyn11 with neutral CT	1 No
13	<u>Supply of 33kV breaker panels</u> Vacuum circuit breaker (VCB) panels – indoor type – with CTs, PTs, relays, meters etc: (a) 10 incomers and 5outgoers at solar power plant end, (b) 7 incomers, 2outgoerpanels and 1 Bus PT panel at 33kV grid end.	1 set
14	Supply of earth mat materials and laying of earth mat for 132kV switchyard at main control room (CMCS end).	1 set
15	Supply and installation of complete set of switchyard equipment on 132kV side of transformer: List includes SF6 breaker, CTs, CVTs, GOS isolators with earth switches / motor / motor controls, surge arrestors, bus post insulators, Gantry towers & beams, ACSR conductors, earthing materials, lightning mast etc. The scope also covers laying of foundations and erection of steel	1 set

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	structures for these switchyard electrical equipments.	
16	Supply and installation of C&R panel and ABT metering panel for 132kV line metering and transformer protection.	1 No
17	Supply of SCADA system including data loggers / PLC panels, computers, software systems and related peripherals & accessories.	1 set
18	Supply of GPS time synchronization equipment (master clock) for interfacing with ABT meter.	1 No.

4.0 Instructions to vendors on bid submission

4.1	<p>Offer shall be submitted in two-parts (Two part-bid).</p> <p>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.</p>
4.2	<p>First-part shall be techno-commercial bid. Following details shall be furnished:</p> <ol style="list-style-type: none"> 1. List of installation / commissioning / works carried out for solar photovoltaic power projects indicating name of project, size of project (in kW/MW), location of site, name of client, year of installation, scope of work. 2. Technical offer with covering letter. 3. Filled-up enclosures as per BHEL formats (meant for first-part) provided in tender. 4. Company brochure. 5. Project implementation time schedule. 6. Stage-wise manpower schedule.
4.3	<p>Second-part shall be price bid with filled up enclosures as per BHEL formats provided in tender.</p>
4.4	<p>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.</p>

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5.0 Technical specification for supply, installation and commissioning

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

#	BHEL specification
5.1	<p>Setting up of temporary site office</p> <p>(1) Vendor shall set up a temporary site office using two porta cabins, each of 200 sq-ft minimum, within one week to 10 days from the date of purchase order to enable speedy commencement of site activities.</p> <p>(2) Cabin shall be retained at the site until completion of 3 months after commissioning.</p> <p>(3) Cabin shall be furnished with essential amenities such as two work tables, six chairs and necessary number of power points, lamps and fans.</p>
5.2	<p>Electrical power, water for construction, drinking water</p> <p>(1) Vendor shall organize necessary electrical power supply such as DG sets etc required for construction activities and also for the porta cabin.</p> <p>(2) Vendor shall also establish, on their own, water source such as bore wells, water tankers etc for construction activities.</p> <p>(3) Vendor shall arrange drinking water for the site engineers of BHEL and the staff/employees of vendor.</p>
5.3	<p>Construction of temporary yard for safe storage of all BHEL as well as vendor supplied items</p> <p>(1) Vendor shall, at a suitable location at the site, as decided based on discussions with BHEL site engineer, construct a temporary yard for safe storage of BHEL as well as vendor supplied items. This includes storage of all items such as electrical panels (PCUs, LT panels, HT panels, Battery banks, Battery chargers etc), transformers, cables, string monitoring boxes, solar PV modules, spares, tools, instruments etc.</p> <p>(2) Area of storage yard shall be approximately 1500 sq-m. Typical size shall be 30m x 50m. However, exact size shall be decided mutually with BHEL based on site conditions.</p> <p>(3) Of this, an appropriate area shall be provided with suitable roof (asbestos, FRP, steel sheet etc) supported by steel poles that shall be grouted using suitable concrete foundations.</p> <p>(4) Necessary raised / covered arrangements shall be provided to the individual panels / equipment to ensure that these items are not affected by water at the ground level during time of rain storm, flood etc.</p> <p>(5) Yard shall be fenced all around with a steel gate of width of 5m minimum. Height of fence and gate shall be 2.5m minimum above the ground level.</p> <p>(6) Suitable fencing shall be provided using steel poles at every 3m intervals and barbed wires between the poles.</p> <p>(7) Gate shall be suitably secured to the fencing poles and shall be provided with lock and key.</p> <p>(8) Watch and ward security personnel shall be provided for the yard on round-the-clock basis.</p>



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5.4	<p>Receipt, unloading, safe storage and movement of BHEL and vendor supplied items:</p> <ol style="list-style-type: none">(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 received at the site and subsequent movement to the storage yard. Similar arrangements shall also be made by vendor for movements of the items from storage yard to the point of construction.(2) Vendor shall maintain proper documentation / compilation of all the records related to shipping (invoices, delivery challans etc) and shall take verification and approval from BHEL site engineer for every consignment. The documents shall be suitably preserved for further handing over to BHEL.(3) Safeguarding the items from pilferage etc is responsibility of vendor. For this purpose, vendor shall post adequate watch and ward for the yard on round-the-clock basis.(4) Registers shall be maintained for the yard to keep track of incoming / outgoing items.(5) Vendor shall arrange for necessary insurance for the stored items of vendor supply up to the time of commissioning.(6) BHEL will ensure insurance for all the BHEL supplied items.
5.5	<p>Construction of bore wells including hydro survey, water analysis, electrical cabling and plumbing works.</p> <ol style="list-style-type: none">(1) Five bore wells shall be dug at locations as identified by hydrological survey and as certified by BHEL.(2) Bore wells shall be of necessary depth based on water table at the identified locations.(3) Water analysis shall be carried out and report submitted to BHEL.(4) Submersible AC centrifugal pump of 5HP (3 phase) with all necessary electrical cabling up to main ACDB panel of CMCS room (or) the ACDB panels of the nearest inverter room.(5) Casing as required shall be provided for the pump.(6) Pump and the electrical cables of appropriate rating and cores shall be in vendor scope of supply.(7) Cables shall be directly buried as per relevant clauses of "Cabling" section of this specification.(8) Length of cable required shall be appropriately selected by the vendor.(9) Pump make: CGL, Suguna, Kirloskar or any other reputed equivalent as shall be approved by BHEL / NTPC.(10) Cables shall be of make as per NTPC approved vendor list.
5.6	<p>Laying of pipelines between bore wells and overhead tank</p> <ol style="list-style-type: none">(1) GI pipes (2-inch) shall be laid underground (at depth of 600 mm minimum) from the bore wells to overhead tank of control room.(2) All necessary GI fittings such as T-joints, bends, nipples, reducers, couplers etc shall be used as applicable.



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- (3) Lines from different bore wells shall have independent 2-inch non-returnable valves (forged steel) and 2-inch ball valve (forged steel). Further, the lines shall be interconnected underground to become a single line as it approaches the CMCS control room.
- (4) Vendor shall submit a detailed water pipeline layout scheme with bill of materials for BHEL/NTPC approval.

5.7 Interconnection of SPV modules to form strings

Supply of SPV modules is in BHEL scope.

Type of module: L20220 type, rating: ~240 Wp as per BHEL drawing enclosed with tender.

Total quantity = 62,640Nos

Erection of mounting structures (including foundations) and mounting of the SPV modules on the structures are in BHEL scope.

Vendor shall interconnect the 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, 24 modules shall be connected in series. Each set of connections is called as a series string. Thus, a total of 2610 strings will be used to achieve $2610 \times 24 \times 240 \text{Wp} = \sim 15 \text{ MWp}$.
- (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.
- (e) Interconnected cables shall be neatly routed and dressed using UV resistant nylon cable ties of appropriate dimension.
- (f) These cable ties shall be in vendor scope of supply. **Approved make:** 3M, Phoenix contact, Weidmuller, Hellermanntyton, Panduit.
Specs: Nylon cable ties, polyamide 6.6 UV stabilized black, UL94 flammability rating V2, meant for outdoor use. Operating temperature up to 85 deg C. Width of cable tie shall be minimum 4.5 mm. BHEL approval shall be obtained for the selected brand and sizes of cable tie.
- (g) Cables shall not be loosely hanging.



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| 5.8 | Installation of string monitoring boxes
<p>(1) Supply of string monitoring boxes (SMB), 120 sets, is in BHEL scope. These are 22-in and 1-out type.</p> <p>(2) Vendor shall install the SMBs in the solar array field.</p> <p>(3) All fixtures including stand, canopy, hardware etc required for installation of SMBs are in BHEL scope of supply.</p> <p>(4) Drawings and details of SMBs and the fixtures will be provided to the vendor after placement of purchase order.</p> <p>(5) Vendor shall grout the stands of the SMBs into the ground using RCC foundation with M25 concrete and steel rods of 8mm minimum diameter. Depth of foundation shall be a minimum of 800mm below the ground level. Foundation shall be raised up to a level of 300mm minimum above the ground level.</p> <p>(6) Foundation drawing shall be submitted for BHEL/NTPC approval.</p> <p>(7) SMBs shall be fixed on the stands using the hardware that are supplied by BHEL as part of SMB assembly kit.</p> <p>(8) All tools necessary for mounting shall be in vendor scope.</p> |
| 5.9 | Interconnection of SPV module cable to 6 sq-mm cable:
<p>(1) Each SPV module string shall be connected to SMB using 1Cx 6 sq-mm cable (copper, XLPO insulation, PVC outer sheath, as per TUV 2pfg 1169/08.2007) supplied by BHEL.</p> <p>(2) SPV module is provided with positive and negative cables (4 sq-mm) having male and female parts of MC4 type connectors.</p> <p>(3) Vendor shall supply plug connectors of MC4 type, each set having a pair of male and female parts, to join the 6 sq-mm cable with SPV module cable.</p> <p>(4) MC4 connectors shall have rating of 1000VDC (IEC), rated current of 30A, Type approved by TUV Rheinland for product safety.</p> <p>(5) Approved make: Multi-contact (MC4).</p> <p>(6) Total quantity of MC4 connector sets required = 2610 sets (each set having a male and a female part)</p> <p>(7) Extra quantity shall also be procured considering possibilities of damages during the installation. Vendor shall ensure that there shall not be any shortage during execution time.</p> <p>(8) Two sets of tool kits (with plastic 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 4 sq-mm and 6-sqmm (of both pliers).</p> <p>(9) Note: For any other equivalent make of plug connectors and tool sets, BHEL/NTPC approval shall be taken prior to procurement.</p> |



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5.10	<p>Routing of 1Cx 6 sq-mm cable</p> <ol style="list-style-type: none">(1) 6 sq-mm cables connecting the SPV module strings to SMBs shall be neatly routed along a GI cable tray, 2mm thick x 150mm minimum width x 25 mm max height, of make as per NTPC approved vendor list.(2) Cable tray shall run along the stretch of structures up to the SMB box.(3) Make, dimensions, specifications of the cable tray shall be submitted to BHEL / NTPC for approval.(4) Cable ties, nylon polyamide 6.6 UV stabilized black, UL94 flammability rating V2, operating temperature up to 85 deg C, shall be used to arrest any possibility of movement or sagging. Cable ties shall be of make: 3M, Phoenix contact, Weidmuller, Hellermannntyton, Panduit. Width of the cable ties shall be a minimum of 4.5 mm.(5) Total length of cable tray required shall be appropriately selected by the vendor.
5.11	<p>Underground laying of 6 sq-mm cables between the rows</p> <ol style="list-style-type: none">(1) Where 6 sq-mm cables run between two rows of structure, HDPE double walled corrugated (DWC) pipe shall be used to guide the cables underground from one row to the other.(2) HDPE DWC pipe shall be within scope of vendor supply.(3) Specification of HDPE DWC pipe: As per IEC 61386 part 1-4; ID shall be selected to accommodate the number of 6 sq-mm cables to be guided. However, ID shall be minimum 63mm.(4) Make, part number, sizes / dimensions shall be submitted for BHEL/NTPC approval.(5) Cables with the HDPE pipe shall be directly buried underground as per trench dimensions below:<ol style="list-style-type: none">(a) Trench depth = 750 mm minimum(b) Trench width = 200 mm minimum(c) Bottom layer shall be sand of IS: 383 with 100mm thick.(d) HDPE conduit with cables shall be laid over the sand layer.(e) Another layer of sand of 100 mm thick.(f) Trench shall, then, be filled with refill soil and compactedCable installation procedures under "Cabling" section of this specification shall also be referred for this.(6) Total length of HDPE DWC pipe shall be as required.
5.12	<p>Connecting the 6 sq-mm cables on input side of SMBs</p> <ol style="list-style-type: none">(1) 6 sq-mm 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 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



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	<p>accordance with the termination arrangement within the SMB. Quantity required shall be appropriately selected by the vendor (cable lug + any other hardware if required).</p> <p>(4) Any other hardware, if necessary for fulfilling the connection, such as bolts, nuts, screws, washers etc shall be in vendor scope of supply. In such a case, all hardware shall be of SS304.</p> <p>(5) All necessary tools such as pliers, strippers, crimping tool etc shall be within vendor scope.</p>
5.13	<p>Connecting the 240 sq-mm cables on output side of SMBs</p> <p>(1) Cables of 2Cx240 sq-mm (Aluminium, armoured, XLPE insulation, PVC sheathed, as per IS:7098) cables with positive and negative cores shall be terminated at the output side of SMBs. Supply of this cable is in BHEL scope.</p> <p>(2) Vendor scope includes removal of sleeve at the cable end, crimping with suitable cable lug of appropriate type/size and connecting the lugged end to the bus bar within the SMB. Cables shall enter the SMB through the metallic cable glands that are also supplied by BHEL along with SMBs.</p> <p>(3) Cable lug shall be in vendor scope of supply. Lug shall be selected as per relevant clauses of "Cabling" section of this specification. Make of lugs shall be as per NTPC approved vendor list. Cable lug quantity shall be 240 Nos + contingency requirements during installation.</p> <p>(4) Hardware such as bolts, nuts, plain washers and spring washers shall be in vendor scope of supply. The size and type of these shall be in accordance with termination arrangement on the bus bar.</p> <p>(5) All necessary tools such as pliers, strippers, crimping tool etc shall be within vendor scope.</p>
5.14	<p>Construction of Inverter rooms</p> <p>Each inverter room houses 4 PCUs, 2 incomer VCB panels, 1 outgoer VCB panel, necessary ACDB and DCDB boards, SCADA panels with UPS etc. Similarly, each inverter is attached to two transformer yards each placed on either side of the room.</p> <p>A typical sketch showing the panel positions and transformer yard location is enclosed with tender. Vendor shall submit the drawings and bill of materials of the complete inverter room structure with the features as described below, along with the design calculations for foundations and structures, for BHEL/NTPC approval, during detailed engineering.</p> <p>1) The inverter room shall be double walled metal clad, weather tight building envelope, suitable for complete life of solar plant. The layout of Inverter room shall be designed so as to divert the heat generated from each inverter outside the room. The inverter room shall be designed for a life of 25 years. The successful bidder shall have to get the structural design done as per the prevailing IS codes. The structural design of inverter room of each identical type shall have to be proof checked by any IIT / NIT and shall have to be got approved from NTPC, before actual start of the work.</p>



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2) Structure:

The steel structure of the Shelter shall be designed for loads and load combination as per Indian Standards (latest revisions) such as IS: 875, IS:1893, IS:800, IS:456 etc

The steel shall be hot-dipped galvanized with a minimum Z180 coating for load bearing applications and Z120 for non-load bearing applications. Alternately, the steel hot-dipped in Alum/Zinc (with 55% Aluminium and 45% Zinc) can be also used. The applicable codes are ASTM A653 for galvanized and ASTM A792 for Galvalume/Zincalume.

3) Fasteners:

Steel bolts, nuts and washers complying with AS 1112:2000. Self-drilling screws complying with AS 3566.1 and AS 3566.2 shall be used.

4) Roof:

The roofing shall be double skin trapezoidal profile sheet of pre-painted 0.45 mm BMT (Base Metal Thickness) Hi Tensile Zincalume/Galvalume 0.5 TCT, confirming to IS:513 and ASTM A792M/AS1397.

Stiffening ribs / subtle fluting for effective water shedding and special male / female ends with full return legs on side laps for purlin support and anti-capillary flute in side lap

Both upper and lower sheets shall be separated through spacers and fastened through zinc /zinc-tin coated self drilling screws. The fastener size shall be calculated as per the design or manufacturers recommendations.

Both sheets shall be sandwiched with an under insulation of 50mm thick glass wool of density 50 kg/m³ with aluminum foil backing or PUF with density 40+/-2 kg/m³ and thermal conductivity 0.019-2.2 W/m-oC along with gutters and down take pipes. Along with Flashing & Top cap of required size and color complete with all necessary hardware complete. Roof shall be projected atleast 600 mm from the wall.

5) Doors Frames

Door frames shall be of T-iron frame of mild steel Tee-sections as per DSR-2007 item no 10.13.

All doors shall be provided necessary fittings like hinges, handles, mortice locks, tower bolts, stopper, hydraulic door closer, magic eye (for main doors) etc of CP brass complete as detailed in tender drawing or submitted by bidder in shop drawing and approved by NTPC.

Black powder coated aluminium doors shall be with extruded built up standard tubular sections, appropriate Z sections and other sections of approved make conforming to IS:733 and IS:1285, fixed to Pre-engineered structure including necessary filling up of gaps at junctions with required PVC/neoprene felt etc including hinges / pivots and double action hydraulic floor spring of approved brand and manufacture IS:6315 marked, lock, handle and



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all necessary fittings

The door entrance shall include Mild Steel single leaf door. The structural steel shall conform to IS: 7452 and IS: 2062. The holdfasts shall be made from steel flats (50 mm and 5 mm thick). The fixtures, fastenings and door latch are to be made with same materials.

6) Windows Frame:

Aluminium black powder coated section, frame shall be of 92x31 mm, minimum 16G thick as per approved design

7) Ventilators

Aluminum black powder coated frame of minimum size 62x25 mm and 16G thick as per approved design. Suitable sunshades made out of approved colour sheet reinforced with Aluminium angle frame of minimum 35x35x4 mm size with soffit of same material will be provided to all external windows and door. The minimum projection for the sunshades will be 450 mm and 300mm wider than the width of the opening

8) Plinth Protection:

750 wide plinth protection 50 mm thick of cement concrete 1:3:6 (1cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth, shall be provided around the Pre-Engineered Structure.

9) Floor Finish

Flooring, including preparation of surface, cleaning etc shall be of cement concrete flooring as per IS 2571-1970 with ironite hardener. The inverter room floor shall be at least 30 cm above the ground level.

10) Wall Cladding:

The walls shall be of double skinned trapezoidal profile sheet of pre-painted 0.45 mm BMT (Base Metal Thickness) Hi Tensile Zinalume/Galvalume 0.5 TCT, confirming to IS:513 and ASTM A792M/AS1397. The profile shall be trapezoidal.

Both the walls should be separated by spacers system made up of cold formed steel bars and fastened through zinc /zinc-tin coated self drilling screws.

11) Wall Insulation:

All voids of external and internal metalised walls shall be filled with 50 mm thick Mineral glass Wool/rockwool insulation of density 50 kg/m³ covered with high strength meshless Aluminium foil PUF with density 40+/-2kg/m³ and thermal conductivity 0.019-2.2 W/m-oC with proper supports etc as approved.

12) Painting



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The exterior sheet (roof as well as wall) shall have total paint thickness of 25 micrometre comprising of 20 micrometer exterior coat of Super Durable Polyester (XRW) and 5 micrometer primers coats.

Other faces of sheets shall be painted with 10 micron polyester over 5 micrometer primer coats. The colour shade shall be subject to NTPC approval.

13) Lighting:

The inverter room shall be provided with electric light to achieve average illumination level of 75 Lux. However room should be designed to utilize maximum natural light during the day.

14) Room exhaust fans:

Inverter rooms shall be provided with necessary cut-outs in the wall for fixing the exhaust fans required for the room. Vendor shall provide minimum of two exhaust fans of appropriate size and rating and fit the same in the cut-outs.

15) PCU exhaust fans:

Inverter rooms shall also be provided with necessary cut-outs in the wall for fixing the exhaust fans of PCU ducting system. Dimensions of these fans shall be furnished by BHEL at the time of detailed engineering.

16) Cable trenches:

Inverter rooms shall be provided with cable trenches of appropriate depth and width so that electrical panels shall be placed with their back half portions above the trench and front half portions seated on the floor. ISMC 100 angles shall be fixed on the walls of cable trench at three vertical tiers. The top tier is meant for supporting the panels. The lower level tiers are meant for placing the cable trays that will support the DC and AC cables. Starting edge of cable trench shall be at a minimum distance of 1m from the inverter room wall. Drawing of cable trench shall be submitted for BHEL/NTPC approval.

17) All other items (if any, other than the above) that are required to meet the various technical requirements of foundations / structures / ventilation / illumination etc, as per relevant standards, shall be incorporated by vendor.

5.15 Switchyards / transformer yards attached to inverter rooms:

(1) Each inverter room is attached to two transformer yards (switchyards), with one yard placed on either side of the room as shown in the sketch enclosed along with the tender. Both the yards shall be provided with underground earth mat grid of appropriate design as per relevant clauses under the "Earthing system" section of this specification. Further, each yard shall house a 1600kVA, 33kV/xxx-xxxV transformer (oil-immersion type, BHEL supply) placed on a suitable RCC foundation that is in vendor scope.



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- (2) Following are the requirements of transformer foundation:
- (a) Weight of each transformer ~ 5000 Kg
 - (b) Soil report is enclosed.
 - (c) Foundation structure shall include appropriate layers of PCC, sand, boulders, RCC portions etc as per design requirements.
 - (d) Foundation depth shall be as per design requirements.
 - (e) Foundation pedestal height above the finished ground level 500 mm minimum.
 - (f) Concrete used shall be M25 grade minimum.
 - (g) Suitable oil soak pit around the foundation structure shall be provided, in case such a pit is required as per relevant standards, CBIP / CEIG regulations etc.
 - (h) Hardware arrangements (steel bolts, plates, nuts, washers etc), which will be part of foundation pedestal for anchoring the transformer, shall be provided as per transformer drawing that will be provided by BHEL.
 - (i) Pedestal shall be provided with cement plastering all around to achieve a smooth finish and painted with two coats of approved brand and colour water proofing cement paint. Second coat of painting shall be carried out after installation of transformer.
- (3) Transformer and its accessory parts such as radiators, cable boxes, hardware etc as supplied by BHEL shall be moved from storage yard and positioned on foundation pedestal. All parts and hardware shall be assembled as per guidance at site provided by BHEL / transformer vendor.
- (4) Vendor shall provide all necessary support and assistance to the representative of transformer manufacturer during installation:
- (a) Oil filling in all transformers.
 - (b) Measurement of parameters: insulation resistance etc.
 - (c) Connections to marshalling box
- (5) Foundation shall be designed, as per relevant standards and procedures, for the soil condition and the transformer weight / dimensions etc. The foundation drawings with design calculations shall be submitted to BHEL/NTPC for approval.
- (6) The fencing work required for outdoor electrical switchyard and transformer yard shall be of barbed wire / twisted G.I. fencing wire in accordance to IS: 278 and CEIG requirement. It shall be of commercial type and conforming to "IS: 226-1969". MS angle posts shall confirm to "IS: 226-1969 and IS 800-1984". Vendor shall submit drawing of fencing for BHEL/NTPC approval.
- (7) For each switchyard, one steel gate of appropriate width and height shall be provided with frame of 50x50 mm (4 mm thick) of MS pipe, vertical grills of 16mm square bar at 120 mm



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c/c and other necessary details such as hinges, padlocks, wheels etc. Gate shall be finished with red oxide (one coat) and paint of BHEL/NTPC approved colour and type.

- (8) After installation of transformers at the switchyard of each inverter room, vendor shall level the ground with an appropriate magnitude and direction of slope to facilitate draining of rain water away from switchyard. Accordingly, to prevent stagnation of water within switchyard, vendor shall, wherever necessary, fill up the land with suitable soil and compact the filled-up portions either manually or with rollers, as applicable, as per site conditions, to achieve required slope.
- (9) Switchyard size shall be appropriately selected by the vendor and approved by BHEL/NTPC. Approximate size of each switchyard shall be 8 x 6 m. (Inverter room size: 12mx 10 m)
- (10) Stone jellies of 20mm or 40mm shall be spread uniformly with a layer of minimum 100 mm thick throughout the switchyard area except for the stretches of RCC slabs of cable trenches.
- (11) All other items (if any, other than the above) that are required to meet the technical requirements of switchyard / transformer yard shall be incorporated by the vendor.
- (12) Vendor shall submit the switchyard layout together with relevant drawings for BHEL/NTPC approval, during detailed engineering.

