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VOLUME - IA

TECHNICAL CONDITIONS OF CONTRACT (TCC) FOR SUPPLY, I&C, O&M OF BALANCE OF SYSTEM ITEMS AT 65 MW SOLAR POWER PLANT OF NLC, NEYVELI, TAMILNADU.

TCC No: HY/PE&SD/E&C-Sub Contract/ Solar/65MW/NLC/ BOS, Rev.00

BHARAT HEAVY ELECTRICALS LIMITED

PROJECT ENGINEERING & SYSTEMS DIVISION HYDERABAD



TECHNICAL CONDITIONS OF CONTRACT (TCC)

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TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-I. Project Details

1.0 Project Details

M/s NLC Ltd is establishing 2 block of 65MW (AC) Grid Interactive Solar PV Plant on EPC basis at Neyveli, Cuddalore District, Tamil Nadu. BHEL has been awarded 1 block of 65 MW which is divided in two different site with each of 40 MW & 25 MW respectively.

1	Customer	:	M/s Neyveli Lignite Corporation Limited.
2	Project Information	:	1x65 MW(AC) Grid Interactive Solar PV Power Plant Area of 65MW block is divided into two sub blocks of 40MW and 25MW. The distance between these blocks is around 8kM.
3	Location	:	At Neyveli, Cuddalore District, Tamil Nadu. The site is 200 KM from Chennai.
4	Address Detail	:	Neyveli, Cuddalore District, Tamil Nadu.
5	Nearest Railway Station	:	Neyveli,
6	Road Approach	:	State Highway connecting Vridhachalam-Cuddalore and is about 18 KMs East of Vridhachalam and about 43 KMs South West of Cuddalore on Eastern Coast.
7	Nearest Air Port	:	Chennai
11	Ambient Air Temperature (Average)	:	a) Maximum : 40.0 ⁰ C b) Minimum : 18.4 ⁰ C
12	Average Relative Humidity	:	28-96 %
13	Climatic Condition	:	Tropical Climate

Bidder is advised to visit the project site and appraise himself about the local conditions and infrastructure available in the area for fulfilling their commitments under the contract. BHEL will not admit any claims whatsoever on account of Contractor's non-familiarization of local conditions.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-I. Project Details

1.1 Introduction

1.1.1 Project outline of 1x65MWp solar photovoltaic power plant

Bharat Heavy Electricals Limited (BHEL), PE&SD, Hyderabad is setting up a 65MWp solar photovoltaic (SPV) power plant at Neyveli, Cuddalore District, Tamil Nadu for NLC. An overview outline of the project is as follows:

- (a) Neyveli Lignite Corporation Limited (NLC), a Navaratna Government of India Enterprise, functioning under the administrative control of Ministry of Coal is an integrated complex involving in Lignite Mining and Thermal Power Generation. NLC is setting up a 2x65MW solar PV power plant, at Neyveli, Tamil Nadu state.
- (b) The solar PV power project at Neyveli site is located within NLC's command area adjoining township at Neyveli, Cuddalore District, and Tamil Nadu, India. The land is of flat terrain and firm soiled. The entire 130 MWp solar PV power plant comprises of two nos. blocks of capacity 65 MWp each. In which BHEL is setting up one of the 65MW capacity block. For each block of 65MW at Neyveli site, two location are earmarked as 40MW and 25MW blocks to meet the site area requirement. The distance between 40MW area and 25MW area is around 8 KM.
- (c) The SPV modules employed at the power plant generates DC electricity that in turn is inverted to 3-phase AC with ~ 350V. The voltage is further stepped up to 33kV using 2.7MVA transformers. Twenty six such transformers are employed to achieve 65MWp. In which 16 nos. transformers are associated with 40MW block and 10 nos. transformers are associated with 25 MW.
- (d) String monitoring boxes (SMBs, 549nos.) are employed to monitor the DC parameters of the strings of solar array. The DC power outputs from the SMBs are fed to 52 Nos of 1250kW grid-interactive power conditioning units (inverters) that are housed in a distributed manner among 11 PCSS rooms/inverter rooms and two PESS buildings/central control rooms. The PCSS room, each generating 5MWp, are placed at different locations of the power plant. Each such room is associated with a 33kV transformer yard, employing two oil-immersion transformers each of 2.7MVA, 33kV/350-350 V (one HV and two LV windings). Each LV winding voltage is expected to be in the range ~350V-380V.