5.16 Central Monitoring and Control Station (CMCS) room

CMCS is the main control room to which the 132kV switchyard (where the power export to the 132kV grid takes place) is attached and from which the solar array field and the five inverter rooms are centrally controlled. A typical sketch showing the room layout is enclosed with tender. Vendor shall submit the drawings and bill of materials of the complete CMCS room structure with the features as described below, along with the design calculations for foundations and structures, for BHEL/NTPC approval, during detailed engineering.

For the operation & maintenance of SPV Plant the central CMCS has been proposed in the area of approximately 600 sqm. It shall have

1. Air conditioned SCADA room: Air Conditioner shall be of non-ozone depleting type.
2. Room for PCU (Inverter) / ACDB / DCDB / 33kV VCB panels / 132kV C&R panels
3. Battery room
4. Store Room
5. Lobby
6. Pantry
7. Toilet and Urinal
8. Stair case with terrace

In addition, vendor shall construct at least one security room of suitable size near the entry gate with toilet and water facility.



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The buildings shall be designed to meet national building code requirement with a design life of 25 years guarantee. The design shall be as per IS standards for power plants based on soil report provided with this document.

i) RCC Works

All RCC works shall be of minimum M-25 grade of concrete and the materials used viz. cement, reinforcement steel etc. shall be as per relevant IS standards. In addition IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must be complied. Reinforcement shall be high strength TMT Fe 415 or Fe 500 conforming to "IS: 1786-1985". A minimum 100mm thick PCC of minimum M-10 grade concrete 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.

ii) Masonry work

All brick works shall be using at least class designation 7.5 of approved quality as per IS 1077:1992, IS:2212 and IS: 3495. The cement mortar for brick masonry shall be in the ratio 1 cement and 5 sand by weight. The cement mortar shall be machine mixed. Bricks 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. Masonry work shall be kept moist on all the faces for a period of seven days.

iii) Doors & Windows

Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings (where ever provided), and all windows and ventilators of main plant and service building shall have, electro colour dyed (anodized with 15 micron coating thickness) aluminium framework with glazing. All doors of toilet areas shall be of steel framed solid core flush shutter. All other buildings doors windows ventilators (unless otherwise specified) shall be of steel. Number of doors, windows, ventilators, exhaust fans shall be as per NBC specifications unless otherwise mentioned.

The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS: 4351. Steel windows and ventilators shall be as per IS:1361 and IS:1038. All windows and ventilators on ground floor of all buildings shall be provided with suitable grill.

Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However for toilets minimum width shall be 0.75 m and office are as minimum width shall be 1.20m.

The main entrance shall include Mild Steel single leaf door. The structural steel shall conform to IS: 7452 and IS: 2062. The holdfasts shall be made from steel flats (50 mm and 5 mm thick). The fixtures, fastenings and door latch are to be made with same materials.

All Windows shall be metal steel framed and manufactured from low carbon, hot-rolled Z-



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bar steel sections, and 25 mm wide and of minimum thickness 3 mm, drilled and tapped for hardware. The top of frames shall be provided with rain lip.

Each window unit shall have a solid bronze polished, cam locking handle and strike. All steel windows shall be suitably painted after fabrication in accordance with the relevant Indian Standard(s).

Fixing of metallic doors and windows shall be done in accordance to IS: 1081 and IS 7452.

Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings except for main entrance door to the control room where the projection shall be 1500mm.

iv) Glazing

All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, plain or tinted for preventing solar radiations, unless otherwise specified.

For single glazed aluminium partitions and doors, float glass of 8mm or 10 mm thickness shall be used. All glazing work shall conform to IS:1083 and IS:3548.

6 mm reflective toughened glass, with following minimum technical characteristics: Solar factor 45% or less, U-value less than 5.7 W/ SQMK, VLT min 35%: The glass to be used should be from the manufacturers of glass like Glavebel (Belgium), Saint Gobain (France) or Fort (USA) Or equivalent. The glass should be free from distortion and thermal stress

v) Plastering:

All external surfaces shall have 18 mm cement plaster in two coats, under layer 12 mm thick cement plaster 1:5 and finished with a top layer 6 mm thick cement plaster 1:6 (DSR 13.19) with water proofing compound. White cement primer shall be used as per manufacturer's recommendation.

At least one coat of plaster shall be applied to interior walls by hand or mechanically, to a total thickness of 12 mm using 1:6, 1 cement and 6 sand. Plastering shall comply to IS: 1542, IS:1661, IS:1630. Oil bound washable distemper on smooth surface applied with 2 mm thick Plaster of Paris putty for control room.

Plaster of Paris (Gypsum Anhydrous) conforming to IS:2547 shall be used for plaster of Paris punning.

vi) Flooring:

The Cement shall be OPC/PPC as per relevant IS codes. Flooring for office building,



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security cabin shall be of Kota stone over PCC of minimum M-20 grade concrete 3" thick.

Flooring for all air conditioned areas and offices area shall be provided with vitrified ceramic tiles of size 600X 600 mm of min 9 mm thickness, laid with 3 mm ground joints as per approved pattern, painted neatly with 3X4 mm stainless epoxy grout or equivalent

Flooring for stores, security cabin shall be of cement concrete flooring as per IS 2571-1970.

Heavy duty (Grade V) dust pressed ceramic tiles (300X 300 mm) as per IS 13755, shall be provided for flooring of toilets and pantries.

For pantry slab floor mirror polished (6 layers of polish) Granite stone (slab) of minimum thickness of 18 mm shall be used.

vii) Roofing.

Roof of the C.R. Building shall consist of Cast-in-situ RCC slab treated with a water proofing system which shall be an integral cement based treatment conforming to CPWD specification (item no. 25.8 of DSR 1997). The roof of the building shall be water proof with membrane type waterproofing as approved by NTPC. The roof shall be designed for minimum superimposed load to 150 kg/m^2 .

For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface. The roof of the CMCS shall be projecting out by at least 3 feet all around the CMCS building for its external walls protection from rain water. The bidder shall also provide structurally adequate rain water harvesting system in order to ensure rain water harvesting.

viii) Painting of Walls & Ceilings

The paint shall be anti-fungal quality of reputed brand suitable for masonry surfaces for high rainfall zone. All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller. For painting on concrete, masonry and plastered surface IS:2395 shall be followed. All paints shall be of approved make including chemical resistant paint. Minimum 2 finishing coats of paint shall be applied over a coat of primer.

For painting on steel work and ferrous metals, BS: 5493 and IS:1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.



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The cement paint as per as per IS : 5410 shall be of approved brand and manufacturer. Ceiling of all rooms except Battery room shall be white washed. The ceiling of Battery room (if provided) shall be acid resistant paint.

ix) Plinth Protection

Plinth protection shall be provided around all the buildings with Brickbats and PCC 1:2:4 of at least 150mm thickness & smoothly finish of top surface.

x) Water supply

GI pipes of Medium quality conforming to IS 1239 (Part I-1990) and IS 1795-1982 (reaffirmed 1990) for Mild Steel pipes shall be used for all water supply and plumbing works.

The Syntax or equivalent make PVC storage water storage tank conforming to IS:12701 shall be provided over the roof of the control room with adequate capacity for 10 No person and 24 hr requirement, complete with all fitting including float valve, stop cock etc. The capacity of the tank shall be minimum 500 litres.

xi) Plumbing and Sanitary

Each toilet shall have the following minimum fittings.

- (a) WC (Western type) 390 mm high with toilet paper roll holder and all fittings or WC (Indian Type) with all fittings (both types of WCs shall be provided at alternate locations).
- (b) Urinal (430 x 260 x 350 mm size) with all fittings.
- (c) Wash basin (550 x 400 mm) with all fittings.
- (d) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
- (e) CP brass towel rail (600 x 20 mm) with C.P. brass brackets
- (f) Soap holder and liquid soap dispenser

All fittings, fastener, grating shall be chromium plated. Necessary plumbing lines shall be provided for office cum control room building and Security cabin.

The floor finish for washroom, pantry and toilet shall be vitrified ceramic anti-slip tiles and Dado glaze ceramic tiles upto 2.1m shall be used. The normal size of Ceramic tiles shall be 300 mm X 300 mm X 9 mm and shall comply IS: 15622.

The vendor shall design & provide below ground septic tank and soak pit(s) for each location (CMCS and Security room) assuming that a total of 15 people shall use the facility.

The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with trap, with inlet and outlet connections and GI concealed water supply pipe of minimum 12 mm dia of medium class, sanitary pipe of minimum 75 mm diameter, floor trap with



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Stainless Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)

xiii) Electrification of Building

Electrification of all building shall be carried out as per IS: 732-1989, IS 46481968 and other relevant standards like NBC etc.

xiv) Stairs:

Bidder to provide service ladder made up of aluminum with load bearing capacity of at least 150 kg to access the roof & watch tower for maintenance of communication equipment and water tank.

xv) False Ceiling:

The control room shall be provided with false ceiling of 15 mm thick mineral fibre board, in tile form of size 600mm x 600mm, along with galvanized light gauge rolled form supporting system in double web construction pre painted with steel capping, of approved shade and colour, to give grid of maximum size of 1200x600 mm as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts(if required), return air grills(if required), light fixtures, etc., all complete.

xvi) PCU exhaust fans:

CMCS rooms shall also be provided with necessary cut-outs in the wall for fixing the exhaust fans of PCU ducting system. Dimensions of these fans shall be furnished by BHEL at the time of detailed engineering.

xvii) Cable trenches:

CMCS rooms shall be provided with cable trenches of appropriate depth and width so that electrical panels shall be placed with their back half portions above the trench and front half portions seated on the floor. ISMC 100 angles shall be fixed on the walls of cable trench at suitable number of vertical tiers to separate the HT, LT and control cables. The top tier of angles is meant for supporting the electrical panels. The lower level tiers are meant for placing the cable trays that will support the DC and AC cables. Vendor shall submit drawing of cable trench for BHEL/NTPC approval.

5.17 33/132kV Switchyard attached to CMCS room:

The 33/132kV switchyard is attached to the main control room of the plant. Construction of some portions of the switchyard is in vendor scope, whereas the balance portions are in BHEL scope.



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BHEL scope includes land leveling, laying of underground earth mat grid, erection of 16MVA, 33/132kV transformer, erection of all the electrical equipment on the 132kV side of the 16MVA transformer, fencing, gate, stone jelly spreading, cable trenches for 132kV side etc.

Vendor scope of work shall be as follows:

- (a) Foundations and erection of two BHEL-supplied transformers of 1600kVA, 33kV/xxx-xxxV rating including earthing connections to the earth mat.
- (b) Cabling between control room panels and these two transformers including design and construction of cable trench in switchyard for the LT, HT (33kV) and control / data cables.
- (c) Supply, foundation and erection of auxiliary transformer of 200kVA, 33kV/433V rating. Refer relevant clause of this specification for detailed specification of this transformer.
- (d) Foundation requirements for 1600kVA and 200kVA transformers:
 1. Weight of transformer shall be duly considered.
 2. Soil report is enclosed.
 3. Foundation structure shall include appropriate layers of PCC, sand, boulders, RCC portions etc as per design requirements.
 4. Foundation depth shall be as per design requirements.
 5. Foundation pedestal height above the finished ground level 500 mm minimum. In the case of 200kVA transformer, adequate ground clearance shall be maintained as per relevant standards, IE rules, CBIP/CEIG norms.
 6. Concrete used shall be M25 grade minimum.
 7. Suitable oil soak pit around the foundation structure shall be provided, in case such a pit is required as per relevant standards, CBIP / CEIG regulations etc.
 8. Hardware arrangements (steel bolts, plates, nuts, washers etc), which will be part of foundation pedestal for anchoring the transformer, shall be provided as per transformer drawing that will be provided by BHEL.
 9. Pedestal shall be provided with cement plastering all around to achieve a smooth finish and painted with two coats of approved brand and colour water proofing cement paint. Second coat of painting shall be carried out after installation of transformer.
- (e) Transformer and its accessory parts such as radiators, cable boxes, hardware etc as supplied by BHEL shall be moved from storage yard and positioned on foundation pedestal. All parts and hardware shall be assembled as per guidance at site provided by BHEL / transformer vendor.
- (f) Vendor shall provide all necessary support and assistance to the representative of transformer manufacturer during installation:
 1. Oil filling in all transformers.
 2. Measurement of parameters: insulation resistance etc.



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3. Connections to marshalling box

- (g) Foundation and cable trench in switchyard shall be designed, as per relevant standards and procedures, for the soil condition and the transformer weight / dimensions etc. The foundation drawings with design calculations shall be submitted to BHEL/NTPC for approval.
- (h) Oil pits for 1600 kVA transformers, if required, in switchyard attached to CMCS room:
- (1) Transformers shall be provided with suitable soak pit around the foundation in case it is required as per relevant standards, Indian electricity rule, state electricity board, CBIP / CEIG requirements / practices.
 - (2) Further, such arrangements of individual transformers shall be interconnected using suitable hume / concrete pipes and terminated at a remote oil tank. Note: Oil capacity per transformer: ~ 1200 Liters
 - (3) The foundation of transformer shall be accordingly designed to facilitate the provision of soak pits.
 - (4) Drawings of soak pit / pipes / remote tank arrangements shall be submitted to BHEL for approval. Further, based on these inputs, transformer foundation shall be fine-tuned.
- (i) Firewall between 1600 kVA transformers at switchyard attached to CMCS room.
A firewall shall be constructed between the two 1600kVA transformers at 33/132kV switchyard of CMCS room end, based on relevant standards, Indian electricity rules, CBIP / CEIG regulations, state electricity board guidelines etc, duly considering the soil report enclosed with tender.
1. Length of firewall ~4000 mm; Height ~3500 mm above ground level.
 2. Firewall shall be 230mm minimum thick with suitable reinforcing steel and concrete for stability.
 3. Foundation for a minimum depth of 900 mm below ground level.
 4. Foundation shall include appropriate layers of PCC, sand, boulders, RCC portions etc as per design requirements.
 5. Firewall shall be finished with cement plaster and water proof cement paint of BHEL approved colour all around.
 6. Vendor shall provide the firewall drawing and design calculations to BHEL for approval.

5.18 Installation (indoor) of electrical panels within five inverter rooms and one central monitoring and control station (CMCS) together with cable trays in cable trench:

- (1) Panel installation within 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 within **each** inverter room:



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- (a) 630kW PCU panels together with LT air circuit box: 4 sets
- (b) VCB panels: 2 incomer panels + 1 outgoer panel
- (c) ACDB and DCDB power supply distribution boards (wall mounted or floor mounted as the case may be)
- (d) SCADA panels together with UPS
- (2) Panel installation within CMCS room:
 - (a) 630kW PCU panels together with LT air circuit box: 4 sets
 - (e) VCB panels: 7 incomers + 2 outgoers+ 1 Bus PT
 - (f) Battery bank (220V, 300AH): 2 sets
 - (g) Battery charger panel: 2 sets
 - (h) ACDB main panel: 1 set
 - (i) DCDB main panel: 1 set
 - (j) SCADA data station panel for SCADA: 1 set
 - (k) HMI SCADA control desk with PCs and accessories: 1 set
- (3) 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/NTPC.
- (4) PCUs, VCB panels shall be placed on cable trench of inverter / CMCS rooms, with cable entry from bottom side (from back half portion of the panel)
- (5) Panels shall be suitably grouted using welding / bolting methods as appropriate. BHEL approval shall be obtained for the grouting arrangement. All necessary hardware for the same shall be within vendor scope of supply.
- (6) Vendor shall supply and install cable trays within control room for laying DC and AC cables over the trays. It shall be made of perforated GI, hot dip galvanized, thickness = 3mm minimum, depth of 40mm minimum, width as appropriate to accommodate the cables. Drawings / make / part number of cable trays shall be submitted for BHEL/NTPC approval. Corner-bend trays shall be used to align with the normal type types at the corners.
- (7) Vendor shall fix the cable trays on the projecting steel sections in cable trench of control room.
- (8) Suitable cut outs shall be made in the cable trays to provide path for the cable to reach the lower level trays.
- (9) Adjacent cable trays shall be interconnected using suitable hardware items that shall be in vendor scope of supply.
- (10) Cables shall be laid over the cable trays and neatly dressed using appropriate cable ties etc.
- (11) Cable trays shall be provided at every applicable place as per relevant clauses of "Cabling" section of this specification. BHEL / NTPC approval shall be taken for the cable tray and support arrangement for the cable routing.
- (12) Similarly, cable ladders shall be provided for 1Cx 300 sq-mm AC cables to avoid sagging strain, near the exit points, through which the cables approach transformers placed at the switchyard. Cable ladders shall be made of MS, painted using red oxide and black paint.



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	<p>Drawing of ladder arrangement shall be submitted to BHEL for approval.</p> <p>(13) 1Cx300 sq-mm AC cables are routed from inverter room / CMCS to transformers in switchyard through an opening in the walls of control room. These openings shall be closed using suitable sheet made of steel / aluminium / fiber etc to arrest entry of rodents. The arrangement shall be approved by BHEL/NTPC.</p>
5.19	<p>DC power cable terminations at PCUs in the five inverter rooms and the main control room CMCS:</p> <p>“Cabling” section of this specification shall be referred.</p> <p>(1) On DC side, for each PCU, vendor shall carry out the cable terminations for 5 positive and 5 negative inputs connections – unsleeving, crimping and connecting.</p> <p>(2) BHEL shall supply the DC cables (2Cx240 sq-mm aluminium, armoured, XLPE insulation, PVC sheath). Cable glands, cable lugs, bolts, nuts and washers shall be in vendor scope of supply. BHEL will indicate the exact cable diameter to facilitate right selection of these cable accessories / hardware.</p> <p>(3) All tools and accessories required to carry out the termination shall be within scope of vendor.</p>
5.20	<p>AC/DC power cables and terminations at PCUs, LT panels, 1600 kVA transformers, VCB panels / Bus PT panel, 16MVA transformer, 200kVA auxiliary transformer, ACDB / DCDB panels / SCADA panels etc.</p> <p>“General specification of HT cables”, “General specification of LT cables” and “Cabling” sections of this specification shall be referred for all aspects of these cables such as technical specifications (ratings, sizes, calculations etc), selection, tests, cable installation, cable accessories etc.</p> <p>(1) All AC cables together with cable trays, cable conduits, cable glands, cable lugs, HT termination kits, bolts, nuts, washers etc shall be in vendor scope of supply. Make shall be as per NTPC approved vendor list. Approximate (indicative) length requirements for the cables are given below. However, it is the responsibility of the vendor to assess the actual length requirements.</p> <p>(2) Vendor shall submit the details of make, GTP particulars, Bill of materials including the associated cable accessories such as glands, lugs, cable trays, cable conduits, HT termination kits, bolts, nuts, washers etc for BHEL/NTPC approval, during detailed engineering.</p> <p>(3) Specifications of respective cables as follows: (a) PCU– LT panel – 1600kVA transformers:</p>



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	<p>3-phase 3-wire cable, 3Rx1Cx300mm² per phase (with R, Y, B colour coding), 1.1kV grade, aluminium conductor, XLPE insulation, armoured, PVC sheathed as per IS: 7098. Approximate length = 2 Km per phase. (Note: cable from control room to switchyard shall be laid underground)</p> <p>(b) HV (33kV) side connections in VCB panels (incomers, outgoers), Bus PT panel, 16MVA transformer, 200kVA transformer.</p> <p>3-phase 3-wire cable, 3Cx300mm², 33kV, aluminium conductor, XLPE insulation, armoured, PVC sheathed as per IS: 7098. Approximate total length = 3 Km.</p> <p>(c) Auxiliary transformer in switchyard to ACDB panel in CMCS room:</p> <p>3-phase 4-wire cable, 3Cx95mm², 1.1kV grade, aluminium conductor, armoured, XLPE insulation, PVC sheathed as per IS: 7098. Approximate length requirement = 100m maximum.</p> <p>(d) LT AC / DC power supply cables, for auxiliary power consumption, from ACDB / DCDB panels in CMCS room to other panels and equipments at various locations in the plant: Vendor shall appropriately select the cable type / size / rating etc and design calculations shall be submitted for BHEL/NTPC approval. Quantity shall be appropriately assessed by the vendor.</p> <p>(4) Vendor shall make the measurements between the equipment, cut the cables to the required lengths, fix them with glands, unsleeve them at the ends, crimp them with the lugs and terminate them at the respective bus bar provisions within the panels / equipments.</p> <p>(5) All tools and accessories required to carry out the termination shall be within scope of vendor.</p>
5.21	<p>Control / data / instrumentation / OFC cables and terminations</p> <p>“General specification of LT cables” and “Cabling” sections of this specification shall be referred for all aspects of cables such as technical specifications (ratings, sizes, calculations etc), selection, tests, cable installation, cable accessories etc.</p> <p>(1) BHEL will supply the following SCADA related data communication cables</p> <ul style="list-style-type: none">(a) Inverter room SCADA panels to CMCS room SCADA panels (OFC cables)(b) SMBs to inverter room / CMCS room SCADA panels(c) PCUs to SCADA panels in respective inverter rooms / CMCS room(d) Energy meters of VCB / C&R panels to SCADA panels in inverter rooms / CMCS rooms(e) LAN cables within SCADA network <p>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, based on cable size details from BHEL. Cable laying and cable terminations shall be in vendor scope.</p>



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	<p>(2) All the other cables such as (1) control cables from transformer marshaling boxes to relay circuits in VCB, (2) control cables from metering panel to relay circuits in VCB panels, (3) instrumentation cables from transformer marshaling boxes to SCADA panels (WTI, OTI values) etc shall be within vendor scope of supply. Control cable shall be 1.5 sq-mm minimum, copper conductor, PVC. Instrumentation cable shall be 0.5 sq-mm minimum, copper conductor, PVC. Other features such as armoured / unarmoured, number of cores, lengths etc shall be appropriately selected by vendor. Instrumentation</p> <p>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 as per NTPC approved vendor list.</p> <p>(3) Design calculations for cables together with GTP particulars, make etc shall be submitted for BHEL/NTPC approval. Similarly, length requirements shall be appropriately assessed by the vendor.</p> <p>(4) All tools and accessories required to carry out the termination shall be within scope of vendor.</p>
5.22	<p>Underground cable trenches and laying of cables in solar array field, switchyards etc for HT, LT (including DC cables), data communication / control / SCADA / OFC cables.</p> <p>Section titled “Cabling” shall be referred for burying the cables underground.</p> <p>Following cables shall be laid underground by way of direct burying using appropriate layers of sand, appropriate protective covering, refill soil etc to appropriate excavation depth below the ground level as per relevant Indian standards (IS:1255), Indian Electricity rule, CEIG/CBIP norms etc related to cable installation practices and procedures :</p> <ul style="list-style-type: none">(a) DC power cables and data communication cables from SMBs to inverter / CMCS rooms(b) AC power supply cables from ACDB panel of CMCS room to (i) ACDB switchboards of inverter rooms and to (ii) AC-DC power supply cards of SMBs.(c) AC power supply cables from the ACDB switchboards of the nearest inverter rooms / CMCS room to (i) the lighting poles in solar array field, switchyards and boundary walls and to (ii) submersible bore well pumps(d) DC power supply cables from DCDB feeders of battery banks / chargers in CMCS room to DCDB switchboards of inverter rooms(e) SCADA cables (OFC cables etc) from SCADA station in CMCS room to SCADA panels of inverter rooms(f) HT cables (33kV), LT cables, data communication / control / SCADA cables in switchyards. <p>Cable trench layouts and cross section drawings shall be submitted to BHEL/NTPC for approval.</p>
5.23	<p>General specification of HT cables</p> <p>HT CABLES</p>



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1.0 Codes & 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:7098 (Part -II)	Cross linked polyethylene insulated PVC sheathed cable for working voltage from 3.3 KV upto& including 33 KV .
IS : 3961	Recommended current ratings for cables
IS : 3975	Low Carbon Galvanized steel wires, formed wires and tapes forarmouring of cables.
IS : 4905	Methods for random sampling.
IS : 5831	PVC insulation and sheath of electrical cables.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEC-754 (Part-I)	Test on gases evolved during combustion of electric cables.
IEEE-383	Standard for type test of Class IE Electric Cables.
IEC -332 Part-3	Tests on Electric cables under fire conditions. Tests on bunched wires or cables (category -B)

2.0 Technical Requirements

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

Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical,



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electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

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

XLPE insulation shall be suitable for continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 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 aluminium wires. For multi core 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-sq. mm/ mtr. at 20 deg.C. The types and sizes of aluminiumarmouring shall be same as indicated for galvanised steel at 2.06.00 above.

The gap between armour wires / formed wire 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 wires/formed wires.

Outer sheath shall be of PVC black in colour. 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 (to ASTM D 2863)



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- (b) Acid gas emission of max. 20% (to IEC-754-I).
- (c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM-D-2843.

Cores of the cables of upto 3 cores shall be identified by colouring of insulation or by providing coloured tapes helically over the cores with Red, Yellow & Blue colours.

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) Screen Fault current ___KA for ___ Sec. (Value of current & time shall be indicated)
- (d) Sequential marking of length of the cable in metres at every one metre. -To be embossed / printed

The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible. For EPR cables identification shall be printed on outer sheath.

All cables shall meet the fire resistance requirement as per IEEE - 383 with cable installations made in accordance with 'Flammability Test' and 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.

In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

The cross-sectional area of the metallic screen strip/tape shall be considered in design calculations.

The eccentricity shall be calculated as $(t_{max} - t_{min}) \times 100 / t_{max}$

and the ovality shall be calculated as $(d_{max} - d_{min}) \times 100 / d_{max}$

Where t-max/t-min is the maximum/minimum thickness of insulation and d-max/d-min is the maximum / minimum diameter of the core. The eccentricity of the core shall not exceed 10% and ovality not to exceed 2%.

Cable selection & sizing

HT cables shall be sized based on the following considerations:

- a) Rated current of the equipment



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- 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

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 grnd 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 directly buried.

3.0 Constructional Feature 19/33 KV Grade Cables

Cables shall conform to IS: 7098 Part - II. These cables shall have mutli-stranded, compacted circular, aluminium conductors, XLPE insulated, metallic screened suitable for carrying the system earth fault current, PVC outer sheathed. The conductor screen and insulation screen shall both be of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for 19/33KV cables shall be "dry curing / gas curing".

The metallic screen of each core shall consist of copper tape with minimum overlap of 20%. However for single core armoured cables, the armouring shall constitute the metallic part of the screening.

4.0 Cable Drums

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. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

Each drum shall carry manufacturer's name, purchaser's name, address and contract



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number, item number and type, size and length of cable and net gross weight stencilled 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.

5.0 Type, Routing And Acceptance Tests

All equipments to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's 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 the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.

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 equipment price.

The type test reports once approved for any projects shall be treated as reference . For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change".

Minor changes if any shall be highlighted on the endorsement sheet.

TESTS

All types and sizes of cables being supplied shall be subjected to routine tests and acceptance tests as specified below and according to relevant standards.

a) The reports for following type tests shall be furnished for 19/33kV cables:

Sl	Type Test	Remarks
	Conductor	
1.	Resistance test	
	For Armour Wires / Formed Wires	
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	



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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

b) The reports for following type tests shall be furnished for each type(voltage grade) & size of the cable:

Type tests for all cables

1. Insulation resistance test (volume resistivity method)
2. High voltage test

Type tests for 19/33kV grade only:

1. Partial discharge only
2. Bending test
3. Dielectric power factor test
 - (a) As a function of voltage
 - (b) As a function of temperature
4. Heating cycle test
5. Impulse withstand test



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Indicative list of tests / checks, routine and acceptance tests shall be as per Quality Assurance and Inspection table of HT cables enclosed.

5.24 General specification of LT 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. Instrumentation / signal cable shall be of 225 V grade. MV / HV cables shall be manufactured using dry curing method.

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

TUV specification 2 Pfg 1169/08.2007	DC cable for photovoltaic system
IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltages upto 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) TECHNICAL REQUIREMENTS

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 including EPR cables shall be flame retardant, low smoke (FRLS) type designed



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to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

All cables of module area if laid on cable trays should be covered. 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. Conductor of control cables shall be made of stranded, plain annealed copper.

XLPE insulation shall be suitable for a continuous conductor temperature of 120 deg. C and short circuit conductor temperature of 200 deg C for 5 secs.

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 :
Calculated nominal dia. Size and Type of armour of cable
under armour

Upto 13 mm 1.4mm dia GS wire

Above 13 & upto 25mm 0.8 mm thick GS formed wire / 1.6 mm dia GS wire
Above 25 & upto 40 mm 0.8mm thick GS formed wire / 2.0mm dia GS wire
Above 40 & upto 55mm 1.4 mm thick GS formed wire / 2.5mm dia GS wire
Above 55 & upto 70 mm 1.4mm thick GS formed wire / 3.15mm dia GS wire
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 $0.028264 \text{ ohm mm}^2$ 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.



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Outer sheath of module inter-connecting DC cable as per TUV specification 2 Pfg 1169/08.2007.

Outer sheath shall be of PVC as per IS: 5831 & black in colour for power cables & 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 ASTM-D-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.

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.

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. For EPR cables identification shall be printed on outer sheath.

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



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Module inter-connecting DC cable shall meet the fire resistance requirement as per TUV specification 2 Pfg 1169/08.2007.

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.

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

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.



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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.

(3) CONSTRUCTIONAL FEATURES for LT Power Cables

1.1 KV Grade 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).

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).

1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber(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-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968.

(4) 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 Propylene Rubber(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-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968. Minimum conductor size shall be 2.5 sqmm.

Cable Drums

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. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.



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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.

5.25 Cabling

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



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	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 type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables. Indian Electricity Act. Indian Electricity Rules.
<p>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.</p>	
2. DESIGN AND CONSTRUCTIONAL FEATURE	
Inter Plant Cabling	
<p>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 buried cables, if essential ,shall not have concentration of more than 4 cables in one route. All buried cables shall be armoured.</p>	
Trenches	
<p>PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.</p>	



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No sub zero 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. for aluminium 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 galvanized 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.



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2. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware fittings 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 galvanised 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, drilling and other machining operation.
5. The typical arrangement of flexible support system is described briefly below:

- i. The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS.
- ii. Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
- iii. 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.

(c) The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to the Employer. The bidder shall submit the detailed drawings of the system offered by him along with the bid.

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



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- 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



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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 sheet 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 polyimide 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

- a) Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.
- b) 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



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wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.

- 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.



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4.4 Cable Installation

- a) Cable installation shall be carried out as per IS:1255 and other applicable standards.
- b) For Cable unloading , pulling etc following guidelines shall be followed in general :

Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.

- c) Cables shall be laid on cable trays strictly in line with cable schedule
- d) Power and control cables shall be laid on separate tiers in line with approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, 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.
- e) Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.
- f) Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/
- g) 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



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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

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

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

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



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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.

- 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.

5.26 Metering System at 33kV end of SPV power plant

- (a) Vendor shall install one ABT tariff main metering panel on 33kV side of 16MVA,



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33/132kV transformer. The panel shall be installed in CMCS room and all necessary cable interconnections shall be made with the associated CT and PT of outgoer VCB and Bus PT panels.

Note: In addition to the above meter, BHEL will supply and install one main metering panel in CMCS room for 132kV side of the transformer.

- (b) Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment. Vendor shall synchronize the meter using GPS time synchronization equipment that is in BHEL scope of supply. All the accessories and hardware required for synchronization shall also be in the scope of vendor.
- i. All type test reports shall be as per IEC 62052-11/ IEC 62053-22
 - ii. Technical Requirements of ABT Compliant Energy Meters
 - (1) Shall be microprocessor-based conforming to IEC 60687 /IEC 62052-11/IEC 62053-22 / IEC 62056 /IS15959 for category B.
 - (2) Shall carry out measurement of active energy (both import and export) and reactive energy (both import and export) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.
 - (3) Shall have an accuracy of energy measurement of at least Class 0.2S for active energy and at least Class 0.5 for reactive energy according to IEC60687, and shall be connected to Class 0.2S CT cores and Class 0.2 VT windings.
 - (4) The active and reactive energy shall be directly computed in CT & VT primary ratings.
 - (5) The reactive energy shall be recorded for each metering interval in four different registers as MVARh (lag) when active export, MVARh (Lag) when active import, MVARh (lead) when active export, MVARh (Lead) when active import.
- (c) Two separate registers shall be provided to record MVARh when system voltage is 103% and when system voltage is < 97%.
- (d) Shall compute the net MWh and MVARh during each successive 15-minute block metering interval along with a plus/minus sign, instantaneous net MWh, instantaneous net MVARh, average frequency of each 15 minutes, net active energy at midnight, net reactive energy for voltage low and high conditions at each midnight.
- (e) Each energy meter shall have a display unit with a seven digit display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MW demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.
- (f) All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for



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export/import.

- (g) At least the following data shall be stored before being over-written for the following parameters.

Sl	Parameters	Details	Min No of days
1.	Net MWH	15 min block	40 days in meter
2.	Aver Freq	15 min block	40days in meter
3.	Net MVARH for $V > 103\%$	15min block	40days in meter
4.	Net MVARH for $V < 97\%$	15min block	40days in meter
5.	Cumulative Net MWH	At every midnight	10 days in meter / 40 days in PC
6.	Cumulative Net MVARH for $V > 103\%$	At every midnight	10 days in Meter / 40 days in PC
7.	Cumulative Net MVARH for $V < 97\%$	At every midnight	10 days in Meter / 40 days in PC

Date and time blocks of VT failure on any phase.

- (h) Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.
- (i) Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment.
- (j) The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be as per relevant standard.
- (k) Meter shall have provision for RS485 Modbus RTU communication for SCADA interfacing.

5.27 Auxiliary AC/DC power supply system

- (1) Vendor shall establish an auxiliary AC supply system for (a) various utility power consumption purposes such as inverter / CMCS room lamps, ceiling fans, exhaust fans, various pumps (bore well, water washing system for SPV module, etc), yard lighting poles, air-conditioner, other appliances, auxiliary power supply to PCUs, VCB panels, transformers etc and also, for (b) powering the battery chargers that charge the battery banks.
- (2) The system shall comprise of following items:
- (a) An auxiliary transformer 200kVA, 33kV/433V, Dyn11, Outdoor, Oil-immersion / ONAN type shall be installed in the switchyard attached to CMCS room. Supply and installation of 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.



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- (b) An ACDB distribution board panel (fed by the 433V auxiliary transformer supply) that distributes the AC power to various utility applications as mentioned above through separately allocated feeders shall be installed in CMCS room. Design, supply and installation of ACDB main panel including all necessary cable terminations, cable installation and cable interconnections with auxiliary transformer (on the input side) and utility loads (on the output feeders end) shall be in vendor scope.
- (c) 2 sets of battery banks (lead-acid type), 220V/300AH each, together with 2 sets of battery chargers shall be installed in CMCS room. Design, supply and installation of panel including all necessary cabling, cable terminations and cable interconnections with ACDB / DCDB panels shall be in vendor scope.
- (d) A DCDB main distribution panel to distribute the DC supply to various utilities such as VCB breaker on/off, spring charge motor, indicating lamps, electromagnetic relays, numerical relays, etc shall be installed in CMCS room. Design, supply, testing, installation of the DCDB panel including all necessary cable terminations, cable installation and cable interconnections with ACDB main panel (on the input side) and utility loads (on the output feeders end) shall be in vendor scope.
- (e) ACDB and DCDB distribution boards in every inverter room for receiving the supply from respective ACDB/DCDB main panels at CMCS room and distributing to the utilities of the inverter room and attached switchyards. Design, supply, testing, installation of these panels including all necessary cable terminations, cable installation and cable interconnections with ACDB / DCDB panels of CMCS room (on the input side) and the utility loads (on the output feeders end) shall be in vendor scope.
- (3) Detailed specifications of these LT panel / switchboard items are provided in related clauses of this specification.
- (4) Vendor shall submit the GA drawings, GTP particulars and Bill of materials for all the above items as per relevant standards for BHEL/NTPC approval during detailed engineering.
- (5) Makes of the items and components shall be as per NTPC-approved vendor list, wherever applicable. For other items, reputed makes shall be used as shall be approved by BHEL/NTPC.



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5.28 Specification of auxiliary transformer 200kVA, 33kV/433V, Dyn11, Outdoor, ONAN type:

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, IS:6600, IEC:60076, CBIP
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°.
17	Cable entry on HV side	Bottom entry of cables. 3C, 33kV 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.



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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°C, 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°C, 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 °C	< 2 % for UPF For 0.8 PF lagging, to be indicated by vendor.



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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	<p>Transformer shall be constructed in accordance with IS: 2026 and IS: 3639 or equivalent international standard.</p> <p>All materials / components used shall be of best quality and class most suitable for working under the conditions specified.</p> <p>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.</p>
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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-



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	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: <ul style="list-style-type: none"> (i) Full vacuum of 760 mm of Hg, for filling with oil by vacuum. Internal gas pressure of 0.35 Kg/cm² (5 lbs/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) equivalent to M4 grade steels or better.
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.



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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.
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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 the neutral earthing 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



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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 Marshalling box

2.7.1	Vendor shall provide a marshalling box and marshal to it all the contacts / terminals of electrical devices mounted on the transformer.
2.7.2	It shall be in the vendor scope to provide the interconnection cabling between the marshalling box and all the accessory devices of transformer by either PVC insulated unarmoured cables routed through GI conduit (or) PVC insulated, armoured cables.
2.7.3	Necessary cable glands shall be provided at the marshalling box for the above mentioned cables as well as for terminating the incoming cables from remote panels.
2.7.4	Marshalling box shall be tank mounted, outdoor and weather/vermin/dust proof (protection class IP55), sheet-steel (2mm thick minimum) enclosure, with hinged door having padlocking facility and painted. All doors, covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 1600 mm above floor level and provided with gland plate and cable glands as required. Top surface shall be sloped to drain off water falling on the box.

2.8 Transformer oil

2.8.1	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.
2.8.2	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.

2.9 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	1 set
2	HV cable box	1 set



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3	HV disconnecting chamber	1 set
4	LV cable box	1 set
5	LV disconnecting chamber	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	2 Nos
8	Earthing terminals with hardware suitable for connecting 50x6 GI earth strips. Separate terminals shall be provided for cable boxes, tank etc.	1 set
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	Double float Buchholz relay with alarm and trip contact. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. Buchholz relay shall be provided with one shut-off valve on conservator side of size 50 mm	1 set
11	Provision for collecting gas and oil from Buchholz relay	1 set
12	Silica gel dehydrating breather with oil cup	1 set
13	Magnetic oil level gauge (MOG), dial type, with alarm contact, minimum and maximum filling level markings. Contact shall be suitable for 220V DC. The oil level at 30 deg C shall be marked on the gauge.	1 set
14	Prismatic / toughened glass oil level gauge for transformer and tap changer chamber with min and max markings.	1 set
15	Spring operated Pressure relief valve with alarm/trip contacts. Location of this valve shall be such that the hot oil discharge shall not fall on the transformer or any of its parts. This shall include all necessary arrangements to facilitate proper discharge of PRV through pipes away from the transformer.	2 sets
16	Explosion vent (double diaphragm) with sight glasses and equalizing pipe connection to conservator	1 set
17	Thermometer pocket for OTI	1 No
18	Temperature sensor for OTI	1 No
19	Thermometer pocket for WTI	1 No
20	CT for WTI	1 No
21	Oil temperature indicator, 150 mm dial type, with alarm and trip contacts, maximum reading pointer & resetting device. Oil temperature range: -40 to 150 deg C (resolution 1 deg C) Oil temperature accuracy: +/- 2 deg C RTD PT-100 temperature sensor for OTI (IEC 751). Two analog outputs of 4-20mA for remote indication of OTI.	1 No



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22	Winding temperature indicator, 150-mm dial type, with alarm and trip contacts, maximum reading pointer & resetting device. Winding temperature range: -40 to 200 deg C (resolution 1 deg C) Winding temperature accuracy: +/- 2 deg C Two analog outputs of 4-20mA for remote indication of WTI.	1 No
23	Marshalling box (IP55) shall be provided with removable gland plates and glands for cable entry from bottom side. Marshalling box shall be provided with OTI, WTI, transmitters (for 4-20mA output of OTI and WTI), space heater, thermostat, lamp, MCBs, power socket, switch for WTI, terminal connectors and all other attachments that are necessary to meet its functional aspects. Terminal connectors for the following signals / connections shall be made available. Number of terminal connectors for each case shall be as per connection requirements: PT-100 sensor from thermometer pocket 1) 4-20mA output for OTI 2) 4-20mA output for WTI 3) WTI CT secondary 4) Alarm contact of WTI 5) Trip contact of WTI 6) Alarm contact of OTI 7) Trip contact of OTI 8) Buchholz relay alarm 9) Buchholz relay trip 10) Magnetic oil level gauge alarm 11) Pressure relief valve alarm 12) 90-260V DC power supply (external source) 13) 240V AC supply (external source) 14) Spare connectors: Eight terminals Note: Alarm and trip contacts shall be rated for 220V DC.	1 set
24	Inspection window with cover	1 set
25	Cover lifting lugs / eyes	2 Nos
26	Core and winding lifting lugs / eyes	2 Nos
27	Tank lifting lugs / eyes for the entire transformer	2 Nos
28	Jacking pad with hauling eyes, to enable transformer with oil to be raised or lowered using hydraulic or screw jacks.	4 sets
29	LV cable box supports with mounting plates	2 sets
30	HV cable box supports with mounting plates	2 sets
31	Bi-directional flat rollers	4 sets
32	Base channel with towing holes / lugs	2 sets
33	Air release hole with plug	1 No
34	Oil filling hole with cap	1 No



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35	Top filter valve with threaded male adapter (blanking plug)	1 No
36	Bottom filter valve with threaded male adapter (blanking plug)	1 No
37	Drain valve for the tank, with blanking plug	1 No
38	Drain valve for conservator, with blanking plug	1 No
39	Shut-off valves for conservator	2 Nos
40	Sampling valve, with blanking plug	1 No
41	Shut-off valves for radiators, with open and close markings	8 Nos
42	Sludge valve at bottom most point of tank to be provided for easy flush out / removal of sludge during maintenance	1 No
43	Valve schedule plate made of stainless steel or aluminium (anodized)	1 No
44	Rating and diagram plates made of stainless steel or anodized aluminium.	1 No
45	Terminal marking plates	1 Set
46	Protected type Mercury or alcohol in glass thermometer	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 detailed quality plan in NTPC Manufacturing Quality Plan (MQP) format for approval.
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4.0 Tests

4.1	<p>Routine Tests: Following routine tests shall be carried out the transformer.</p> <ol style="list-style-type: none">1) Measurement of voltage ratio and phase displacement as per IEC 60076-12) Measurement of winding resistance on all the taps as per IEC 60076-13) Vector group check as per IEC 60076-14) Polarity check as per IEC 60076-15) Magnetic balance and magnetizing current test6) Measurement of no-load current with 415V, 50Hz AC supply7) Measurement of no-load losses and current at 90%, 100% and 110% of rated voltage as per IEC 60076-18) Measurement of impedance voltage / short-circuit impedance, load loss on principal and extreme taps9) Measurement of insulation resistance as per IEC 60076-110) Dielectric tests as per IEC 60076-3<ol style="list-style-type: none">a) Separate source voltage withstand testb) Induced AC voltage short duration test (ACSD) <p>Note: Max allowed change in PD after voltage enhancement = 100 pC. The background noise level shall not exceed 100 pC.</p>
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	<p>11) Repeating the no-load current, no-load loss and IR measurements after completion of all the dielectric tests</p> <p>12) Oil leakage test on completely assembled transformer along with unit coolers / radiators: All tank and oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature and applying pressure equal to the normal pressure plus 35 kN/sq-m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur. This test shall be repeated as pre-commissioning test at site with test duration of 24 hours.</p> <p>13) Jacking test followed by DP test</p> <p>14) Marshalling box / Cable box: IP Class test (IP55): It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.</p> <p>15) IR measurement on wiring of Marshalling Box.</p> <p>16) BDV test on oil as per IS:335-1993: Test certificate shall be submitted to BHEL.</p>										
	<p>4.2 Temperature rise test as per IS: 2026 (Type Test)</p> <p>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/NTPC. In case extra charges are required, the same shall be indicated separately in the offer on per-transformer basis. Offers that do not include this specific type test are liable for rejection.</p> <p>This temperature rise test shall be carried out at a tap corresponding to maximum losses as per IS: 2026.</p> <p>Gas chromatography shall be conducted, as per relevant standard, on oil sample taken before and immediately after temperature rise test. Test report shall be furnished to BHEL.</p>										
	<p>4.3 Other Type Tests:</p> <p>In case the vendor has conducted the type test(s) within last ten years as on the date of technical bid opening, report(s) of the type test(s) shall be submitted to BHEL for waiver of conducting those particular type tests. Such report(s) should be for the test(s) conducted on transformer that is similar to this present specification. Also, the test(s) should have been either conducted at an independent laboratory (or) should have been witnessed by a client.</p> <p>In case the vendor is not able to submit report(s) of the type test(s) conducted within last ten years from the date of technical bid opening (or) in case the type test reports are not found to be meeting the specification requirements, the vendor shall conduct the type test(s) as per applicable standards at no additional cost to BHEL and the type test reports shall be submitted to BHEL/NTPC for approval.</p> <table border="1"> <tr> <td>4.3.1</td> <td>Tank vacuum and pressure test as per CBIP norms. (In process inspection)</td> </tr> <tr> <td>4.3.2</td> <td>Zero sequence impedance measurement test</td> </tr> <tr> <td>4.3.3</td> <td>Measurement of harmonics of no load current</td> </tr> <tr> <td>4.3.4</td> <td>Measurement of acoustic noise level as per NEMA TR-1</td> </tr> <tr> <td>4.3.5</td> <td>Lightning impulse (full & chopped wave) test on HV & LV windings</td> </tr> </table>	4.3.1	Tank vacuum and pressure test as per CBIP norms. (In process inspection)	4.3.2	Zero sequence impedance measurement test	4.3.3	Measurement of harmonics of no load current	4.3.4	Measurement of acoustic noise level as per NEMA TR-1	4.3.5	Lightning impulse (full & chopped wave) test on HV & LV windings
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5.0 Documents to be submitted after receipt of purchase order

5.1	<p>Following documents shall be submitted for BHEL approval within seven days from date of purchase order.</p> <ol style="list-style-type: none">(1) Detailed transformer drawings for<ol style="list-style-type: none">(a) Overall General Arrangement (plan, elevation, end view) with overall dimensions and bill of accessories.(b) Rating plate details(c) Valve schedule plate details with elevation and side view showing valve positions(d) HV cable box with disconnecting chamber, bushings, gland plate, cable termination details etc.(e) LV cable box with disconnecting chamber, bushings, gland plate, cable termination details etc.(f) Marshalling box GA (front view, side view, bill of items) and wiring diagram(g) Foundation plan(h) Bill of material of transformer(i) Untanking details (removal of core and assembly from tank)(2) Guaranteed technical specification of transformer in line with Appendix-B (schedule of technical particulars to be furnished by manufacturer) of IS: 2026 (part-1)-1977.(3) Quality assurance plan (routine tests, type tests, test certificates) covering incoming materials, stage-wise inspection during manufacturing, finished goods, packing and forwarding. Quality Assurance Plan shall be in the format of NTPC Manufacturing Quality Plan (MQP), which shall be forwarded to vendor during detailed engineering. Witness by NTPC and BHEL shall be included for stage inspection / final inspection as per approved MQP.(4) Detailed Test Procedure for all routine, type and special tests.(5) Manufacturing clearance shall be subject to approval of the above documents by NTPC.
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6.0 Documents to be submitted along with consignment

6.1	<p>Following documents shall be submitted to BHEL at the time of delivery of the consignment:</p> <ol style="list-style-type: none">(1) As built drawings of transformer(2) Routine test reports on transformer(3) Type test reports on transformer(4) Test certificate for pressure & vacuum test on tank(5) Test certificate for transformer oil(6) Operations and maintenance manual of transformer(7) Technical datasheets of transformer accessories such as Buchholz relay, Magnetic oil level gauge, Pressure release valve, OTI, WTI, Temperature sensor (PT-100), Explosion vent with diaphragm, Breather with silica gel, HV / LV Bushings, CT for WTI, etc.
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7.0 REFERENCE STANDARDS



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Following shall be the list of standards to be adopted:

Power Transformer	IS: 2026 IS: 6600 IEC: 60076
Fittings and Accessories	IS: 3639
Loading of oil immersed transformer	IS: 6600
Oil	IS: 335
Bushing for >1000 V AC	IS: 2099
Bushing for <1000 V AC	IS: 7421
Degree of protection	IS: 2147
Tests and tolerance of guaranteed particulars	IS: 2147
Buchholz relay	IS: 3637
Electrical insulation classified by thermal stability	IS: 1271
Climate proofing	IS: 3202

5.29 General specifications for ACDB panels / DCDB panels / Battery chargers

These indoor LT AC / DC panels and battery charger panels of IP42 class shall be as per relevant standards. Overall technical features are as detailed below. These shall have minimum features such as MCCB / MCB / fuses, digital ammeters, digital voltmeters, earth leakage relay, RYB indication lamps, ammeter / voltmeter selector switches etc. The main ACDB panel in CMCS room shall have EM6400 (Conserve / Schneider make) multifunction meters with RS485 compatibility at the incoming end to facilitate capturing of auxiliary energy consumption of the plant.

- (a) All the electrical components, bus bars etc shall be of appropriate type / ratings / size and of reputed make as shall be approved by BHEL / NTPC. Wherever applicable, makes shall be selected as per NTPC-approved vendor list.
- (b) Vendor shall submit the GA drawings, GTP particulars, single line diagrams and Bill of materials for each kind of these panels for BHEL/NTPC approval.

Overall technical features of the LT AC / DC switchboard panels:

1.0 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 published one month prior to the date of opening of bids. 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 codes and standards.

IS 5	Colors for ready-mixed paints and enamels.
IS 694	PVC insulated cables for working voltages upto and including 1100V



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IS 722	A.C. Electricity Meters
IS 1248	Electrical Indicating instruments
IS/IEC 60947-1	Degree of protection provided by enclosures for low voltage Switchgear and Control gear
IS/IEC 60947-2	A.C. circuit Breakers including MCCBs
IS 2551	Danger Notice Plates
IS 2629	Hot dip galvanizing
IS 2705	Current Transformers
IS/IEC 60947-4-1	Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 V DC
IS 3043	Code of practice for earthing.
IS 3072	Code of practice for installation and maintenance of Switchgear
IS 3156	Voltage Transformers
IS 3202	Code of practice for climate proofing of electrical equipment.
IS 3231	Electrical relays for power system protection.
IS/IEC 60947	Air-Break Switches, air break disconnectors, air break disconnector and fuse combination units for voltages not exceeding 1000V AC or 1200 V DC.
IS/IEC 60947-1	General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V.
IS 5082	Wrought Aluminum and Aluminum alloys for electrical purposes.
IS 6005	Code of practice of phosphating of iron and steel.
IS/IEC 60947-5-1	LV switchgear and Control gear Control current devices and switching element.
IS 8623 (3 parts) / IEC 60439	Specification for factory built assemblies of Switchgear & Control gear for voltages upto and including 1000 V AC & 1200 V DC.
IS 8686	Static Relays
IS 13703 / IEC 60269	HRC Cartridge fuses
IS 10118 (4 parts)	Code of practice for selection, installation and maintenance of switchgear and control gear.
IS 11171	Specification for dry type transformers.
IEC 60255	Electrical Relays
IEC 61850	Communication networks and systems in substations
IS 11353	Guide for uniform system of marking and identification of



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	conductors and apparatus terminals
IS 12021	Specification of control transformers for switchgear and Control gear for voltage not exceeding 1000V AC.
IEC 60947-7-1	Terminal blocks for copper conductors
IS 513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips

2.0 Technical parameters

Power supply AC system

- Voltage: 415V +/- 10%, 3 phase, 4 wire, neutral solidly earthed
- Frequency: 50 Hz +/- 5%
- Combined variation (in volts and frequency): 10% absolute sum
- Fault level: 50kA rms

Bus bar rating:

- (a) Continuous current rating: as per requirement
- (b) Short time rating where CB is used as incomer: 50kA rms for 1sec
- (c) Short time rating where fuse protection is used in incomer: prospective current of 50kA rms for the fuse clearing time.
- (d) Dynamic rating where CB is used as incomer: 105kA peak
- (e) Dynamic rating where fuse protection is used in incomer: prospective current of 105kA peak as limited by fuse.
- (f) Bus bar insulation: PVC sleeve insulated

Meters:

- (a) Accuracy class: 2.0
- (b) One minute power frequency withstand test voltage: 2kV rms

Current transformer

- (a) Type: cast resin bar primary
- (b) Voltage class and frequency: 650V, 50 Hz
- (c) Class of insulation: E or better
- (d) Accuracy class and burden for protection: 5P20, 5VA, PS class for REF
- (e) Accuracy class and burden for metering: CI 1.0, 5VA minimum
- (f) Short time withstand for CT associated with circuit breaker: 50kA rms for 1 sec
- (g) Short time withstand for CT associated with fuse protected feeders: prospective current of 50kA rms for fuse clearing time.
- (h) Dynamic resistance for CT associated with circuit breaker: 105kA peak
- (i) Dynamic resistance for CT associated with fuse protected feeders: prospective current of 105kA peak as limited by fuse.

Voltage transformer

- (a) Type: cast resin
- (b) Voltage ratio: 415V/110V for line PT, $415V/\sqrt{3} / 110V\sqrt{3}$ for Bus PT



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- (c) Method of construction: VeeVee
- (d) Accuracy class: 0.5
- (e) Rated voltage factor: 1.1 continuous, 1.5 for seconds
- (f) Class of insulation: E or better
- (g) One minute power frequency withstand voltage: 2.5kV

HRC fuse

- (a) Voltage class: 650V
- (b) Rupturing capacity: 80kA rms for ac circuits, 20kA for dc circuits

Current transformer

- (a) Type: dry / cast resin
- (b) Voltage ratio: 415V/110V with taps +/- 5% in steps of 2.5%
- (c) Class of insulation: B or better
- (d) One minute power frequency withstand voltage: 2.5kV
- (e) Rating: 1.5x adequate for application

MCCB

- (a) Rated voltage: 415V
- (b) Rated insulation level: 690V
- (c) Rated ultimate end service SC breaking capacity: 50kA
- (d) Rated making capacity: 105kA
- (e) Utilization category: A

3.0 CONSTRUCTIONAL DETAILS OF SWITCHBOARDS

3.1 All Switchboards shall be of metal enclosed, indoor, floor-mounted, free-standing type.

3.2 All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material.

3.3 All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that they do not permanently bulge/ bend by the weight of maintenance personnel working on it.

3.4 The switchboards shall be of bolted design. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cutouts shall be true in shape and devoid of sharp edges.

3.5 All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS/IEC 60947. However, the busbar chambers



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having a degree of protection of IP: 42 are also acceptable where continuous busbar rating is 1600A and above. Provision shall be made in all compartments for providing IP: 5X degree of protection, when circuit - breaker or module trolley has been removed. All cutouts shall be provided with EPDM / Neoprene gaskets.

3.6 Provision of louvers on switchboards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating is 1600 A and above.

3.7 All switchboards shall be of uniform height not exceeding 2450 mm.

3.8 Switchboards shall be easily extendable on both sides by the addition of vertical sections after removing the end covers.

3.9 Switchboards shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates. The base frame height shall be such that floor finishing (50mm thick) to be done by Employer after erection of the switchboards does not obstruct the movement of doors, covers, with draw able modules etc.

3.10 All switchboards shall be divided into distinct vertical sections (panels), each comprising of the following compartments:

(a) BUSBAR COMPARTMENT

A completely enclosed bus bar compartment shall be provided for the horizontal and vertical busbars. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power busbars shall be in separate compartments.

(b) SWITCHGEAR / FEEDER COMPARTMENT

All equipment associated with an incomer or outgoing feeder shall be housed in a separate compartment of the vertical section. Two-tier breaker arrangement in a vertical section shall be offered for outgoing breaker feeders of rating up to 1600A. The design of the vertical section for such an arrangement shall ensure ease of termination of power cables of size & quantity as specified in clause 43.00.00. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. Insulating sheet at rear of the compartment is also acceptable. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure.

(c) CABLE COMPARTMENT OR CABLE ALLEY

A full-height vertical cable alley of minimum 250mm width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations located in cable alley shall be designed to meet the Form IVb Type 7 (as per IEC 60439-1) for safety purpose. The termination for each module shall have its own integral glanding facility. Wherever cable alleys are not provided for distribution

boards, segregated cable boxes for individual feeders shall be provided at the rear for direct termination of cables. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable



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alley. Cable alley door shall be hinged.

(d) CONTROL COMPARTMENT

A separate compartment shall be provided for relays and other control devices associated with a circuit breaker.

- 3.11 Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. EPDM / Neoprene gasket shall be provided between the panel sections to avoid ingress of dust into panels.
- 3.12 After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.
- 3.13 All 415V switchgear (circuit-breaker) panels shall be of single-front type. MCCs and DBs shall be of single-front / double-front construction as per requirement. All single-front switch boards shall be provided with single-leaf, hinged or bolted covers at the rear. The bolts shall be of captive type. The covers shall be provided with "DANGER" labels. All panel doors shall open by 90 deg or more. In case of double-front MCCs, if this cannot be achieved for panels adjacent to a breaker panel, suitable dummy panel shall be provided by the Bidder wherever necessary.
- 3.14 All 415V circuit-breaker modules and contactor controlled motor modules shall be offully draw out type having distinct 'Service' and 'Test' positions. The equipment pertaining to a draw out type incomer or feeder module shall be mounted on a fully withdrawable chassis which can be drawn out without having to unscrew any wire or cable connection. Suitable arrangement with cradle / rollers, guides along with tool / lever operated racking in / out mechanism shall be provided for smooth and effortless movement of the chassis. For modules of size more than half the panel height, double guides shall be provided for smooth removal or insertion of module. All identical module chassis of same size shall be fully interchangeable without having to carryout any modifications. Suitable interlock shall be provided in DCDBs for prevention of opening of Isolator (Incomer) when the bus coupler is open and vice-versa.
- 3.15 All disconnecting contacts for power and control circuits of drawout modules shall be of robust and proven design, fully self aligning and spring-loaded. Both fixed and moving contacts shall be silver-plated and replaceable. The spring-loaded power and control drawout contacts shall be on withdrawable chassis and the same on fixed portion shall not be accepted. Detachable plug and socket type control terminals shall also be acceptable.
- 3.16 Individual opening in the vertical bus enclosure shall permit the entry of moving contacts from the drawout modules into vertical droppers.



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3.17 All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to employer's approval. The Contractor shall submit dimensional drawings showing complete internal details of busbars and module components, for each type and rating for approval of Employer.

3.18 The tentative power and control cable entry shall be from bottom. However, the Employer reserves the right to alter the cable entries, if required during detailed engineering, without any additional commercial implication.

3.19 Each switchboard shall be provided with undrilled, removable type gland plate, which shall cover the entire cable alley. Bidder shall ensure that sufficient cable glanding space is available for all the cables coming in a particular section through gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall preferably be provided in two distinct parts for the easy of terminating addition cables in future. The gland plate shall be provided with gasket to ensure enclosure protection. Recommended drilling chart of gland plates for all power and control cables in the vertical panels shall be indicated by the Contractor in the respective G.A. drawings of the boards.

3.20 The Bidder shall consider layout of panels in a switchboard consisting of various feeder modules as per system requirement in a straight line, unless specified otherwise. The actual composition and disposition of various modules in a switchboard shall be finalised during detailed engineering. The Bidder shall include in his quoted price the cost of any adopter panel / dummy panel required to meet various configuration / arrangement of busbars adopted by the Bidder.

3.21 CLEARANCES

The minimum clearance in air between phases and between phases and earth for the entire run of horizontal and vertical busbars and bus-link connections at circuit-breaker shall be 25mm. For all other components, the clearance between "two live parts", "a live part and an earthed part", shall be at least ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal and vertical busbars the clearances specified above should be maintained even when the busbars are sleeved or insulated. All connections from the busbars up to switch / fuses shall be fully insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits.

4.0 POWER BUSBARS AND INSULATORS

4.1 All 415V Switchboards shall be provided with three phase and neutral busbars. Two separate sets of vertical busbars shall be provided in each panel of double front MCCs. Interleaving arrangement for busbars shall be adopted for switchboards with a rating of more than 1600A. DCDBs shall be provided with two (2) busbars. Entire busbar system shall be insulated with PVC sleeves.

4.2 All busbars and jumper connections shall be of high conductivity aluminum alloy / copper of



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adequate size.

4.3 The cross-section of the busbars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars.

4.4 All busbars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength sheet molded compound or equivalent type polyester fiber glass molded insulator. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The busbar insulators shall be supported on the main structure.

4.5 All busbar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the busbar. All copper to aluminum joints shall be provided with suitable bimetallic washers.

4.6 All busbars shall be colour coded as per IS: 375.

4.7 Wherever the bus bars are painted with black Matt paint, the same should be suitable for temperature encountered in the switchboard under normal operating conditions. The Bidder shall furnish calculations establishing the adequacy of bus bar sizes for specified current ratings.

5.0 AUXILIARY BUSBARS AND CONTROL TRANSFORMERS

5.1 AC CONTROL SUPPLY BUSBAR

Each bus-section of all Switchgears and MCCs shall be provided with two (2) nos. 415V / 110V control transformers. The 110V AC control supply from the control transformers shall be run through the MCC by means of two sets of control supply busbars of electrolytic copper. In case of one transformer failure, whole bus section can be fed through single transformer. The control supply to different modules shall be tapped individually from the control supply busbars.

5.2 DC CONTROL SUPPLY BUSBARS

Electrically controlled circuit breaker boards shall be provided with DC control supply busbars. The manually controlled breakers shall also be provided with such busbars in case relays are provided. Each section of the switchboard shall be provided with a DC supply. The Contractor shall provide suitable terminals, switch-fuse etc. to receive the DC supply and distribute the same through above mentioned control busbars to the required modules of the respective section. The DC control supply bus of one section shall be coupled to the control supply of other section through a switch located in the bus-coupler



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breaker panel. The DC supply to the bus-coupler breaker may be given from any of the control buses. For emergency switchgear, Employer shall provide two DC supplies. The contractor shall provide suitable diodes to derive the control supply through diode auctioneering from the above two supplies.

5.3 SPACE HEATER BUSBARS

Panel and motor space heaters shall be fed from separate AC auxiliary busbars running throughout the switchboard. The supply for these busbars shall be tapped from incomer, before the isolating switch/ circuit breaker. Incoming circuit to space-heater bus shall have an isolating switch, HRC fuse and neutral link of suitable rating. Suitable terminals shall also be provided to facilitate energisation of space-heater bus from outside during long shutdowns of unit / switch-board.

6.0 EARTH BUS AND EARTHING

- 6.1 A galvanized steel / Copper / Aluminium earth bus shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar. Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus.
- 6.2 The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth, as indicated in "Technical Parameters", without exceeding the allowable temperature rise.
- 6.3 Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to earthing conductors. The horizontal earth bus shall project out of the switchboard ends and shall have predrilled holes for this connection. All joint splices to earth bus shall be made through at least two bolts, and taps by proper lug and bolt connection.
- 6.4 All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting.
- 6.5 The carriage and breaker frame shall get earthed while being inserted in the panel and positive earthing of the breaker frame shall be maintained in all positions, i.e. SERVICE & ISOLATED, as well as throughout the intermediate travel.
- 6.6 Each module frame shall get engaged to the vertical earth bus before the disconnecting contacts on the module are engaged to the vertical busbars.
- 6.7 All metallic cases of relays, instruments and other panel-mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. All the equipment mounted on the door shall be earthed through flexible wire/braids. Insulation color code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors, soldering is not acceptable. Looping of earth connections, which would result in loss of earth connections to other devices, when a



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device is removed, is not acceptable. However, looping of earth connections between equipment to provide alternative paths to earth bus is acceptable.

6.8 VT and CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.

6.9 All hinged doors having potential carrying equipment mounted on it shall be earthed by flexible wire/ braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges/ hinge pins of proven design may also acceptable. The Contractor shall establish earth continuity at site also.

7.0 AIR BREAK SWITCHES

7.1 Air break switches shall be of heavy duty, single throw, group operated, load break, fault make type when associated with fuses. All switches for motor circuits shall be of utilization category AC-23A with 1NO +1NC auxiliary contact, which shall be wired to the control circuit as shown in the schematic drawings. All switches for other outgoing feeders shall be of utilization category AC-22A. All switches for DC circuits shall be suitable for 240 V DC and shall be of DC-22 utilization category.

7.2 The combination of switch-fuse unit would be preferred. However, if separate switch and fuses are provided, switch shall be located before fuses.

7.3 The main switches shall be operable from outside the module door. The switch handle shall clearly indicate the position of switch. Switch operating handles shall be provided with padlocking facilities. However, incomer switches of switchboards shall be provided with padlocking facility in both 'ON' and 'OFF' positions.

7.4 Interlocks shall be provided such that the cubicle door will not open when the switch is in closed position and the switch will close only when the door is closed. However, suitable means shall be provided to intentionally defeat these interlocks.

7.5 Switches and fuses for AC/DC control supply and heater supply wherever required, shall be mounted inside the cubicles. Toggle switch is not acceptable.

8.0 MCCB

8.1 MCCB shall be fixed type/part of withdrawable feeder module as per specification, three pole, air break type having trip free mechanism with quick make and quick break type contacts. MCCB shall have current limiting feature. MCCB of identical ratings shall be physically and electrically interchangeable. MCCB shall be provided with 1 NO and 1NC auxiliary contacts.

8.2 MCCB shall be provided with Microprocessor based inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit also. The protection settings shall have suitable range to achieve the required time & current settings. LED indications shall also be provided for faults, MCCB status (on/off etc).

8.3 MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes



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relevant to circuit rating. Extended cable terminal arrangement for higher size cable may also be offered. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door can not be opened unless the MCCB is in OFF position. Means shall be provided for defeating this interlock at any time. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked. The MCCBs being offered shall have common/interchangeable accessories for all ratings like aux. switch, shunt trip, alarm switch etc. The MCCBs shall have the current discrimination up to full short circuit capacity and shall be selected as per manufacturer's discrimination table.

8.4 The auxiliary contacts of the MCCB shall be fed to the digital inputs in the numerical relays of Incomer/bus coupler/motor circuit breaker feeders, for integration in to the numerical relay network.

9.0 FUSES

9.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be rated for 80kA rms (prospective) breaking capacity at 415V AC and for DC circuits, 20kA rms breaking capacity at 240V DC.

9.2 Fuse shall have visible operation indicators. Insulating barriers shall be provided between individual power fuses.

9.3 Fuse shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchboard.

9.4 Fuse ratings for motor feeders shall be coordinated by the Bidder to achieve class-II protection coordination and also to match the motor characteristics. Switch rating shall in no case be less than the fuse rating.

9.5 The Neutral links shall be mounted on fuse carriers which shall be mounted on fuse bases.

10.0 INTERNAL WIRING

10.1 All switchboards shall be supplied completely wired internally upto the terminals, ready to receive external cables.

10.2 All intercubicle and interpanel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the Bidder.

10.3 All auxiliary wiring shall be carried out with 650V grade, single core stranded copper conductor, colour coded, PVC insulated wires. Conductor size shall be 1.5 mm² (min.) for control circuit wiring and 2.5 mm² (min) for CT and space heater circuits.

10.4 Extra flexible wires shall be used for wiring to devices mounted on moving parts such as



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hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped.

10.5 All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.

10.6 All internal wiring terminations shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible. Screw-less (spring loaded) / cage clamp type terminal shall also be provided with lugs.

10.7 Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.

10.8 Wiring for equipment, which are to be supplied by the Employer and for which the Contractor has to provide mounting arrangement in his panels, shall also be provided by the Contractor, upto the terminal blocks.

10.9 All connections from vertical busbars for individual modules above 100 A shall be by Copper / Aluminum links only. The cable connections for modules less than 100 A shall be selected in such a way that there will not be any melting / shorting in case of a short circuit inside the module and the cable shall have current rating to carry the let through energy of the corresponding fuses in case of a fault. The insulation of the cable and its cross section shall be decided considering the high ambient temperature within the module. For all modules where use of cable is envisaged by the Contractor specific approval from the Employer regarding cable details are to be taken. For power wiring colour coded wire insulation / tapes shall be provided.

11.0 POWER CABLE TERMINATION

11.1 Cable termination compartment and arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminum conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc., shall be provided by the contractor, to suit the final cable sizes.

11.2 All power cable terminals shall be of stud type and the power cable lugs shall be of tinned copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.

12.0 NAME PLATES AND LABELS

12.1 All Switchgears, MCCs, Distribution Boards, Fuse boards, all feeders, local push-button stations and local motor starters shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels



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shall be provided at the rear switchgear also.

12.2 All name plates shall be of non-rusting metal or 3-ply Lamicoid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Employer's approval.

12.3 Suitable stenciled paint mark shall be provided inside the panel/module for identification of all equipment in addition to the plastic sticker labels, if provided. These labels shall be positioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring drawings.

12.4 Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.

13.0 PAINTING

13.1 All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation,

13.2 Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

14.0 GASKETS

The gaskets, wherever specified, shall be of good quality EPDM / Neoprene with good ageing, compression and oil resistance characteristics suitable for panel applications.

15.0 TEMPERATURE RISE

The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current. The above temperature rise limits are applicable for busducts also without any current derating.

16.0 DERATING OF EQUIPMENTS



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16.1 The Bidder shall, ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per Indian Standards / Specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.

16.2 The Bidder shall indicate clearly the derating factors if any employed for each component and furnish the basis for arriving at these derating factors duly considering the specified current ratings and ambient temperature of 50 deg C.

17.0 PROTECTION CO-ORDINATION

It shall be the responsibility of the Contractor to fully coordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers / fuses / motor starters, to provide satisfactory discrimination. Further the various equipment supplied shall meet the requirements of Type II class of Co-ordination as per IS: 8544.

18.0 AC MODULES DESCRIPTION

18.1 Module type DAE (Circuit Breaker Module)

- (a) One (1) Triple-pole circuit breaker, complete with all accessories and power operated mechanism, as specified.
- (b) Three (3) Current transformers for Protection and metering.
- (c) One (1) DC isolating Switch
- (d) Six (6) HRC Control fuses.
- (e) Numerical relay for the following:
 - 1. Short Circuit Protection
 - 2. Earth Fault Protection
 - 3. Over Load protection
 - 4. Energy Metering
 - 5. Current and Voltage metering
 - 6. Trip Circuit Supervision
 - 7. CB Monitoring
 - 8. Synchronizing Check feature

18.2 Module Type DAET (Circuit Breaker Incomer From Transformer)

Similar to module type DAE; but with additional PS Class Current transformers for Restricted Earth Fault Protection. The Numerical relay shall have provision for REF protection in addition to the features listed against module type DAE.

18.3 Module Type DG (Circuit Breaker Incomer From DG Set)

- (a) One (1) Triple-pole circuit breaker, complete with all accessories and power operated mechanism, as specified.
- (b) Three (3) Current transformers for protection & metering.
- (c) One (1) DC isolating Switch



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- (d) Six (6) HRC control fuses
- (e) Numerical relay for the following:
 1. Differential protection
 2. Over Load protection
 3. Reverse Power Protection
 4. DG Neutral displacement
 5. Energy Metering
 6. Current and Voltage metering
 7. DG Monitoring

5.30 Specification of Battery banks and Battery chargers

1.0 CODES AND STANDARDS

- a) IS: 10918 Specification for vented type Nickel Cadmium Batteries.
- b) IS: 1652 Specification for stationary cells and batteries, lead acid type (with Plante positive plates)
- c) Indian electricity rules / Indian Electricity Acts.

2.0 BATTERY RATINGS

DC Batteries shall be stationary Nickel Cadmium Pocket plate type (KPH)/ (KPL) or Lead Acid Plante type. VRLA battery shall not be accepted.

DC Batteries shall be stationary lead acid Plante positive plate type conforming to IS:1652. The number of cells for the 220 Volts shall be 107, number of cells for 110V shall be 54 & number of cells for 48V shall be 23.

If Nickel Cadmium battery is used, the number of cells for the 220 Volts shall be 169, number of cells for 110V shall be 85 & number of cells for 48V shall be 37.

3.0 BATTERY RACK

Mild steel racks for all the Nickel Cadmium batteries shall be provided. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators/High impact plastic insulators. Batteries shall preferably be located in the single tier arrangement. However, batteries having a complete cell weight of lower than 50 Kg could be located in the double tier arrangement. The batteries racks and supports for cable termination shall be coated with three (3) coats of anti-alkali paint of approved shade. Name plates, resistant to alkali, for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor.

For lead acid plante battery, wooden racks for all the batteries shall be provided. These racks shall be made of good quality first class seasoned teak wood in line with CPWD specification.

4.0 Battery Charger panel

The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers



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shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC lead-acid Batteries while supplying the D.C. 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.

The chargers 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.

a) Battery Charger for Ni-Cd battery

The Batteries shall be Trickle charged at 1.4 to 1.42 Volts per cell. All chargers shall be capable of Boost Charging the associated D.C. Battery at 1.53 to 1.7 Volts per cell at the desired rate.

b) Battery Charger for Lead-Acid battery

The Batteries shall be Trickle charged at 2.25 Volts per cell. All chargers shall also be capable of Boost Charging the associated D.C. Battery at 2.3 to 2.7 Volts per cell at the desired rate.

Battery charger panel shall have the following:

1. 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.
2. It shall have the following meters that shall be 96 sq-mm 90-deg scale Class 1.5
 - AC input voltmeter
 - DC float output ammeter
 - DC load current ammeter
 - *DC boost charger ammeter
 - Battery charge/discharge ammeter
 - DC output voltmeter
 - Battery leakage ammeter
3. It shall also have selector switches for Float Auto / Manual, Boost Auto/ Manual, Float / Boost / Autoboot selector switches. Also, Voltmeter / Ammeter selector switches as applicable.
4. It shall have adequate output feeders to meet the load distribution requirements of the power plant.

5.31 DG set as back-up power supply

(1) The ACDB board shall have standby power supply from Diesel Generator to meet



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requirement in case of power failure. Diesel generator shall comply with BS:5514, IS:4722 and any other relevant standard. It shall have sound proofing system which should be designed to comply with local pollution control board. The radiator of the engine shall be water cooled.

- (2) The diesel generator shall be 3-phase, 15 kVA with A1 class of governing to maintain the speed substantially constant even with sudden variation of load. The generator shall be synchronous type of output 415V at 50 Hz with complete excitation system and all accessories. The AH rating of battery of DG set shall not be less than 90. VRLA battery shall not be accepted for the purpose.
- (3) Vendor shall submit detailed specifications of the DG set for BHEL/NTPC approval during detailed engineering.

5.32 Installation and commissioning of SCADA integration system for SPV power plant:

- (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 five major segments as follows:
 - (a) String monitoring boxes (120 Nos) in solar array field
 - (b) Weather monitoring equipment: Pyranometer for solar irradiation, thermometer for ambient temperature, anemometer for wind velocity.
 - (c) Power conditioning units: DC input /AC output parameters of inverters, grid data, fault status and events logged, etc.
 - (d) Air circuit breaker (ACB) panels / 33kV VCB breaker panels / 132kVC&R panel: status of ACB / VCB / SF6 breakers, status of protection relays of transformers, oil / winding temperatures, AC parameters at PCU levels, AC parameters at every 2.5MW level of the plant (33kV level)
 - (e) Metering panels at 33kV and 132kV of final 15MWp level, for all AC parameters including energy generation values.

(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 CMCS 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 / OFC / LAN cables as brought out in other clauses of this specification.



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(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 CMCS (main control) room. Vendor shall also install the SCADA / data station panels in each of the five inverter rooms.
- (b) Control / instrumentation cables as mentioned in other clauses of this specification.
- (c) Cable trenches (in solar array field and switchyards), cable laying and terminations of all SCADA cables at respective panels / equipments shall be in vendor scope of supply. BHEL will provide the necessary cabling schedule.
- (d) UPS of 5kVA with 1 hour battery back up. Make shall be APC or any other reputed make as shall be approved by BHEL/NTPC.
- (e) Internet lease line of 2 MBPS for remote connectivity of SCADA, with necessary hardware support items such as Modem / Router / Wifi facility etc and for a lease period of one year from the date of completion of trial run.
- (f) Supply and installation of an LCD display panel (1 No):
42 inch 2-dimensional LCD display screen with desktop-PC connectivity feature. Make: Samsung / LG / Sony or reputed equivalent as shall be approved by BHEL. The purpose is to show SCADA parameters on LCD screen, that shall display the contents same as on SCADA PC monitor screen. Thus SCADA desktop PC shall have two independent displays simultaneously.

LCD display screen shall have following minimum features:

- a. Display: 42 inch, 2 dimensional
- b. Desktop PC connectivity as above
- c. Resolution: 1920X1080
- d. Input: VGA, HDMI

LCD screen shall be installed (wall- mount) in SCADA room by vendor. The cables (power/ control & communication cables) shall be supplied, laid & dressed properly inside the room by vendor. Signal input shall be taken from desktop PC through VGA/ HDMI cable. End-to-end connections shall be made by vendor. Any additional port/ card required to enable dual display connection & other relevant accessories shall be supplied & fixed in PC by vendor.

(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 – 120Nos

- (a) RS485 Modbus (RTU) cables from string monitoring (combiner) boxes of solar photovoltaic array field, whereby each box provides data signals viz. max 22 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



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array field to SCADA room, based on the daisy-chain grouping of string monitoring box RS485 Modbus (RTU) outputs.

4.2 Weather monitoring equipment – 3Nos

Analog signals from the weather monitoring equipment viz. pyranometer, anemometer and ambient temperature sensor.

4.3 Power conditioning units (PCUs) 630kW: 24Nos

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. Vendor shall loop appropriate number of PCUs using daisy-chain.

4.4 LT and HT equipments (Transformers, ACB panels, VCB panels, 132kV C&R panel etc)

- a) 1600kVA transformer oil temperature value: 12 cables, 4-20mA analog signal.
- b) 1600kVA transformer winding temperature value: 12 cables, 4-20mA analog signal.
- c) 1600kVA transformer protection fault signals: Buchholz alarm, Low oil level alarm, PRD alarm, OTI alarm &WTI alarm: 12x5 = 60 cables, potential free NO contact, Digital.
- d) LT Panel ACB On/Off status: 24 cables, potential free NO contact, Digital.
- e) HT Panel VCB On/Off status: 24 cables, potential free NO contact, Digital.
- f) Numerical relay (Over current / Earth fault): 1 cable from each inverter room (terminals looped within each inverter room), RS-485 Modbus.
- g) Numerical relay (Under voltage / Overvoltage): 1 cable from 1 Bus PT of CMCS room, 1 cable from every inverter room, RS-485 Modbus.
- h) HT VCB panel load managers (EM6400 or equivalent): 1 cable from every inverter room, (load managers looped within inverter room), 1 cable from CMCS room (load managers looped within CMCS room), RS-485 Modbus.
- i) 16MVA transformer oil temperature value: 1 cable, 4-20mA analog signal.
- j) 16MVA transformer winding temperature value: 1 cable, 4-20mA analog signal.
- k) 16MVA transformer protection fault signals: Buchholz alarm, Low oil level alarm, PRD alarm, OTI alarm &WTI alarm: 5 cables, potential free NO contact, Digital.
- l) Auxiliary power consumption meter (EM6400 or equivalent): 1 cable from 1 terminal, RS-485 Modbus.
- m) 132kV C&R panel signals: ON/OFF status of SF6 breaker (1 signal), ON/OFF status of isolator / earth switch (4 signals), transformer differential (1 signal), line differential (1 signal), restricted earth fault (1 signal): potential free NO contact, digital signals.
- n) 200kVA transformer OTI value, WTI value, Buchholz alarm, low oil level alarm, PRD alarm, OTI alarm, WTI alarm: 7 signals, potential free NO contact, Digital.
- o) Energy meters at the output end of the power plant: one cable each from 33kV side and 132kV side



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meters, RS-485 Modbus.

- p) In addition to the above, spare provisions shall be considered for digital, analog (4-20mA) and RS485 modbus: at least 10 in each case.

5.33 Earthing system for solar array structures, string monitoring boxes, electrical panels in inverter rooms / CMCS rooms, control room electrical wiring circuits, switchyard equipments, support steel structures of switchyard, lightning arrestors, weather monitoring equipments, switchyard fencing, compound wall angles and all other panels / equipments / metallic structures as applicable.

(Note: Solar array structures shall be earthed using underground earth mat grid. All structures shall be interconnected and the individual (block-wise) grids shall be interconnected as required.)

EARTHING SYSTEM

- (1) Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts.

Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All off-site areas shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system.

- (2) The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects
- (3) The material of the earthing conductors shall be as follows:

Conductors above ground level and in built up trenches.	Galvanized steel
Conductors buried in earth	Mild steel
Earth electrodes	Mild steel rod

- (4) The sizes of earthing conductors for various electrical equipments shall be as below:

#	Equipment	Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches
1	Main earth grid	40 mm dia. MS rod	65 x 8mm GS flat
2	33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	-	65 x 8mm GS flat
3	415 V MCC/ Distribution boards / Transformers	-	50 x 6mm GS flat



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4	LT Motors above 125 KW	-	50 x 6mm GS flat
	25 KW to 125 KW	-	25 x 6mm GS flat
	1KW to 25 KW	-	25 x 3mm GS flat
	Fractional House power motor	-	8 SWG GS wire
5	Control panel & control desk	-	25 x 3 mm GS flat
6	Push button station / Junction box	-	8 SWG GI wire
7	Columns, structures, cable trays and bus ducts enclosures	--	50 x 6mm GS flat
8	Crane, rails, rail tracks & other non-current carrying metal parts	-	25 x 6mm GS flat

- (5) Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.
- (6) Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available , necessary connections shall be done by driving an earth electrode in the ground
- (7) Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.
- (8) Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.
- (9) Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.
- (10) Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.
- (11) Connections between equipment earthing leads and between main earthing conductors shall be of welded



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type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.

- (12) Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.
- (13) Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.
- (14) Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.
- (15) A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.
- (16) Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.
- (17) Earth pit shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal if average resistance of soil is more than 20 ohm meter.
- (18) On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.
- (19) Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.

(20) Other Requirements of Earthing System:

Standard/Code	IEEE 80, IS 3043
Earthing System	
Life expectancy	40 Years
System Fault Level	As per system requirement (B0)
Soil resistivity	Actual as per site conditions.
Min. Steel corrosion	0.12mm/year
Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.



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	<p>Conductor joints By electric arc welding, with resistance of joint not more than that of the conductor.</p> <p>Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.</p> <p>Surface resistivity - Gravel 3000 ohm-meter</p> <p style="padding-left: 150px;">- Concrete 500 ohm-meter</p>
<p>5.34</p>	<p>Supply and installation of lightning protection system (lightning arrestors) to protect the electrical equipments of SPV power plant from lightning.</p> <p>(1) Lightning protection system (lightning arrestors) shall be in strict accordance with IS: 2309.</p> <p>(2) Vendor shall design a protection system and submit the scheme along with bill of materials for BHEL/NTPC approval, during detailed engineering stage. Supply and installation of the lightning protection system together with all necessary accessories and hardware as below shall be in scope of vendor.</p> <p>(3) It shall be ensured that the proposed system provides protective coverage to the entire area of SPV power plant so that all the structures and equipments are effectively protected from lightning effects.</p> <p>(4) Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system</p> <p>(5) Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.</p> <p>(6) Down Conductors</p> <p style="padding-left: 20px;">b. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.</p> <p style="padding-left: 20px;">c. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.</p> <p style="padding-left: 20px;">d. All joints in the down conductors shall be welded type.</p> <p style="padding-left: 20px;">e. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.</p>



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	<ul style="list-style-type: none">f. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.g. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.h. Lightning conductors shall not pass through or run inside GI Conduits.i. Testing link shall be made of galvanized steel of size 25x 6mm.j. Pulser system for lightning shall not be accepted.k. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.
5.35	<p>Lighting / illumination requirements of SPV power plant (including 132kV switchyard attached to CMCS room)</p> <ul style="list-style-type: none">i. Lighting system description, design philosophy, ballasts, junction boxes, conduits, fitting and accessories, pull out boxes, lighting wires, lighting poles and lighting masts are described as below.ii. Also, location-wise (control room, street lighting roads, switchyard etc) average illumination lux levels and required type of fixtures are also brought out here below.iii. For the open areas such as solar array field, switchyards, approach roads, pathways etc within the solar power plant boundary, it shall be ensured that lighting poles are evenly distributed to ensure the specified across the solar array field, switchyard,iv. Further, it shall be ensured that the system proposed does not cast shadow on the solar photovoltaic modules. Accordingly, the lighting poles, ballasts etc shall be selected.v. Vendor shall design a comprehensive system and submit the scheme for BHEL/NTPC approval, during detailed engineering stage. <p><u>LIGHTING SYSTEM DESCRIPTION</u></p> <p>Normal AC Lighting System: AC lighting system 415V, 3Phase,4wire, will be fed from lighting panels Control Board(LPs) which in turn will be fed from the lighting distribution boards (LDBs) of AC Switch board MCC.</p> <p>Emergency AC Lightning System: The lighting fixtures connected to this system shall be normally "ON" along with the normal AC system. These will be fed from emergency lighting panels (ELPs) which in turn will be fed 3-phase, 4-wire supply from the emergency lighting distribution boards (ELDB'S) of AC Switch board MCC. Approximately 20% of the lightning shall</p>



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be from emergency lightning.

DESIGN PHILOSOPHY

- (a) A comprehensive illumination system shall be provided in the entire project.
- (b) All outdoor lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.

(c) LED Luminaries:

LED Luminaires shall be used for the lighting of Control Room & Control Equipment areas.

The individual lamp wattage for LED shall be min 3 watt. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 70 Lm/W. Suitable heat sink shall be designed & shall be provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 65. Colour designation of LED shall be "cool day light" (min 5700K) type. The LED luminaire shall have minimum life of 25,000 burning hours with 80% of lumen maintenance at the end of the life.

The beam angle for LED chip shall be 120 degrees. The max junction temperature of LED shall be 85 deg C, further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaries shall be less than 10%. Further the EMC shall be as per relevant standards. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire.

The connecting wires used inside the system, shall be low smoke halogen free, fire retardant PTFE cable and fuse protection shall be provided in input side specifically for LED luminaires.

Care shall be taken in the design that there is no water stagnation anywhere. The entire housing shall be dust and water proof protection as per IS 12063.

Driver Circuit: LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED manufacturer.

LED Drivers may have following control & protections:-

- Suitable precision current control of LED.
- Open Circuit Protection
- Short Circuit Protection
- Over Temperature Protection
- Overload Protection

- (d) All lighting fixtures and control gears shall be powder coated. All outdoor fixtures shall be



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weather proof and of IP55 degree of protection.

- (e) Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have IP55 degree of protection.
- (f) Wires of different phase shall normally run in separate conduit.
- (g) Power supply shall be fed from 415 / 240 V normal AC supply through suitable number of conveniently located lighting distribution boards (LDB) and
- (h) At least one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc. Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for welding purposes at one location.
- (i) All fluorescent fixtures, shall have energy efficient 'T5' type fluorescent lamps except the fluorescent fixtures used for division 2 hazardous area. The louvers of these fixtures shall be designed for 'T5' type fluorescent lamps. All fluorescent lamps shall have "Cool day light" colour designation. The mirror optics type fluorescent fixtures shall have no iridescence effect. Fixtures with better efficiency and upgraded proven system may also be considered.
- (j) Incandescent lamps may be used only with DC Lighting.

Ballasts

All HPSV and HPMV lamp fixtures shall be provided with wire-wound ballasts. All fluorescent fixtures except for Class-I, Div-II fittings/ increased safety fittings (Div-II/Hazardous Area) shall be provided with electronic ballasts.

All luminaries and their accessories and components shall be of type readily replaceable by available Indian makes.

Junction Boxes, Conduits, Fitting & Accessories , Pull Out Boxes:

Junction box for indoor lighting shall be made of fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type.

Junction boxes for street lighting poles and lighting mast if 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 upto 16A shall be modular type. These shall be provided with pre-galvanized/galvanized modular switchbox & plate.



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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.

Lighting Wires

Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R,Y,B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5 sq mm for copper and 4 sqmm for aluminium.

Lighting Poles

The 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 IS2629/ IS2633/ IS4759. 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.

The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.

Lighting Masts

Bidder to provide one lighting mast at a suitable location in switchyard. Lighting Mast shall be of continuously tapered polygonal cross section hot dip galvanized. The Mast shall be of 30 M or suitable height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaries, suitable aviation warning light, lightning along with necessary power



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cables within the mast. The mast shall be delivered in not more than three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

The Mast together with the fixtures shall be capable of withstanding the appropriate wind loads as per IS:875. The Mast shall be fabricated from special steel plates conforming to BS-EN10-025 and folded to form a polygonal section.

Suitable feeder pillar with TPN MCB, contactors, timer, MCB and other necessary accessories for operation & protection of the mast and fixtures shall be provided.

Lighting fixtures shall generally be group controlled directly from lighting panel. However, in office areas, control shall be provided through switch boxes. Each switch shall control a maximum of three fluorescent fixtures.

Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles 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.

Alternately Vendor may offer technically superior and proven product subject to approval of employer.

Galvanizing Tests

IS:2633 Methods for testing uniformity of coating of zinc coated articles.

IS:2629 Recommended practice for hot-dip galvanizing of iron and steel.

1. The quality of galvanizing shall be smooth, continuous, free from flux stains and shall be inspected visually.
2. In addition following tests shall be conducted as acceptance tests.
 - (a) Uniformity of coating - The coating of any article shall withstand four 1minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.
 - (b) The quality of cadmium/zinc plating on items with screw threads shall be free from visible defects such as unplated areas, blisters and modules and shall be inspected visually.
 - (c) In addition, the plating thickness shall be determined microscopically/ chemically or electronically.

	Average	
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Location	illumination level (Lux)	Type of fixture
Control room	300	LED luminaries
Store room	200	Industrial trough type, fluorescent
Switchgear room, HT breaker room	150	Industrial trough type, fluorescent
Street lighting in roads, pathways	10	Industrial trough type, fluorescent
AIS switchyard and substation	20 (general), 50 (on strategic equipment)	HPSPV flood light
Security room	50	CFL

5.36 Water washing arrangement for cleaning of SPV modules

(1) Vendor shall provide permanent arrangement for module washing in the SPV Plant.

(2) This shall include installing tube well(s) / bore well(s) with pump(s) and motor and laying network of GI pipelines in the solar array field. Suitable arrangement (such as storage tanks etc of adequate size / capacity shall also be provided.

(3) Along the water pipeline, manual isolating valves should be provided at regular interval in each row of SPV modules.

(4) Vendor shall install flow meter for measurement of water consumption.

(5) Vendor shall design and submit layout drawings (showing locations of tube wells / bore wells, pumps, valves, pipelines, 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 / NTPC approval during detailed engineering.



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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 "Cabling" 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 "Cabling" of this specification.

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

5.38 Display boards and sign boards

1	Board displaying instruction chart for restoration of person from Electric Shock	6 Nos
2	Board displaying instruction chart for artificial respiration	6 Nos
3	Board displaying dos and don'ts.	6 No
4	Board displaying fire extinguishers details and operations	6 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 with details such as value of voltage etc for string monitoring boxes, PCUs, LT panels, Transformers, HT panels, Four pole / two pole structures in switchyard etc.	Qty as required
9	Identification boards, of suitable sizes, within and outside control room such as control room 3MW, control room 2MW, executive lounge, store room, security room, gents / ladies toilets etc. BHEL will provide the list.	20 Nos

(a) 5mm thick sun board with LG make vinyl sticker (computerized cutting and pasting) shall be used for SINos 4, 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 / NTPC and installed at a suitable location near the main entrance gate of the plant.



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5.39	<p>Electrical insulation mat</p> <p>(1) Vendor shall supply electrical insulating mats as follows:</p> <ul style="list-style-type: none"> (a) Reputed make as shall be approved by BHEL/ NTPC. (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/NTPC during detailed engineering. (f) Colour: to be confirmed by BHEL/NTPC (g) Max use voltage = 33 kV (h) Marking of IS standard on the mat <p>(2) Test certificate shall be provided by vendor</p> <p>(3) Vendor shall lay the mats in front of all the indoor electrical panels viz. PCUs, LT panels, VCB panels, Batteries, Battery chargers, ACDB / DCDB panels etc.</p>																				
5.40	<p>Checkered plate for closing the cable trenches (a) behind the panels such as PCUs, LT panels, ACDB panels etc in inverter rooms / CMCS room and also (b) other open trench areas.</p> <p>(1) Plate shall have a suitable handle (welded to the plate) to facilitate ease of lifting and movements.</p> <p>(2) Plate thickness = 6mm minimum</p> <p>(3) Width and length of checkered plates shall be selected so that the cable trenches are neatly sealed without any gaps.</p> <p>(4) Plate shall be red oxide coated followed by black painting.</p> <p>(5) BHEL/NTPC approval shall be obtained for overall arrangement of checkered plate.</p>																				
5.41	<p>Air conditioner</p> <p>(1) Air conditioner for SCADA room shall be of non-ozone depleting type.</p> <p>(2) Size / capacity shall be selected based on the room size and shall be approved by BHEL / NTPC.</p> <p>(3) It shall be of reputed make as shall be approved by BHEL / NTPC.</p>																				
5.42	<p>Tool kits and instruments</p> <p>Vendor shall supply the following tool kits and instruments:</p> <p>A. Measuring instruments</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%;">1</td> <td style="width: 35%;">Digital Earth Resistance Tester</td> <td style="width: 30%;">Cambridge Instruments</td> <td style="width: 15%;">DET-2000</td> <td style="width: 15%;">2 Nos</td> </tr> <tr> <td>2</td> <td>Digital multimeter</td> <td>Reputed make</td> <td></td> <td>2 Nos</td> </tr> <tr> <td>3</td> <td>AC-DC Clamp Meter</td> <td>Lutron</td> <td>DM-6506</td> <td>2 Nos</td> </tr> <tr> <td>4</td> <td>Thermometer, Laser Beam</td> <td>Fluke</td> <td>62 Mini</td> <td>2 Nos</td> </tr> </table>	1	Digital Earth Resistance Tester	Cambridge Instruments	DET-2000	2 Nos	2	Digital multimeter	Reputed make		2 Nos	3	AC-DC Clamp Meter	Lutron	DM-6506	2 Nos	4	Thermometer, Laser Beam	Fluke	62 Mini	2 Nos
1	Digital Earth Resistance Tester	Cambridge Instruments	DET-2000	2 Nos																	
2	Digital multimeter	Reputed make		2 Nos																	
3	AC-DC Clamp Meter	Lutron	DM-6506	2 Nos																	
4	Thermometer, Laser Beam	Fluke	62 Mini	2 Nos																	



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5	Digital thermometer (wall hanging)	Reputed Make	2 Nos
6	Megger – 5KV	Shanti Electric Instruments, Nippen	2 Nos
7	Electrical Tester	Reputed Make	2 Nos

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

B. Tool kits

1	Double ended spanner Set of sizes 10-11, 12-13, 14-15, 16-17, 17-18	2 Noseach
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 Office furniture

1	Executive table, wooden type, complete with draws and side racks	6 sets
2	Chairs, swivel type, with arm rest	10 Nos
3	Sofa set with one teapoy	1 set
4	PC table with chairs	2 sets
5	Storage almirahs	3Nos
6	Filing cabinets	3Nos

Make: Godrej or reputed equivalent as shall be approved by BHEL / NTPC.

BHEL approval shall be obtained, prior to procurement, for the type of office furniture, for which catalog with model numbers, sizes / dimensions etc shall be submitted to BHEL.



5.44 Fire protection system, fire extinguishers and other safety related items

The SPV plant shall be equipped with suitable fire protection & fire fighting systems for protection of electrical panels / equipment in inverter rooms and main control room (CMCS) as per CEIG requirements.

Vendor shall comply with recommendation of Tariff Advisory Committee to incurring minimal premium for insurance. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.

(1) Fire protection system

Vendor shall provide intelligent microprocessor-based main fire alarm panel 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 alarm initiating devices e.g. multi sensor type smoke detectors and alarm notification appliances (Audio device).

Multi sensor type smoke detectors shall be provided for below false ceiling areas of control room and ACDB room and/or inverter room. One sensor shall be provided for each 25 sq-m 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 the 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 an 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 layout of fire protection system in inverter rooms and main control room (CMCS) along with Bill of Materials (items such as control / display panel with required number of zones, sensors, hooters, manual call points etc) for BHEL/NTPC approval during detailed engineering.



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(2) Fire extinguishers

Vendor shall provide fire extinguishers as follows:

	DCP type (ABC type) 10 Kg	CO2 type Hand 9 Kg	Foam type hand 9 Kg	Hand portable pressurized water CO2 9 liters	Sand buckets with suitable stands
Main control room CMCS	1	2	1	1	4
Each inverter room	1	1			2
ACDB room	1	1			2
Each switchyard of inverter room	2	2	1		2
Switchyard of main control room	2	2	1		4

(3) Other safety related items

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

5.45 Security cabin near the main entrance Gate

Note: Also, refer the section on CMCS room.

RCC type security cabin, with provisions of toilet, urinal, water plumbing system, room electrification and appliances (MCB switchboards, lamps, ceiling fan etc) shall be constructed near the main entrance gate. Tentative BHEL drawing is enclosed with tender. Exact location will be decided based on site conditions and interactive discussions with BHEL / NTPC site engineer.

Vendor shall submit the drawing of security cabin with bill of materials for BHEL/NTPC approval, during detailed engineering.

5.46 Boundary Wall

The complete 61 acres area has to be protected by boundary wall along its periphery. The length of the boundary wall is estimated to be **2.6 km**. The tender drawing of boundary wall has been enclosed with the tender documents to provide a general idea about the



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	<p>work to be performed under the scope of the contract. This is only a preliminary drawing and is by no means the final drawing. Work has to be executed according to "Released for Construction" drawings with addition, alteration and modifications made from time to time as required or as approved by BHEL/NTPC.</p> <p>Bidder to use only Ash bricks for construction of pathways.</p>
5.47	<p>Pathways</p> <p>Pathways shall be leveled and compacted. The pathway shall be made of either brick laid on edge over a well compacted base or concrete blocks of minimum 75mm thickness (with required strength) laid over a well compacted base. Brick should be class designation 7.5 as per IS 1077:1992. The width of the pathways shall be designed so as to carry panel & daily maintenance. The width of pathway shall be ascertained as per the functional requirement and shall not be less than 2m.</p> <p>Vendor shall use only Ash bricks for construction of pathways.</p>
5.48	<p>Drainage System</p> <p>Vendor shall design storm water drainage system for storm water. The trunk / main drains of a minimum length of 600m shall be of RCC type. All other drains can be brick/stone masonry type. The drain shall be preferably trapezoidal type of suitable sizes as per design requirements. The critical rain fall intensity shall be taken as 75 mm/hr for design.</p> <p>As per design requirements, suitable sizes of drains, with a total running length of minimum 5 Km, shall also be provided on both sides of the road/pathway and connected to the main drains.</p> <p>Vendor shall submit the layout and cross section drawings of drains for BHEL/NTPC approval during detailed engineering.</p>
5.49	<p>Approach road</p> <p>Approach road of min 200m length shall be flexible type Bituminous layer with WBM of width at least 3.75 m with one meter shoulder each side as per IRC.</p>
5.50	<p>Railway level crossing near entry point of solar plant</p> <p>Railway Level crossing near entry point of solar PV power plant shall be designed and constructed as per Railway authority regulations and NTPC specifications with gates and a security guard throughout the day operation of gates.</p>



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5.51	<p>Watch Tower</p> <p>One watch tower at a suitable location with platform at approx 8 Mts height with covered roof and full width sliding glass windows on all four sides with proper stair case entry. This shall be used for security purposes and viewing gallery.</p> <p>Tentative drawing of watch tower is attached along with tender and final drawing shall be submitted by the vendor for approval of BHEL/NTPC.</p> <p>Flexible focused flash lights with local switches shall be available on all four sides to be used as and when required by the night security guards.</p>
5.52	<p>Landscaping</p> <p>Front side land portions of main CMCS control room (the land stretch from the main gate / compound wall up to the room) shall be provided with necessary landscaping greenery features such as suitable grass, turfing, flower plants (of different colours / types), underground water pipelines with water jet points / valves / hose pipes for gardening purpose, dome lights for illumination during night time, brick lining / borders etc.</p> <p>Portico area of CMCS room shall be suitably decorated with flower pots, dressed with money plants / creepers etc.</p> <p>These shall be suitably designed and implemented so as to provide an elegant appearance to the power plant entrance, CMCS room and inverter rooms.</p> <p>The design shall be submitted for BHEL / NTPC approval, prior to implementation.</p>
5.53	<p>Pre-commissioning inspections / checks / tests and coordination with state departments for necessary approvals and clearances for commissioning, synchronization with grid and post-commissioning operation of the plant:</p> <p>(A) Vendor shall carry out following minimum pre-commissioning checks:</p> <ol style="list-style-type: none">(1) Verification of firmness of terminations in all electrical equipment: SMBs, PCUs/LT panels, VCB panels, transformers, SCADA stations, weather monitoring equipment.(2) Verification of earthing for all these electrical equipment.(3) Measurement and verification of parameters at string monitoring boxes at solar array field: string current, voltage, combined SMB output current, module temperature, SMB temperature.(4) Measurement and verification of parameters on DC input side of PCUs: DC current and voltage; Vendor shall support the PCU engineer on these tests.(5) Insulation resistance measurements (HV megger tests) for all the electrical equipment of control room and switchyard.(6) Functional checks for LT panels (Air circuit breakers): ACB on/off operations, spring



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charging, LED indications, etc.

- (7) Functional checks for PCUs: Vendor shall support the PCU engineer during the pre-commissioning tests.
 - (8) Functional checks for transformer marshalling box:
Availability of AC/DC power supply, (b) Responses of the relays at VCB panels and corresponding indications at annunciation windows by simulating the alarm / trip of Buchholz, PRV, WTI, OTI, LOLA at marshalling box.
 - (9) Functional checks for VCB panels and annunciation windows on the panels:
 - (a) Availability of AC/DC power supplies, (b) VCB on/ off, (c) spring charging, (d) LED indications, (e) functioning of electromagnetic and numerical relays, (f) responses at VCB panels to remote operations from SCADA station, (g) indications on annunciation windows, alarm accept/reset operations.
 - (b) Verification of interlock operations related to incomer and outgoer VCBs.
 - (10) Verification of parameters at SCADA station: (a) DC/AC parameters from SMBs, PCUs, VCB panels, ACDB panels, Metering panels, (b) status of ACB/VCB breakers and transformer protection relays, (c) weather monitoring parameters.
 - (11) Functional checks on SCADA software: mimic diagrams, trend graphs, remote accessibility etc.
 - (12) Earth resistance measurements for solar array, control room panels and switchyard equipment.
- (B) Pre-commissioning tests on transformers, CTs, PTs, Lightning arrestors, vacuum circuit breakers, relays, etc:
- (1) Usually performed tests are indicated as below. However, exact type of tests required to be conducted at site prior to commissioning shall be in line with concerned state electricity board / CEIG requirements.
 - (a) Transformers: IR tests, ratio tests, excitation current measurement, magnetic balance test on HV, short circuit test, excitation test LV side, vector group test.
 - (b) 33kV vacuum circuit breaker panels: IR tests and continuity tests for panels, IR values for CTs/PTs, excitation test on CTs, primary injection tests for CTs, ratio test for PTs
 - (c) Auxiliary transformers: IR tests, ratio tests.
 - (d) Relays in VCB panels: open/close, tripping, primary injection tests.
 - (e) CTs/PTs: IR tests, Polarity tests, Ratio tests, Burden tests, Winding resistance tests, Primary injection tests, excitation tests.
 - (f) Lightning arrestors: IR tests
 - (2) Appropriate testing agency shall be arranged for the tests.
 - (3) Vendor shall coordinate / liaison with concerned state / central electricity board departments / CEIG etc, as the case may be, to fix up test schedules and witness by their representatives.
 - (4) Vendor shall prepare and submit the reports to concerned MRT departments and obtain their approval through necessary liaison activities.



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(C) Vendor shall coordinate and liaison with concerned state / central electricity departments / CEIG etc, as the case may be, prepare and submit the applications with necessary enclosures on behalf of BHEL / NTPC and obtain their approval:

- (a) Approval for drawings
- (b) Approval for synchronization of plant with grid.
- (c) CEIG inspection of power plant
- (d) Provisional CEIG clearance to proceed with commissioning

(D) Vendor shall implement corrective steps on the observations of CEIG, follow-up with them and obtain final clearance for licensed operation of the plant on a continuous basis.

Note: Scope of coordinating with concerned state / central electricity departments, CEIG to get the clearances / approvals for licensed / statutory operation of the power plant on a continuous basis includes all transactions required for successful liaison and clearances. Application fees and renewal fees (say, in the form of DD) to be enclosed with application / renewal documents shall be in the scope of BHEL / NTPC. All other expenses in the above process shall be in the scope of vendor.



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5.54 Spares required to be supplied along with main consignment:

- 1) MC4 connectors: 150 sets
- 2) 33kV termination kits: 5 Nos
- 3) MCCB, MCB, Fuses for all types (AC/DC): 5% of total population of respective items
- 4) Indicating lamp set of all types (AC / DC): 5% of total population of respective items
- 5) Surge protection devices / MOV: 5% of total population of respective items
- 6) Illumination lamps of invert rooms / CMCS rooms / yard lighting: 5% of total population of respective items
- 7) Auxiliary transformer (200kVA, 33kv/433V) items:

1	HV Bushings with metal parts and gaskets	3 Nos
2	LV Bushings with metal parts and gaskets	3 Nos
3	Neutral Bushings with metal parts and gaskets	1 No
4	Isolating valves of all types (List of different types of valves with type-wise population quantity and spare quantity shall be indicated by vendor)	5% of total population for the respective types (In case of decimal figure, it shall be rounded off to the next higher integer)
5	Pressure Relief Device with alarm / trip contacts	1No
6	Winding temperature indicator with alarm & trip contacts	1 No
7	Oil temperature indicator with alarm & trip contacts	1 No
8	Buchholz Relay (complete unit)	1 No
9	Gaskets of all types (List of different types of gaskets with type-wise population quantity and spare quantity shall be indicated by vendor)	5% of total population for the respective types (In case of decimal figure, it shall be rounded off to the next higher integer)
10	MOG of transformer	1 No
11	Silica gel breather with charge	2 Nos
12	Diaphragm of explosion vent	2 Nos
13	Oil in sealed drums	100 Liters

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6.0 General technical requirements

6.1	<p>Introduction</p> <p>This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.</p>
6.2	<p>Brand name</p> <p>Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the BHEL to determine that the products proposed are equivalent to those named.</p>
6.3	<p>Alternative proposals</p> <p>The vendor shall propose the offer based upon the use of equipment and material complying fully with the requirements specified herein. However, it is recognized that the vendor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein.</p> <p>Accordingly, alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to BHEL / NTPC. Sufficient amount of information for justifying such proposals shall be furnished to BHEL / NTPC along with the bid to enable BHEL / NTPC to determine the acceptability of these proposals.</p> <p>However, discretion for accepting alternative proposals strictly lies with BHEL / NTPC.</p>
6.4	<p>Supply of items as per NTPC approved vendor lists</p> <p>Vendor shall supply the materials / components / panels / equipments etc as per NTPC approved sub-vendor lists enclosed with tender. Only the sub-vendors with "A" category status as on the date of tender opening shall be considered.</p> <p>In case an item does not appear in the approved sub-vendors list, make / vendor of such item shall be as specified in this specification. However, in case this specification too does not specify explicitly, vendor shall propose reputed make for BHEL / NTPC approval.</p>



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6.5	Completeness of technical requirements of the items supplied All the materials / components / panels / equipments etc furnished by the vendor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions. Further, all similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.
6.6	Codes and standards In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following: (a) Bureau of Indian Standards (BIS) (b) Indian electricity act (c) Indian electricity rules (d) Indian Explosives Act (e) Indian Factories Act and State Factories Act (f) Indian Boiler Regulations (IBR) (g) Regulations of the Central Pollution Control Board, India (h) Regulations of the Ministry of Environment & Forest (MoEF), Government of India (i) Pollution Control Regulations of Department of Environment, Government of India (j) State Pollution Control Board. (k) Rules for Electrical installation by Tariff Advisory Committee (TAC). (l) Any other statutory codes / standards / regulations, as may be applicable. Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply: (a) Japanese Industrial Standards (JIS) (b) American National Standards Institute (ANSI) (c) American Society of Testing and Materials (ASTM) (d) American Society of Mechanical Engineers (ASME)



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- (e) American Petroleum Institute (API)
- (f) Standards of the Hydraulic Institute, U.S.A.
- (g) International Organisation for Standardization (ISO)
- (h) Tubular Exchanger Manufacturer's Association (TEMA)
- (i) American Welding Society (AWS)
- (j) National Electrical Manufacturers Association (NEMA)
- (k) National Fire Protection Association (NFPA)
- (l) International Electro-Technical Commission (IEC)
- (m) Expansion Joint Manufacturers Association (EJMA)
- (n) Heat Exchange Institute (HEI)

Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to BHEL / NTPC approval, for which the vendor shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the vendor shall furnish specifically the variations and deviations from the standards mentioned elsewhere in this specification together with the complete word to word translation of the standard that is normally not published in English.

As regards highly standardized equipment such as transformer etc, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.

In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, BHEL / NTPC shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the vendor to bring to the notice of BHEL such changes and advise on the resulting effect.



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6.7	Design of components / systems and maintenance considerations The vendor shall be responsible for the selection and design of appropriate components, layout, schemes, panels / equipments etc so as to provide the best co-ordinated performance for the plant. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The vendor shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. Vendor shall submit various maintenance intervals, spare parts and man-hour requirements for the components, panels / equipments and systems that are in their scope of supply.
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7.0 General conditions applicable during supply, installation and commissioning phase

7.1	As already mentioned in previous clauses, vendor shall organize power supply on their own. Accordingly, DG sets of suitable capacity shall be deployed by the vendor for construction works.
7.2	Similarly, water required for construction works shall be organized by vendor. Bore wells, which are deliverables of vendor as part of this contract, shall be dug in the beginning stages so that bore well water itself can be used for the construction purposes. In case bore well is not successful, vendor shall make their own alternate arrangements (tankers etc).
7.3	All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement and installation of materials / panels / equipment etc shall be organized by the vendor.
7.4	All necessary tools and tackles such as crimping tool (including heavy duty tools for crimping copper cables up to 300 sq-mm), screw driver set, power 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 for RCC works, spade, shovel, hammer etc shall be organized by the vendor.
7.5	All necessary measuring instruments such as digital multimeters, electrical testers, meggers (1kV, 2.5kV, 5kV), lamp load testers for solar array string measurements, earth resistance meters, weighing machines, water level indicators etc shall be organized by the vendor.
7.6	Vendor shall make their own arrangements for necessary food, drinking water and



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	accommodation for their labour and employees posted at the site. Similarly, food and drinking water required at the site, during the construction operations, shall also be in scope of vendor.
7.7	Vendor shall organize all necessary steps to meet statutory requirements such as labour license, PF, ESI etc and also ensure compliance with relevant acts such as minimum wages act, income tax act, employee insurance act etc for their labour deployed at site.
7.8	Vendor shall maintain updated labour register, with name, age, qualification, salary, attendance details etc at the site.
7.9	Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site.
7.10	Vendor shall adhere to all necessary safety norms such as use of helmet, goggles, hand gloves, gumboots, aprons etc. It is the ultimate responsibility of the vendor in all respect to prevent accidents at the site and safeguard their labour from accidents.
7.11	Vendor shall, at the completion of every work, clear off the debris, which resulted out of the work. In case of excavation work such as cable trench etc, vendor shall finish the land neatly with necessary leveling, rolling etc.
7.12	Vendor shall carry out the work without causing inconvenience to other contract groups at the site. In case of conflicts with other groups, vendor shall ensure that the matter is resolved at once amicably so that the progress of work is not affected.
7.13	Any damages on the building, structures etc attributable to the acts of labour / employees of vendor shall be rectified and made good by the vendor at their own cost.
7.14	No child labour shall be employed for execution of the present contract.
7.15	Any miscellaneous materials, which are found essential for technical completion of the contract but not mentioned explicitly in this specification, shall be deemed to be included in the specification. Accordingly, such materials shall be included by the vendor as part of the offer.
7.16	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.



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7.17	<p>BHEL / NTPC 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.</p> <p>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/NTPC for procurement of the item from dealers.</p>
7.18	<p>Field Quality Plan / Quality control system</p> <p>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/NTPC. Vendor shall deploy a well experienced quality control engineer to monitor all QC activities at site as per approved FQP.</p> <p>Specifically with reference to civil works, vendor shall submit all concrete mix designs and bituminous mix designs for BHEL/NTPC approval before starting of the work. All the third party testings should be conducted in NTPC approved laboratories only. Vendor shall submit the FQP for the civil construction works before starting of the works for approval of BHEL/NTPC.</p>
7.19	<p>Any deviations shall be discussed with BHEL / NTPC site engineers and implementation shall be taken up only after approval from BHEL / NTPC.</p>
7.20	<p>Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.</p>

8.0 Operations and Maintenance

8.1	<p>Date of commencement of operations and maintenance</p> <p>Zero date for O&M shall be the actual date on which the successful trial run on the power plant is completed after commissioning of the 15MWp solar photovoltaic power plant with synchronization / export of power to the 132kV grid. (Note: Trial run is considered as an event with trouble-free operation for a cumulative period of 72 hours).</p>
8.2	<p>Period for O&M</p> <p>Vendor shall operate and maintain the complete solar photovoltaic power plant at MP side, up to metering at 33kV level on the LV side of 16MVA, 33/132kV transformer, for a period of</p>



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	<p>one year commencing immediately after successful trial run.</p> <p>Vendor shall interact / coordinate with other O&M contractors suitably on a day-to-day basis so as to ensure smooth operation and reporting of information about the performance of overall power plant up to SSTPS substation end.</p>
8.3	<p>O&M personnel</p> <ol style="list-style-type: none">1. Vendor shall deploy following minimum personnel:<ol style="list-style-type: none">(a) Technical / administrative / office personnel<ol style="list-style-type: none">(a) 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.(b) Three working level staff with ITI / diploma level qualifications in engineering with competence for operating electrical / electronics / mechanical equipment, taking measurements, data logging / maintaining registers, preparation of reports in computer.(c) Three unskilled persons for regular house-keeping (cleaning / mopping etc) and water cleaning of SPV modules.(d) 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<ol style="list-style-type: none">(e) Minimum six security guards with competence to handle tough situations and safeguard the plant from miscreants.(f) Among these, four shall be deployed during night time and two during day time.2. Vendor shall provide separately identifiable uniforms for the respective office staff and security guards.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.



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7. BHEL / NTPC 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 local NTPC administration.
9. O&M personnel at site shall be deemed to be aware of damages and risks incidental to conditions of NTPC land & works from time to time and BHEL / NTPC 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 staffs are present at the power plant even on festivals, public holidays and any other unique occasions so that the plant is run under competent supervision on all days.
 - (c) Security guards shall be available at the power plant on round the clock basis and on all the days. In case of any break in duty of security guard(s), replacement with alternate guard(s) shall be ensured during the break time.
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.



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8.4	<p>O&M operations – daily basis</p> <ol style="list-style-type: none">(1) Water cleaning of SPV modules(2) Inverter room / CMCS 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/NTPC in case of any problems / anomalies observed with any of the parameters.(7) Drinking water to be arranged for O&M personnel at site.
8.5	<p>O&M activities – weekly basis</p> <ol style="list-style-type: none">(1) Removal of garbage from solar array field, switchyard, roads, drains, pathways, sand buckets; logging in registers with signatures of operating persons and in-charge.(2) Monitoring and logging of fire extinguisher levels / pressures as per BHEL formats
8.6	<p>O&M activities – monthly basis</p> <ol style="list-style-type: none">(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:<ol style="list-style-type: none">a. Daily values of solar array strings (SMB parameters)b. Daily values of weather parameters (solar energy, wind speed, ambient temperature)c. Daily energy generationd. Events (with date, time) of faults / tripping / breakdown of equipmente. Events (with date, time) of grid outagef. Events (with date, time) of equipment damages, accidents and theftsg. 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 NTPC representatives shall be obtained wherever required.



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8.7	<p>O&M activities - quarterly basis</p> <ol style="list-style-type: none">(1) Cleaning of PCUs, LT panels, VCB panels, battery chargers etc to remove accumulated dust.(2) Monitoring and status review, followed by rectification / calibration / replenishment / replacement actions as necessary and applicable for following:<ol style="list-style-type: none">(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.
8.8	<p>O&M activities – half yearly basis</p> <ol style="list-style-type: none">(1) Cleaning of overhead tanks
8.9	<p>O&M activities – yearly basis</p> <ol style="list-style-type: none">(1) BDV measurements for oil samples from all the transformers and submission of report to BHEL / NTPC.(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.
8.10	<p>O&M activities - as and when required (contextual basis)</p> <ol style="list-style-type: none">(1) Monitoring and operation of plant electrical equipment as and when required:<ol style="list-style-type: none">(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



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	<p>BHEL.</p> <ul style="list-style-type: none">(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) Battery and battery charger operations(f) Bore well pump operations to fill the overhead tanks <p>(2) Coordinating, on behalf of BHEL, and obtaining renewal of statutory licenses, clearances and approvals from state departments such as electricity boards, CEIG etc.</p> <p>(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.</p> <p>(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.</p> <p>(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.</p> <p>(6) Coordinating with sub-station upon grid failures, line problems etc and implementing the needful steps to restore the plant to normal operation.</p> <p>(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.</p> <p>(8) Accidents: immediate reporting to BHEL, coordinating with hospitals, logging of events (data, time) and maintaining records.</p>
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9.0 Documents to be submitted for BHEL/NTPC approval after receipt of purchase order (during the project execution stage)

9.1	BHEL approval shall be obtained for the following technical documents, which shall be submitted to BHEL in phased manner based on priority sequence of activities.
9.2	Name of vendor / make, model number / part number, specification / sizes / dimensions / drawings / datasheets shall be submitted for all the vendor supplied items.
9.3	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:



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	<ol style="list-style-type: none">(1) MC4 connectors, cable ties, HDPE conduits, cable trays related to SPV module interconnection and laying of 6-sqmm DC cables.(2) Foundation drawing for string monitoring boxes(3) All cables within vendor scope of supply.(4) Cable (6 sq-mm) routing and positions of string monitoring boxes(5) Underground cable trenches / cable laying in solar array field(6) Underground cable trenches / cable laying in switchyards(7) Inverter room related documents<ol style="list-style-type: none">(a) Design calculations for foundation, structure, ventilation, illumination(b) Stage wise drawings: foundation, superstructure, cable trenches for laying and interconnection of cables to electrical panels, flooring, roofs / walls, windows / doors, exhaust provisions, electrical layout, water plumbing layout, etc(c) Architectural drawings with plans / elevation views / layouts etc(8) Central monitoring and control station (CMCS) room related documents<ol style="list-style-type: none">(a) Design calculations for foundation, structure, ventilation, illumination(b) Stage wise drawings: foundation, superstructure, cable trenches for laying and interconnection of cables to electrical panels, RCC roof slab, flooring, windows / doors, exhaust provisions, electrical layout, water plumbing layout, etc(c) Architectural drawings with plans / elevation views / layouts etc(9) Switchyard layouts attached to inverter rooms and CMCS room(10) RCC foundation / fire wall / oil pits of transformers in switchyards – design calculations and drawings(11) Auxiliary power supply system and components: auxiliary transformer, ACDB/DCDB panels, battery banks, battery chargers, DG set etc(12) SCADA system layout(13) Earthing system for the entire plant - design calculations and drawings(14) Lightning protection system(15) Water washing system for cleaning of SPV modules – design calculations and drawings(16) Lighting system for the entire plant (room lighting, yard lighting etc)(17) ABT metering panel(18) Fire alarm system, fire extinguishers, safety gadgets(19) Boundary walls, pathways, drainage system, approach roads, sewerage, septic tank, landscaping – design calculations and drawings(20) Miscellaneous items: cable tags, cable markers, danger boards, sign boards, display boards, electrical insulation mat, checkered plates, air conditioners, tool kits, measuring instruments, office furniture etc(21) Any other components / panels / equipments / systems as may be applicable to get the technical approval of BHEL / NTPC.
9.4	Quality assurance plans for all the vendor supplied items



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9.5	Field quality plan for the field work
9.6	Detailed activity-time chart for project implementation.
9.7	Detailed manpower deployment schedule.
9.8	Operation and maintenance manuals of various panels and equipments supplied by vendor – such as auxiliary transformer, ACDB panels, DCDB panels, battery bank, battery chargers, tool kits, measuring instruments, lightning protection system, fire alarm system, fire extinguishers, air-conditioner etc

COMMERCIAL TERMS & CONDITIONS (to be enclosed with TECHNO-COMMERCIAL BID) (For Indigenous Purchase Orders)				
RFQ No.HBSMM20002 RFQ DATE : 25.10.2013 DUE DATE :18.11.2013 FOR DESIGN,SUPPLY,I&C AND O&M FOR BALANCE OF 15MW SPV PLANT AT NTPC-SINGRAULI,MP				
Sl No.	Terms	BHEL Term	Confirmation	Deviation / Remarks
1	Bidding	(a) Bid has to be submitted as Two Part – in two sealed covers-Techno Commercial Bid(Part-1) & Price Bid (Part-II)- clearly written on each cover both put in a single sealed envelope super-scribed with RFQ No. and Due date.	Acceptable / Not acceptable	
		(b) Documents as called in Pre-Qualification Criteria (Clause 2.0 of PS-439-858) to be submitted along with technical bid(Part-1).	Acceptable / Not acceptable	
		(c) Enclosures-B & B1 to be submitted along with technical bid (Part-1) & Enclosure-B2 to be submitted along with Price bid (Part-II).	Acceptable / Not acceptable	
		(d) 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).	Acceptable / Not acceptable	
2	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).	Acceptable / Not acceptable	
3	Terms of Delivery	Free On Road Basis to Project site :NTPC-Singrauli-MP.	Acceptable / Not acceptable	
4	Delivery Period	(a) Supply : Completion within 12 weeks from the date of Drawing Approval. Drawing Submission : Within 1 week from PO date.	Acceptable / Not acceptable	
		(b) I&C : Completion within 4 weeks from supply date.	Acceptable / Not acceptable	
		(c) Civil Works : Completion within 12 weeks from the date of Drawing Approval.	Acceptable / Not acceptable	
5	Payment Term	(a) Supply :80% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. 10% on completion of I&C and certification line item wise on pro-rata basis. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.	Acceptable / Not acceptable	
		(b) I&C : 90% on completion of I&C and certification line item wise on pro-rata basis. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.	Acceptable / Not acceptable	
		(c) Civil Works : 100% on completion & certification line item wise on pro-rata basis.	Acceptable / Not acceptable	
		(d) O&M : 100% payment on quarterly basis on completion and certification.	Acceptable / Not acceptable	
		(e) For any other deviation loading will be done as per clause 25(A) of Enquiry - General Terms & Conditions (Ref : SCPV/BOS/01-Rev 00)	Acceptable / Not acceptable	
6	Excise Duty	(a) To confirm whether applicable. If applicable, indicate prevailing rate of Excise duty.	Applicable / Not applicable	Prevailing rate of Excise duty : %
		(b) BHEL is trying to avail Customs Duty & Excise duty exemption. Successful bidder shall support with all relevant documents.	Agree/Not Agree	
7	Sales Tax	(a) To confirm whether applicable. If applicable, indicate prevailing rate of Sales Tax against Form c.	Applicable / Not applicable	Prevailing rate of Sales Tax against Form c: %
		(b) For issue of form "C", vendor has to furnish "E1/E2" form. Please confirm that "E1/E2 Sale form" will be submitted.	Agree/Not Agree	
8	Value Added Tax	Since it is inter-state movement of goods, VAT is not applicable. Only CST against form C is applicable.	Applicable / Not applicable	CST applicable @.....%
		OR Both are in the same State, VAT is applicable please indicate VAT applicable.	Applicable / Not applicable	VAT applicable @.....%
9	Octroi	To confirm whether applicable, if applicable indicate current rate of Octroi.	Applicable / Not applicable	Octroi.....%
10	Service Tax	To confirm whether applicable, if applicable indicate current rate of Service Tax. Furnish Service Tax Regn. No. Confirmation that Service Tax register is maintained.	Applicable / Not applicable	Service Tax% Service Tax Regn. No. S.Tax Register maintained : Yes/No

Annexure B

Sl No.	Terms	BHEL Term	Confirmation	Deviation / Remarks
11	Works Contract Tax	Vendor shall ensure quoting WCT inclusive.TDS applicable as per provisions of MP VAT Act. Vendor to be registered under MPVAT, file returns & remit applicable VAT/WCT.Declaration in Form 3 as per MPVAT to be submitted by vendor.TDS is applicable as per provisions of MPVAT Act. The WCT% included shall be indicated.	Agree/Not Agree	WCT @% included in quoted rate
12	Freight	If Freight is quoted extra, original money receipt from Transporter has to be submitted for payment of freight. Please indicate a lumpsum value for Freight charges in Price bid if quoted extra.	Agree/Not Agree	
13	Insurance	Transit Insurance will be in vendor's scope	Agree/Not Agree	
14	Evaluation of L1 vendor	(a)Over all L1 of Supply + I&C + Civil Works + O&M on "FOR" basis to site will only be considered.	BHEL	
		The percentage of Supply, Civil works, I&C and O&M values shall be in the range indicated below(approximately,with overall tallying to 100%) : (a) Supply : 24-28% (b) I&C : 32-36% (c) Civil : 34-38% (d) O&M : 1-4%	Agree/Not Agree	
15	Warranty / Guarantee	(a) Supply : Warranty for 60 months from the date of commissioning or 63 months from the date of supply whichever is earlier.	Agree/Not Agree	
		(b) Workmanship and I&C : 60 months from the date of I&C	Agree/Not Agree	
16	Pre Shipment Inspection	Pre Shipment Inspection will be carried out by BHEL/NTPC for which test report shall be sent one week in advance.	Agree/Not Agree	
17	Penalty	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. For other activities the activity completion date as certified by Engg. will be considered for penalty calculation.	Agree/Not Agree	
		For any deviation, loading will be done as per Clause 25.B of Enquiry - General Terms & Conditions(Ref : SCPV/BOS/01-Rev 00)	Agree/Not Agree	
18	Road Permit	Road permit if applicable will be given by BHEL before Dispatch of ordered Items	BHEL	
19	PBG	(a)PBG shall be furnished in the BHEL prescribed format. (b) Deviation if any Please specify	Agree/Not Agree	
20	Despatch Documents	Complete set of despatch documents in 3 sets shall be forwarded to BHEL directly. Despatch documents include Commercial Invoice, Excise Invoice (if ED is applicable), Lorry receipt (L/R), Packing list, Warranty certificate, Insurance intimation letter, & Original Performance Bank Guarantee (Directly from issuing bank to BHEL). One set of Invoice, Packing list and L/R shall be faxed immediately after despatch to BHEL-EDN, Bangalore.	Agree/Not Agree	
21	Reverse Auction	BHEL reserves the right to conduct Reverse auction.Procedure for the same will be informed by BHEL . Please confirm your acceptance for reverse auction.	Agree/Not Agree	
22	Other terms & conditions	For any other Terms and Conditions, kindly refer to the enclosed Enquiry - General Terms & Conditions(Ref: SCPV/BOS/01-Rev 00)	Agree/Not Agree	
23	Integrity Pact	The bidder shall sign an "INTEGRITY PACT" in the format enclosed (total 8 sheets). Only those vendors / bidders who have entered into such an Integrity pact with BHEL would be competent to participate in the bidding. In other words, entering into this pact is a preliminary qualification. The Name & Address of Independent External Monitor (IEM) is given below: Shri D. P. Bagchi, IAS (Retd.) Y-165, Regency Park - II, DLF City, Phase IV, Gurgaon - 122 009	Agree/Not Agree	
24	Validity	(a) Quotation should remain valid for a period of 90 days from the due date	Agree/Not Agree	
		(b)Deviation if any Please specify	(b)	
25	Bank Charges	(a) All Bank charges to respective accounts	Agree/Not Agree	
		(b) Deviation if any Please specify	(b)	
26	Billing Schedule	Billing schedule shall be submitted by successful vendor after PO is released.	Agree/Not Agree	
27	Spares	Vendor shall quote for mandatory spares as per PS-439-858. Successful vendor shall provide the price breakup of spares.	Agree/Not Agree	

AUTHORISED SIGNATORY WITH SEAL

TECHNICAL BID ENCLOSURE FOR COMPLIANCE OF QUOTE											
RFQ No.HBSMM20002 RFQ DATE : 25.10.2013 DUE DATE : 18.11.2013 FOR DESIGN,SUPPLY,I&C AND O&M FOR BALANCE OF 15MW SPV PLANT AT NTPC-SINGRAULI											
Sl No.		DESCRIPTION	QTY	UNIT	QUOTED	TAXES					Remarks
						ED %	CST%	VAT %	WORKS CONTRACT TAX	SERVICE TAX %	
A. SUPPLY :											
1	PS0679033467	Supply of MC4, Cable tie, HDPE pipe etc	1	ST	YES/NO				NA	NA	Taxes Extra
2	PS0679033475	Supply of LT/HT/data cables, kits etc	1	ST	YES/NO				NA	NA	Taxes Extra
3	PS0679033483	Supply of Materials for Inv. Room	5	ST	YES/NO				NA	NA	Taxes Extra
4	PS0679033491	Supply of DG Set, Aux Transformer etc	1	ST	YES/NO				NA	NA	Taxes Extra
5	PS0679033505	Supply of items of earthing systems	1	ST	YES/NO				NA	NA	Taxes Extra
6	PS0679033513	Supply items of module cleaning system	1	ST	YES/NO				NA	NA	Taxes Extra
7	PS0679033521	Supply LA for PV array, cntrl room etc	1	ST	YES/NO				NA	NA	Taxes Extra
8	PS0679033530	Supply of items of yard lighting systems	1	ST	YES/NO				NA	NA	Taxes Extra
9	PS0679033548	Supply of miscellaneous items	1	ST	YES/NO				NA	NA	Taxes Extra
10	PS0679033556	Supply fire alarm sys, extinguishers etc	1	ST	YES/NO				NA	NA	Taxes Extra
11	PS0679033742	Supply of spares	1	ST	YES/NO				NA	NA	Taxes Extra
B. I&C :											
1	PS0679033564	I&C: Temp site office, storage yard etc	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
2	PS0679033572	I&C: Interconnection Modules,SMBs etc	6	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
3	PS0679033580	I&C:Trenches,cable laying etc	6	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
4	PS0679033599	I&C : Inverter Room	5	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
5	PS0679033602	I&C: Elec panel instln Inverter room	5	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
6	PS0679033610	I&C: 33 KV S/yard at Inv room	5	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
7	PS0679033637	I&C: Elec panel instln at CMCS	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
8	PS0679033645	I&C: 33 KV S/yard at CMCS	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
9	PS0679033653	I&C.SCADA System	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
10	PS0679033661	I&C : DG Set, aux Transformer, etc	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
11	PS0679033670	I&C: Earthing system: Array, S/yard etc	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
12	PS0679033688	I&C: Yard lighting system	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
13	PS0679033696	I&C: Module cleaning system	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
14	PS0679033718	I&C: Misc Items fire alarm sys etc	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
15	PS0679033726	I&C: Commissioning, state clearances etc	1	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
C. CIVIL WORKS :											
1	PS0679033629	Construction of Main Control Room (CMCS)	1	AU	YES/NO	NA	NA	NA	Included	NA	Taxes Included
2	PS0679033700	Construction of Boundary Wall	5	AU	YES/NO	NA	NA	NA	Included	NA	Taxes Included
3	PS0679033866	Constn. of approach road & level crossing	1	AU	YES/NO	NA	NA	NA	Included	NA	Taxes Included
4	PS0679033874	Construction of Pathways	1	AU	YES/NO	NA	NA	NA	Included	NA	Taxes Included
5	PS0679033882	Construction of Drainage System	5	AU	YES/NO	NA	NA	NA	Included	NA	Taxes Included
6	PS0679033890	Constn. of Security cbn, watch tower etc	1	AU	YES/NO	NA	NA	NA	Included	NA	Taxes Included
D.O&M											
1	PS0679033734	O&M of SPV Power Plant	12	AU	YES/NO	NA	NA	NA	NA		Taxes Extra
E	**Freight Charge including Service Tax on Freight(12.36% on 25% of Freight Value)		LUMPSUM		YES/NO	NA	NA	NA	NA	NA	Freight : Included/Extra
F	**Transit Insurance		LUMPSUM		YES/NO	NA	NA	NA	NA	NA	Insurance : Included/Extra

NOTE: 1.YOUR QUOTED PRICES SHALL BE on "FREE ON ROAD" basis to NTPC-SINGRAULI-MP

2.PL INDICATE TAXES : ED,VAT/CST,SERVICE TAX CLEARLY APPLICABLE AS ON DATE.

3.USE THIS FORMAT FOR COMPLIANCE(REPRODUCING ON YOUR LETTER HEAD IS ACCEPTABLE).

4. FOR SL NOS A,B & D, TAXES WILL BE CONSIDERED EXTRA.PLEASE QUOTE ONLY THE BASIC RATES.

5. FOR SL NO.C, THE WCT% INCLUDED IN RATE SHALL BE INDICATED IN ANNEXURE B(SL.No.11).

6.**INDICATE WHETHER FREIGHT CHARGE & INSURANCE CHARGE IS INCLUDED IN QUOTED RATE OR WILL BE CHARGED EXTRA.

IN ABSENCE OF CLARITY, QUOTED RATE WILL BE CONSIDERED AS INCLUSIVE OF FREIGHT & INSURANCE CHARGES.

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PRICE BID FORMAT										
RFQ No.HBSMM20002 RFQ DATE : 25.10.2013 DUE DATE : 18.11.2013 FOR DESIGN,SUPPLY,I&C AND O&M FOR BALANCE OF 15MW SPV PLANT AT NTPC-SINGRAULI										
Sl No.	DESCRIPTION	QTY	UNIT	Unit Rate (Rs.)	TAXES					Remarks
					ED %	CST%	VAT %	WORKS CONTRACT TAX	SERVICE TAX %	
A. SUPPLY :										
1	PS0679033467	Supply of MC4, Cable tie, HDPE pipe etc	1	ST				NA	NA	Taxes Extra
	Rate in words :									
2	PS0679033475	Supply of LT/HT/data cables, kits etc	1	ST				NA	NA	Taxes Extra
	Rate in words :									
3	PS0679033483	Supply of Materials for Inv. Room	5	ST				NA	NA	Taxes Extra
	Rate in words :									
4	PS0679033491	Supply of DG Set, Aux Transformer etc	1	ST				NA	NA	Taxes Extra
	Rate in words :									
5	PS0679033505	Supply of items of earthing systems	1	ST				NA	NA	Taxes Extra
	Rate in words :									
6	PS0679033513	Supply items of module cleaning system	1	ST				NA	NA	Taxes Extra
	Rate in words :									
7	PS0679033521	Supply LA for PV array, cntrl room etc	1	ST				NA	NA	Taxes Extra
	Rate in words :									
8	PS0679033530	Supply of items of yard lighting systems	1	ST				NA	NA	Taxes Extra
	Rate in words :									
9	PS0679033548	Supply of miscellaneous items	1	ST				NA	NA	Taxes Extra
	Rate in words :									
10	PS0679033556	Supply fire alarm sys, extinguishers etc	1	ST				NA	NA	Taxes Extra
	Rate in words :									
11	PS0679033742	Supply of spares	1	ST				NA	NA	Taxes Extra
	Rate in words :									
B. I&C :										
1	PS0679033564	I&C: Temp site office, storage yard etc	1	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
2	PS0679033572	I&C: Interconnection Modules,SMBs etc	6	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
3	PS0679033580	I&C:Trenches,cable laying etc	6	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
4	PS0679033599	I&C : Inverter Room	5	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
5	PS0679033602	I&C: Elec panel instln Inverter room	5	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
6	PS0679033610	I&C: 33 KV S/yard at Inv room	5	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
7	PS0679033637	I&C: Elec panel instln at CMCS	1	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
8	PS0679033645	I&C: 33 KV S/yard at CMCS	1	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
9	PS0679033653	I&C SCADA System	1	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									
10	PS0679033661	I&C : DG Set, aux Transformer, etc	1	AU		NA	NA	NA	NA	Taxes Extra
	Rate in words :									

AUTHORISED SIGNATORY WITH SEAL

PRICE BID FORMAT											
RFQ No.HBSMM2002 RFQ DATE : 25.10.2013 DUE DATE : 18.11.2013 FOR DESIGN,SUPPLY,I&C AND O&M FOR BALANCE OF 15MW SPV PLANT AT NTPC-SINGRAULI											
Sl No.	DESCRIPTION	QTY	UNIT	Unit Rate (Rs.)	TAXES					Remarks	
					ED %	CST%	VAT %	WORKS CONTRACT TAX	SERVICE TAX %		
11	PS0679033670	I&C: Earthing system: Array, S/yard etc	1	AU		NA	NA	NA	NA		Taxes Extra
	Rate in words :										
12	PS0679033688	I&C: Yard lighting system	1	AU		NA	NA	NA	NA		Taxes Extra
	Rate in words :										
13	PS0679033696	I&C: Module cleaning system	1	AU		NA	NA	NA	NA		Taxes Extra
	Rate in words :										
14	PS0679033718	I&C: Misc Items fire alarm sys etc	1	AU		NA	NA	NA	NA		Taxes Extra
	Rate in words :										
15	PS0679033726	I&C: Commissioning, state clearances etc	1	AU		NA	NA	NA	NA		Taxes Extra
	Rate in words :										
C. CIVIL WORKS :											
1	PS0679033629	Construction of Main Control Room (CMCS)	1	AU		NA	NA	NA	Included	NA	Taxes Included
	Rate in words :										
2	PS0679033700	Construction of Boundary Wall	5	AU		NA	NA	NA	Included	NA	Taxes Included
	Rate in words :										
3	PS0679033866	Constn. of approach road & level corssing	1	AU		NA	NA	NA	Included	NA	Taxes Included
	Rate in words :										
4	PS0679033874	Construction of Pathways	1	AU		NA	NA	NA	Included	NA	Taxes Included
	Rate in words :										
5	PS0679033882	Construction of Drainage System	5	AU		NA	NA	NA	Included	NA	Taxes Included
	Rate in words :										
6	PS0679033890	Constn. of Security cbn, watch tower etc	1	AU		NA	NA	NA	Included	NA	Taxes Included
	Rate in words :										
D.O&M											
1	PS0679033734	O&M of SPV Power Plant	12	AU		NA	NA	NA	NA		Taxes Extra
	Rate in words :										
E	**Freight Charge including Service Tax on Freight(12.36% on 25% of Freight Value)		LUMPSUM			NA	NA	NA	NA	NA	Freight : Included/Extra
	Freight charge in words :										
F	**Transit Insurance		LUMPSUM			NA	NA	NA	NA	NA	Insurance : Included/Extra
	Insurance charge in words :										

- NOTE: 1.YOUR QUOTED PRICES SHALL BE on "FREE ON ROAD" basis to NTPC-SINGRAULI-MP
2.PL INDICATE TAXES : ED,VAT/CST,SERVICE TAX CLEARLY APPLICABLE AS ON DATE.
3.USE THIS FORMAT FOR COMPLIANCE(REPRODUCING ON YOUR LETTER HEAD IS ACCEPTABLE).
4. FOR SL NOS A,B & D, TAXES WILL BE CONSIDERED EXTRA.PLEASE QUOTE ONLY THE BASIC RATES.
5. FOR SL NO.C, THE WCT% INCLUDED IN RATE SHALL BE INDICATED IN ANNEXURE B(SI.No.11).
6.**INDICATE WHETHER FREIGHT CHARGE & INSURANCE CHARGE IS INCLUDED IN QUOTED RATE OR WILL BE CHARGED EXTRA.
IN ABSENCE OF CLARITY, QUOTED RATE WILL BE CONSIDERED AS INCLUSIVE OF FREIGHT & INSURANCE CHARGES.

AUTHORISED SIGNATORY WITH SEAL

Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division
PB No.2606, Mysore Road, Bangalore-560026, India

Enquiry - General Terms & Conditions (Two part bid)

I. Enquiry / Request for Quotation (RFQ):

- (a) Any Purchase Order resulting from this enquiry shall be governed by **these general terms and conditions listed below and special terms and conditions, if any, along with this enquiry** of Bharat Heavy Electricals Limited, Electronics Division, Bangalore-560026 (**hereinafter referred to as BHEL EDN**).
- (b) Any of the terms and conditions not acceptable to vendor, shall be explicitly mentioned in the quotation. Otherwise, it will be treated as that all terms and conditions of this enquiry are acceptable.
- (c) If counter terms and conditions are offered by vendor, BHEL EDN shall not be governed by such terms and conditions, unless it is agreed and incorporated in the Purchase Order of BHEL EDN.
- (d) Any deviation to the terms and conditions not mentioned in the quotation by vendor in response to this enquiry will not be considered, if put forth subsequently or after issue of order, unless clarification is sought for by BHEL EDN and agreed upon in the Purchase Order of BHEL EDN.
- (e) BHEL EDN reserves the right to adopt Reverse Auction for the enquiry sent, at its discretion.
- (f) BHEL EDN shall be at liberty to cancel the tender at any time, before ordering, without assigning any reason.
- (g) Any specific terms and conditions to be complied will be mentioned in RFQ.

II. General Terms and conditions:

1. **TWO PART BID:** Quotation shall be submitted in two part bid i.e.

(a) Techno-commercial i.e., Un-priced Bid (in one sealed envelope):

Techno-commercial bid shall be submitted with complete description of the equipment, specification compliances to the enquired specification and all the commercial terms & conditions indicated in the **COMMERCIAL TERMS (ANNEXURE-A for Foreign Purchase and ANNEXURE-B for Indigenous Purchase)**. Any other enclosure, which the vendor wishes to submit like product catalogue, technical literature etc., may also be submitted in a sealed envelope super scribed clearly as **"TECHNO-COMMERCIAL BID" with RFQ No. and DUE DATE**. An un-priced copy of price bid (without price) as per **ANNEXURE A-1 for Foreign Purchase and ANNEXURE B-1 for Indigenous Purchase** shall also be enclosed with the techno-commercial bid for evaluation of commercial terms. The vendor shall not give the price in the technical bid.

Confirmation to BHEL specifications shall be indicated by the vendor in the respective columns provided in the purchase specification wherever applicable. Deviations to the specification / item description, if any shall be brought out clearly indicating **"DEVIATION TO BHEL SPECIFICATION"** without fail as a part of technical offer.

Compliance to Pre-qualification criteria (if applicable) shall also be enclosed with the Techno-commercial bid.

Manufacturer's name, their trade mark and brand, part number, alternate material to the one asked in enquiry, if any, should be mentioned in quotation and illustrative leaflets giving technical particulars etc. are to be attached to facilitate consideration and technical evaluation of the quotation. BHEL EDN material code number (as in enquiry) shall be indicated for each item quoted.

(b) Price Bid (in one sealed envelope):

Price bid should contain basic unit prices, discount if any, applicable taxes & duties, packing & forwarding charges (if applicable), Freight & insurances (if applicable), FOB charge (if applicable) etc., in a sealed envelope super scribed clearly as **"PRICE BID" with RFQ No. and DUE DATE**.

It is preferred to indicate the rates in both figures and words. In such case, if there is a difference / discrepancy

Signature of tenderer / with seal
Page 1 of 12

between the rates in figures and words, the **least of the two** rates will be considered. **Price bid shall be quoted as per ANNEXURE A-2 for Foreign Purchase and ANNEXURE B-2 for Indigenous Purchase.**

(c) Tender Offer (above two envelopes inside another sealed envelope):

Both these sealed envelopes [(a) Techno-commercial i.e., un-priced Bid and (b) Price Bid] shall be kept in a single sealed envelope and super scribed clearly with **RFQ No. and DUE DATE.**

2. The above sealed envelope (Tender) shall reach our office on or before the due date by 13:00 hrs. Quotations are to be dropped in the tender box marked for the OPENING ON respective days i.e., MONDAY / WEDNESDAY / FRIDAY kept at BHEL-EDN's Reception area of our works with caption "CE, SC & PV, DEFENCE". **Quotations also can be dispatched by Couriers / Registered post / FAX / e-mail to the Purchase Executive indicated in the RFQ at the risk of vendor / bidder.**

Quotation through courier / register post / fax / email when addressed to the specific fax number and email address given in the enquiry, to be sent well in advance to enable BHEL EDN purchase personnel to drop in the tender box before the scheduled opening date and time. Vendor is fully responsible for lack of secrecy on information of such quotations. Vendor shall confirm with the concerned purchase executive after sending the offer regarding such delivery mode to ensure participation. BHEL EDN is not responsible for any delay in receipt of quotation sent by vendor through post/fax/email.

Late Tenders i.e., Tenders received after due date & time will be rejected.

3. The rate quoted shall be in units stated in the enquiry. Where quotation is in terms of unit other than that in enquiry, relationship between the two units must be furnished in the quotation.
4. As far as possible, the quotations shall be free from corrections / overwriting. Corrections / overwriting, if any should be signed by authorized person with the company seal. Any typographical errors, totaling mistakes, currency mistakes, multiplication mistakes, summary mistakes observed in your priced bids, BHEL may consider whichever is beneficial to BHEL for evaluation. Vendor shall doubly ensure that the quote is correct and complete. The corrections / overwriting if any shall be signed with the seal.
5. Quotations are to be duly signed. Unsigned bids/offers are liable for rejection.
6. Tenders will be opened at **13:30 hrs** & the venue is New Engineering Building, 2nd floor, MM conference hall, BHEL EDN, Bangalore. All the tenderers or their authorized representatives (with authorization letter from their principals) may witness opening of techno-commercial bid on the due date.
7. After evaluation of techno-commercial bids, price bids of only those which are technically & commercially accepted, will be opened on a subsequent date, which will be intimated to the concerned in advance for witnessing of price bid opening.
8. The quantity in each item to be purchased may vary from quantity enquired according to the actual requirement at the time of placing the purchase order.

9. DUN & BRADSTREET REPORT (for Foreign purchase):

In case of foreign vendors, BHEL reserves the right to verify the Dun & Bradstreet report during techno-commercial scrutiny. Please mention DUN Number in **Techno-Commercial bid.**

10. Payment of Agency Commission to Indian Agent (for Foreign purchase):

- a. BHEL shall deal directly with foreign vendors, wherever required, for procurement of goods. However, if the foreign principal desires to avail of the services of an Indian agent, then the foreign principal should ensure compliance to regulatory guidelines - which require mandatory submission of an Agency Agreement.
- b. It shall be incumbent on the Indian agent and the foreign principal to adhere to the relevant guidelines of Government of India, issued from time to time.

Signature of tenderer / with seal

- c. The Agency Agreement should specify the precise relationship between the foreign OEM / foreign principal and their Indian agent and their mutual interest in the business. All services to be rendered by agent/ associate, whether of general nature or in relation to the particular contract, must be clearly stated by the foreign supplier/ Indian agent. Any payment, which the agent or associate receives in India or abroad from the OEM, whether as commission or as a general retainer fee should be brought on record in the Agreement and be made explicit in order to ensure compliance to laws of the country.
 - d. Any agency commission to be paid by BHEL to the Indian agent shall be in Indian currency only.
 - e. Tax deduction at source is applicable to the agency commission paid to the Indian agent as per the prevailing rules.
 - f. In the absence of any agency agreement, BHEL shall not deal with any Indian agent (authorized representatives / associate / consultant, or by whatever name called) and shall deal directly with the foreign principal only for all correspondence and business purposes.
 - g. The "Guidelines for Indian Agents of Foreign Suppliers" shall apply in all such cases.
 - h. The supply and execution of the Purchase Order (including indigenous supplies/ service) shall be in the scope of the OEM/ foreign principal. The OEM/ foreign principal should submit their offer inclusive of all indigenous supplies/ services and evaluation will be based on 'total cost to BHEL'. In case OEM/ foreign principal recommends placement of order(s) towards indigenous portion of supplies/ services on Indian supplier(s)/ agent on their behalf, the credentials/ capacity/ capability of the Indian supplier(s)/ agent to make the supplies/ services shall be checked by BHEL as per the extant guidelines of Supplier Evaluation, Approval & Review Procedure (SEARP), before opening of price bids. It will be the responsibility of the OEM/ foreign principal to get acquainted with the evaluation requirements of Indian supplier/ agent as per SEARP available on www.bhel.com.
- The responsibility for successful execution of the contract (including indigenous supplies/ services) lies with the OEM/ foreign principal. All bank guarantees to this effect shall be in the scope of the OEM/ foreign principal.
- i. **Installation & Commissioning:** Scope will be as per RFQ.E&C value should be quoted separately by bidders.
11. **TOTAL COST TO BHEL:** Purchase order will be placed on the lowest quotation (L1) only among the technically & commercially accepted quotations. Lowest quotation (L1) is determined on the basis of the total cost to BHEL.

For Foreign offers, the Exchange rate(TT selling rate of SBI) shall be taken as under.

Single part bids	Date of Tender opening
Two/Three part bid	Date of Part-1 bid opening
Reverse Auction	Date of Part-1 bid opening

If the relevant day happens to be a bank holiday, then the forex rate as on the previous bank (SBI) working day shall be taken.

- (1) If Freight is quoted extra, original money receipt from Transporter shall be submitted for payment of Freight charges.
- (2) C-form : For issue of form "C", vendor has to furnish "E1/E2" form.

12. FIRM PRICE:

Rates quoted should be firm from the date of offer, till completion of supply. No enhancement in the rates and changes in the techno-commercial terms will be allowed once the quotation is accepted and order is placed.

If Installation & Commissioning is in vendor's scope, then the price shall remain FIRM till commissioning & handing over of the complete system.

13. TERMS OF PAYMENT:

1. SUPPLY

A. : FOR FOREIGN PURCHASE

Payment will be made against "SIGHT DRAFT" on presentation of documents to our bankers . Payment through LC is also made subject to loading factors as per Clause 25 (A). For LC payment bank charges within India will be borne by BHEL and outside India will be to vendor"s account.

The payment terms are as follows:

SIGHT DRAFT PAYMENT (direct payment):

SUPPLY :

(a) **I&C not included in vendor's scope** : 90% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.

(b) **Supply & I&C in vendor's scope** : 80% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. 10% on completion of I&C and certification line item wise on pro-rata basis. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks..

(B) FOR INDIGENOUS PURCHASE (DIRECT PAYMENT):

SUPPLY :

(a) **I&C not included in vendor's scope** : 90% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.

(b) **Supply & I&C in vendor's scope** : 80% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. 10% on completion of I&C and certification line item wise on pro-rata basis. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.

2. For I&C: 100% on completion of I&C and certification line item wise on pro-rata basis.

3. Civil Works : 90% on completion of activity milestone and certification line item wise from site-in charge. Balance 10% against PBG for 10% of basic Civil value valid warranty period + 6 months claim period from any of the BHEL Consortium banks.

4.O&M: 100% O&M charges are payable as per RFQ terms against report certified by BHEL.

If PBG cannot not be submitted, vendors can also accept for the final 10% payment, payable after the warranty period + 6 months of claim period against supplementary invoice subject to the completion of commissioning (if applicable).

For any deviation in payment term, the offer will be loaded as per Clause 25.00.

5.ADVANCE PAYMENT: Quotations with "Advance payment" shall be liable for rejection.

14. PENALTY:

Failure to supply within the delivery time as per purchase order will make the vendor liable to an unconditional penalty of 0.5 % (half percent) per week at the basic price of the goods for the undelivered quantity, subject to a maximum of 10%.

Supply : Date of issue of pre-shipment inspection/ call letter with supporting documents like test reports/conformance to test carried by the vendor will be treated as date of dispatch for the purpose of penalty calculation wherever Pre-Inspection Call is carried out.

Signature of tenderer / with seal

For all other activities, the actual date of completion of activity as certified by concerned site-incharge will be considered for the purpose of penalty calculation.

15. PBG:

Performance Bank Guarantee (PBG) to be submitted on non-judicial stamp paper as per the BHEL prescribed format given in **ANNEXURE-E for Foreign Purchase and Annexure-F for Indigenous Purchase** for 10% of the total supply value obtained from any BHEL member (consortium) banks indicated in **ANNEXURE-G**.

The Bank Guarantee shall be submitted directly to the concerned Purchase Executive by the issuing Bank with their forwarding letter. BHEL will verify independently with the bank to establish the authenticity. Alternately, standby LC issued from approved banker can also be considered.

16. TERMS OF DELIVERY:

(a) FOR IMPORTED PURCHASE:

Price offered shall be for goods packed and delivered **FOB** Seaport,/FCA International Airport including packing, forwarding, Handling, Ancillary charges like processing of Sight Draft, negotiation charges of bank, Export declaration, Certificate of origin etc.

Packing shall be Air/Sea worthy, best suitable for trans-shipment and to take care of transit damages. If containerized, no. of containers & size of container shall be mentioned. Packing weight (gross & net) Packing dimensions shall be given prior to shipment to ascertain whether the consignment can be carried on standard cargo in contract or as ODC.

Wooden packing material for all the foreign consignments should be treated as per ISPM-15 & **Fumigation / Phytosanitary certificate** to be submitted to the freight forwarders/ BHEL along with the invoice, B/L, packing list etc.

Vendors shall indicate the name of International Airport/Seaport. Approved Airports are as per **Annexure-C**. The consignment shall be handed over to BHEL approved freight forwarder as mentioned in PO.

17. DELIVERY REQUIREMENT:

Delivery date mentioned in RFQ is tentative. Actual requirement is as per RFQ terms & conditions.

18. VALIDITY:

Quotation should remain valid for a period of **90 days** from the date of technical bid opening.

19. POST-ORDER REQUISITES:

- a. Vendor shall give an Order Acknowledgement indicating the delivery date within one week of receipt of PO.
- b. Pre-shipment inspection at vendor's works, if required, will be carried out by BHEL. Required assistance will have to be provided by the vendor at the time of pre-shipment inspection.
- c. Test certificates, Calibration certificates and warranty certificates as stipulated at the time of ordering shall be furnished.
- d. Items shall be dispatched by Air worthy /Sea worthy/ Road worthy packing. Any damage and later rejection, due to poor / improper packing shall be to vendor's account.
- e. Any damage/rejection should be made good or replaced immediately without any extra cost to BHEL such as freight, duties, taxes etc. The liability is restricted to the value of the order.
- f. Wherever commissioning is involved, it shall be carried out by the vendor's qualified engineers. Scope of work includes installation, commissioning and start-up trials till satisfactory performance level is reached as certified by BHEL.
- g. BHEL will not be responsible for any loss, damage or injuries to vendor's personnel sustained during

Signature of tenderer / with seal

- h. installation / commissioning / start-up trials. Vendor shall ensure compliance with all statutory requisites as laid down by local bodies, state & Central Government. Vendor shall indemnify BHEL for all damages/ losses to various personnel during their presence in BHEL"s premises for whatever purpose.
- i. Suitable markings & damage control indicating devices shall be provided where applicable.
- j. Equipment shall comply with the standard requirements of ISO 14001 & OHSAS 18001.

20. RISK PURCHASE:

The purchaser at his discretion may also make purchase of the materials NOT supplied in time at the RISK & COST of the supplier. In this event, it will be obligatory on the part of the supplier who fails to supply the goods in time to make good to BHEL any loss due to such risk purchase.

21. GENERAL TERMS AND CONDITIONS GOVERNING REVERSE AUCTION (RA):

- (a) In case of RA, BHEL will communicate business rules governing the RA to the bidders through a service provider.
- (b) BHEL EDN reserves the right to adopt Reverse Auction for the enquiry sent, at its discretion.
- (c) Confirm acceptance for RA in ANNEXURE A/B.

22. REGRET LETTER: In case any vendor is unable to quote, vendor shall send a regret letter.

23. Any dispute arising out of this, shall be referred to the sole arbitration of Head of Dept. Materials Management of group concerned, BHEL EDN or any other officer nominated by him and his award shall be final and binding on the parties. The venue of the arbitration in all cases shall be Bangalore, India.

24. Any legal suit in respect of this enquiry lies in the court of Jurisdiction of Bangalore (India) only.

25. LOADING FACTORS:

Loading factors as detailed below will be added to the quoted price (basic) to evaluate the lowest quote for non compliance of BHEL standard commercial term.

A (i). For non compliance of standard Terms of payment (For Foreign Purchase Orders)

Sl. No.	BHEL standard term	If you quote	Loading factor in % for non-compliance
1	80% against "SIGHT DRAFT" + 20% after commissioning and against PBG(where both commissioning & PBG are applicable)	Payment through Letter of Credit (LC)	10%

In general, if the quote is through L/C, it shall be opened 30 days prior to dispatch and valid for 3 months.

A(ii).For non compliance of standard Terms of payment (For Indigenous Purchase Orders)

Sl. No.	BHEL standard term	If you quote	Loading factor in % for non-compliance
1	As per RFQ Terms	Any other Payment term	10%

B.For non compliance of standard Terms of Penalty

Sl. No.	BHEL standard term	If you quote	Loading factor for non-compliance
1	Penalty of 0.5% per week subject to max. of 10% on the basic value of the items not supplied /delayed	Other than the above.	Loading Factor 10%-Quoted Max %

LIST OF INTERNATIONAL AIRPORTS

Sl. No	Country	Air Ports
1	Austria	Vienna, Linz, Graz
2	Australia	Sydney, Melbourne, Perth
3	Belgium	Antwerp, Brussels
4	Canada	Toronto, Montreal
5	China	Shanghai
6	Cyprus	Lamaca
7	Czech Republic	Prague (Via Frankfurt)
8	Denmark	Copenhagen
9	Egypt	Cairo
10	Finland	Helsinki
11	France	Paris (Rosy), Lyon
12	Germany	Darmstadt, Mannheim, Nurnberg, Hamburg, Stuttgart, Munich, Koln, Dusseldorf & Hannover, Frankfurt, Berlin
13	Hong Kong	Hong Kong
14	Italy	Rome, Milan, Turin, Bologna, Florence
15	Ireland	Dublin
16	Israel	Telaviv
17	Japan	Tokyo, Osaka
18	Malaysia	Kuala lumpur, Penang
19	Netherlands	Amsterdam, Rotterdam
20	New Zealand	Auckland
21	Norway	Oslo
22	Oman	Muscat
23	Philippines	Manila
24	Romania	Bucharest
25	Russia	Moscow
26	Saudi Arabia	Riyad
27	Singapore	Singapore
28	Slovakia	Bartslowa
29	South Africa	Johannesburg, Durban
30	South Korea	Kimpo
31	Spain	Barcelona
32	Sweden	Stockholm, Gothenburg, Milano
33	Switzerland	Basle, Zurich, Geneva
34	Taiwan	Taipei
35	U.A.E.	Dubai
36	U.K.	Landon (Heathrow), Newcastle, Oxford, Cheltham, Bristol, Welling borough, Birmingham, East Midland, Manchester, Leeds, Glasgow.
37	U.S.A.	New York, Chicago, San Francisco, Los Angeles, Atlanta
38	Ukraine	Kiev

BHEL EDN APPROVED TRANSPORTERS FOR INLAND ROAD TRANSPORTATION

1. M/s Awagaman Road Carriers ltd., Bangalore. (AWG)
2. M/s BLR India Pvt. Ltd., Bangalore. (BLR)
3. M/s Delhi Assam Roadways corporation ltd., Bangalore. (DRL)
4. M/s Indo Arya Central transport ltd., Bangalore. (IACT)
5. M/s Prakash parcel Services, Bangalore. (PPS)
6. M/s Road Carrier of India, Bangalore. (RCI)
7. M/s Union Roadways ltd., Bangalore. (URL)

Signature of tenderer / with seal
Page 7 of 12

PERFORMANCE BANK GUARANTEE
(FOR FOREIGN PURCHASE ORDERS)
BANK NAME AND ADDRESS

Bharat Heavy Electricals Limited (BHEL),
Electronics Division,
PB No. 2606,
Mysore Road,
BANGALORE- 560 026
INDIA

Dear Sir,
Ref: CONTRACT PERFORMANCE GUARANTEE.

WHEREAS you have entered into a contract reference No PO NO. _____

wit

h M/s

_____ having its registered office _____

at _____ for the supply of _____ as
detailed in your purchase order No. _____ which is hereinafter referred to as "the said contract" and
whereas M/s _____

has undertaken to produce a Bank Guarantee for 10% (Ten Percent) of _____ the contract price
amounting to _____ (_____

_____) to secure its obligations to Electronics Division, BHEL having its registered office at New Delhi
for the performance of the contract including the warranty of the equipment supplied, We _____
Bank , _____ hereby expressly, irrevocably and unreservedly undertake and guarantee as
principal obligors on behalf of M/s _____ that in the event Bharat Heavy Electricals Ltd. (B.H.E.L.)
declares to us in writing that M/s _____ has not fulfilled any obligation according to the
contractual obligation of the said contract, to pay you on demand and without demur to Bharat Heavy Electricals Ltd.,
Electronics Division , Mysore Road, P.B. No. 2606, Bangalore-560 026, India an amount of _____ (in words
_____) subject to as may be determined below:

1) Notwithstanding any right M/s. _____ may have directly against you or any disputes raised
by M/s _____

_____, Your written demand shall be conclusive evidence to us that repayment
is due under the terms of the said contract and shall be binding on us.

2) We shall not be discharged or released from this undertaking and Guarantee by any arrangements, variations
made between you and M/s. _____
with or without our consent and Knowledge or by any alterations in the obligations of M/s.
_____ by any forbearance whether as to payment, time, performance or otherwise.

3) This guarantee shall remain valid until the end of twenty four weeks after the close of the warranty period or until
the same is reported by BHEL to us whichever is earlier.

4) We agree and undertake not to revoke this guarantee during its validity unless discharged in writing by you
subject to the provision of clause (7) below.

5) This guarantee shall be a continuing guarantee subject to the foregoing and shall not be discharged by any change
in the constitution of the Bank or M/s.
_____.

6) This guarantee shall be governed by and constructed in accordance with the Laws of India.

7) At any time _____ Bank may render this guarantee null and void by paying to Bharat Heavy
Electricals Ltd. the full amount being
_____ (in words _____)

For and on behalf of Bank
by its Authorized
Signatory

Note:

Signature of tenderer / with seal
Page 8 of 12

- (1) To be executed in Non-Judicial stamp paper by any authorized Indian Bank.
- (2) To be submitted directly by banker to concerned executive in purchase dept., Please give BHEL address to banker.
- (3) Do not enclose with Bank document.
- (4) Any Modification & omissions to this are not permitted

PERFORMANCE BANK GUARANTEE
(FOR INDIGENOUS PURCHASE ORDERS)

THIS DEED OF GUARANTEE made and executed on the _____ day of _____(year), by the _____ (Bank), registered under the Companies Act 1956/Nationalized Bank constituted under the Banking Companies (acquisition and transfer of undertakings) Act constituted under the State Bank of India Act / Subsidiary Banks Act, having its registered / head office at _____ represented herein by its Branch Manager / authorized representative Sri. _____ & Sri. _____(Hereinafter called 'guarantor ' which term shall mean and include its successors and assigns)

IN FAVOUR OF BHARAT HEAVY ELECTRICALS LIMITED

_____ (Buyer's Name), a company registered under the companies Act, 1956 having its registered office at BHEL House at Siri Fort , New Delhi-100 049 and its Electronics Division at Mysore road, Bangalore-26 (hereinafter referred to as the 'Company' Which term shall include its successors and assigns):

Whereas the company has placed an order on _____ (State the name of the company / firm and its address) (hereinafter referred to as the 'Supplier' which term shall mean and include its liquidators, successors and assign) for the supply of system under order / Contract No _____ Dt _____.

AND WHEREAS the supplier has agreed to supply the materials and carryout the works as detailed and in accordance with the terms set out in the said order/contract.

AND WHEREAS the company is not required to pay to the supplier a sum of Rupees _____ being the 10% of the value of the goods supplied / Works performed / Services rendered under the said order / contract between the supplier and the company, till the company is satisfied with the mechanical Warranties and the performance standards stipulated in the said order / contract between the company and the supplier has been duly fulfilled, except against a Bank Guarantee for the said sum of Rs _____ in favour of the company by reputed Bank, in which case the company has agreed to make payment to the supplier of the said sum of Rupees _____ being (...%) of the value of the goods supplied / Works performed / Services rendered under the agreement between the supplier and the company and the Guarantor has at the request of the supplier, agreed to furnish this Guarantee subject to the terms and conditions stated below:

NOW THIS DEED WITNESSES THAT IN pursuance of the above said agreement, the guarantor hereby agrees and covenants With company is as follows :-

- 1) That during the period this contract of Guarantee remains effectual, the guarantor shall be liable in respect of the amount due and owing to the company in respect of the payments to the extent of Rs _____ (in words) _____ against any loss or damage caused to or suffered by the company by reasons of any breach of the terms of the said order / contract / Agreement by the supplier.
- 2) The Guarantor hereby undertakes to pay the amounts due and payable under this guarantee without any demur, merely on demand from the company intimating that the amount claimed is due by way of loss or damage caused to or suffered or would be caused or suffered by the supplier of any terms contained in the said order / contract. Any such demand made on the guarantor shall be conclusive as regards the amount due and payable by the Guarantor irrespective of the fact whether the Contractor / supplier admits or denies.
- 3) The Guarantor further agrees that the agreement herein contained shall remain in force and effect till all the supplies to be made / Works to be performed / Services to be rendered under the said order / contract / agreement are completed to the entire satisfaction of the company or till company certifies that the terms and conditions of the said order / contract / agreement have been fully and properly carried out by the said supplier and accordingly discharges the Guarantee. Unless a demand or claim under this guarantee is made on the guarantor in writing on or before the expiry of claim period indicated in clause 6 below, the guarantor shall be discharged from all the liability under this guarantee thereafter.
- 4) The guarantor further agrees with the company that the company shall have the fullest liberty without the consent of the guarantor and without effecting in any manner the obligations of the guarantor hereunder to vary any of the terms of the said order / contract / agreement or extend the time of performance by the said supplier from time to time or refrain from exercising the power exercisable by the company against the said supplier or to forebear or omit to enforce any of the terms and conditions relating to the said order / contract / agreement, and the guarantor shall not be relieved of its liability in whole or in part , by reason of any act, commission or forbearance on the part of the company or by reason of any such variation, or extension being granted to the said

Signature of tenderer / with seal

supplier or by reason of any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving the guarantor.

- 5) The guarantor undertakes not to revoke this guarantee during its currency except with the previous consent of the company in writing.
- 6) Notwithstanding anything herein above contained, the liability of the guarantor under these presents is restricted to Rs_____. The guarantee shall be in force till its expiry on _____ unless a demand is made on the guarantor within SIX months from the date of expiry, all the liability of the guarantor under this guarantee shall stand fully discharged. The decision of the claimant in regard to breach of contract is final and binding on the Bank.

IN WITNESS whereof, the guarantor, acting through it authorized representative has executed this deed of Guarantee on the day, month and year first above written.

(Seal of the Bank to be affixed)

WITNESS

- 1.
- 2.

Note:

- (1) To be executed in INR 100 Non-Judicial stamp paper by any authorized Indian Bank.
- (2) To be submitted directly by banker to concerned executive in purchase dept., Please give BHEL address to banker.
- (3) Do not enclose with Bank document.
- (4) Any Modification & omissions to this are not permitted.

BHEL MEMBER BANKS (CONSORTIUM BANKS)**PBG SHALL BE ISSUED FROM THE FOLLOWING BANKS OR THEIR BRANCH OFFICES ONLY**

1	STATE BANK OF INDIA
2	PUNJAB NATIONAL BANK
3	HDFC BANK
4	SYNDICATE BANK
5	CANARA BANK
6	INDIAN BANK
7	ST. BANK OF HYDERABAD
8	ICICI BANK
9	STANDARD CHARTERED BANK
10	UCO BANK
11	KOTAK MAHINDRA
12	ORIENTAL BANK OF COMMERCE
13	STATE BANK OF TRAVANCORE
14	CENTRAL BANK
15	IDBI BANK
16	FEDERAL BANK
17	HSBC LTD
18	DEUTSCHE BANK
19	CORPORATION BANK
20	CITI BANK
21	BANK OF BARODA
22	ABN AMRO BANK
23	UNITED BANK OF INDIA
24	VIJAYA BANK
25	UNION BANK OF INDIA
26	PUNJAB & SIND BANK
27	ANDHRA BANK
28	BANK OF INDIA
29	AXIS BANK

The above list is tentative and is subject to change from time to time.
The Purchase Executive shall be contacted for confirmation of the same.

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at “BHEL House”, Siri Fort, New Delhi – 110049 (India) hereinafter referred to as “The Principal”, which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____, (description of the party along with address), hereinafter referred to as “The Bidder/ Contractor” which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for

_____. The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint Independent External Monitor(s), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 – Commitments of the Principal

- 1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:-
 - 1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.
 - 1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.
 - 1.1.3 The Principal will exclude from the process all known prejudiced persons.
- 1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 – Commitments of the Bidder(s)/ Contractor(s)

- 2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.
 - 2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he / she is not legally entitled to, in

order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant IPC/ PC Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

2.1.4 The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 – Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidders(s)/ Contractor(s) from the tender process or take action as per the separate “Guidelines for Suspension of Business Dealings with Suppliers/ Contractors” framed by the Principal.

Section 4 – Compensation for Damages

- 4.1 If the Principal has disqualified the Bidder(s) from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit/ Bid Security.
- 4.2 If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages equivalent to 5% of the contract value or the amount equivalent to Security Deposit/Performance Bank Guarantee, whichever is higher.

Section 5 – Previous Transgression

- 5.1 The Bidder declares that no previous transgressions occurred in the last 3 years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.
- 5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 – Equal treatment of all Bidders/ Contractors/ Sub-contractors

- 6.1 The Bidder(s)/ Contractor(s) undertake(s) to demand from his sub-contractors a commitment consistent with this Integrity Pact. This commitment shall be taken only from those sub-contractors whose contract value is more than 20% of Bidder's/ Contractor's contract value with the Principal.
- 6.2 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors.
- 6.3 The Principal will disqualify from the tender process all bidders who do not sign this pact or violate its provisions.

Section 7 – Criminal Charges against violating Bidders/ Contractors /Sub-contractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 –Independent External Monitor(s)

- 8.1 The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.
- 8.2 The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.
- 8.3 The Bidder(s)/ Contractor(s) accepts that the Monitor has the right to access without restriction to all contract documentation of the Principal including that provided by the Bidder(s)/ Contractor(s). The Bidder(s)/ Contractor(s) will grant the monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his contract documentation. The same is applicable to Sub-contractor(s). The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/ Contractor(s) / Sub-contractor(s) with confidentiality.
- 8.4 The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.
- 8.5 As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or

take corrective action, or heal the situation, or to take other relevant action. The Monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action.

8.6 The Monitor will submit a written report to the CMD, BHEL within 8 to 10 weeks from the date of reference or intimation to him by the Principal and, should the occasion arise, submit proposals for correcting problematic situations.

8.7 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.

8.8 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant IPC / PC Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.9 The number of Independent External Monitor(s) shall be decided by the CMD, BHEL.

8.10 The word 'Monitor' would include both singular and plural.

Section 9 – Pact Duration

9.1 This Pact begins when both parties have legally signed it. It expires for the Contractor 12 months after the last payment under the respective contract and for all other Bidders 6 months after the contract has been awarded.

9.2 If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified as above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 – Other Provisions

- 10.1 This agreement is subject to Indian Laws and jurisdiction shall be registered office of the Principal, i.e. New Delhi.
- 10.2 Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.
- 10.3 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.
- 10.4 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.
- 10.5 Only those bidders/ contractors who have entered into this agreement with the Principal would be competent to participate in the bidding. In other words, entering into this agreement would be a preliminary qualification.

For & On behalf of the Principal
(Office Seal)

For & On behalf of the Bidder/ Contractor
(Office Seal)

Place-----

Date-----

Witness: _____
(Name & Address) _____

Witness: _____
(Name & Address) _____