The 33KV output of 2 Nos of 2.7MVA transformers are fed to 33KV Switch boards with (2 I/C & 1 O/G) vacuum circuit breaker (VCBs) indoor panels are also placed in each PCSS room. The 33kV outgoing feeder from each PCSS will feed the 33kV switchboard at PESS. From PESS power generated is exported through Metering yard, Gantry to Grid. Thus, 7 PCSS rooms & 1 PESS room put together will generate 40MW in 40MW block and 4 PCSS rooms & 1PESS room put together will generate 25MW in 25MW block.

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Chapter-I. Project Details

As per the above major equipment pertaining 40MW block and 25MW block are listed broadly below

For 40MW block

333 SMBs, 32 PCUs, 7 PCSS, 1 PESS building, 16 Nos 2.7 MVA Transformer and 1 Metering yard (2bays) & gantry.

For 25MW block

216 SMBs, 20 Inverters, 4 Inverter rooms, 1 PESS building, 10 Nos 2.7 MVA Transformer and 1 Metering yard (1bay) & gantry.

- (e) Generated power from 40MW block will be exported through two transmission line, each is sized for 40MW and Generated power from 25MW block will be exported through one transmission line. Each feeder line is supported by a 33kV metering yard comprising of outdoor-mounted equipment viz. CTs, PTs, surge arrestors, GOS isolators, earth switches, support structures, ACSR conductors etc. Each feeder line is provided with three ABT meters (main, check and standby) that are housed in independent panels kept in PESS room.
- (f) The parameters (DC solar array, LT AC inverter level, HT 33kV transformer level) of solar power plant are monitored using SCADA system.
- (g) Power plant is provided with underground earth mat grid system for various electrical installations such as Solar array structures, string monitoring boxes, Inverter/PESS room electrical panels, Transformer yards, Metering yard and other installations.
- (h) 415V AC power for power plant auxiliaries is derived from 415V ACDBs located in PCSS room & PESS building. These ACDB will be further fed from 2x100% 350V/433V Auxiliary transformers. These Auxiliary transformers derive the power from output terminals of inverter.
- (i) 110V DC supply for various electrical equipment such as protection relays, indication lamps etc. is derived from set of battery banks of Battery charger in PESS and PCSS rooms. The power supply to Battery charger is fed from auxiliary ACDB distribution panels.
- (j) 230V UPS power supply for various electrical equipment such as SCADA, PCUs, emergency lighting etc. is provided and are located in PESS and PCSS rooms. The power supply to UPS is fed from auxiliary ACDB distribution panels.
- (k) 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 / PESS rooms, Inergent gas fire protection system for SCADA, IP based telephone system, fire extinguishers, tools and instruments for operations and maintenance etc.

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Chapter-II Scope of Works

2.0 SCOPE OF WORK

Vendor scope includes:

- 1 Design, supply, installation, commissioning, operations and maintenance that includes activities but not limited to design, engineering, drafting of drawings, obtaining BHEL approvals for the design / drawings/ other technical/quality documents, manufacture / testing / inspection at manufacturer's works, packing, supply, transportation, ~~transit insurance*~~, delivery to site, unloading/ safe storage of vendor supplied items., and erection/commissioning of electrical panels.
*The comprehensive MCE of BHEL covers the transit and Storage insurance. Bidder to exclude the same.
- 2 Coordination / liaison activities (related to clearance / approval) with concerned state / central authorities such as CEIG/CEA etc. including renewal of CEIG license during O&M period.
- 3 Operations and maintenance of the complete plant for a period of five years after successful trial run for cumulative 24 hours of trouble-free operation following successful commissioning of the plant (export of generated power to 33kV grid).

2.1.0 GENERAL

- 2.1.1 The drawings enclosed with this tender are intended to give the tenderer a general idea of the type and extent of work involved. The drawings are as such only indicative and not to be considered as the exact construction drawings.

Further this is to be noted that the drawings and the documents furnished along with this specification are the sole property of BHEL. It must not be used directly or indirectly in any way detrimental to the interest of the company.

- 2.1.2 The scope of work will also include such other related works although they may not be specifically mentioned in the above paragraph and all such incidental items not specified but reasonably imply and necessary for completion of the job as a whole all as desired and as directed by the engineer.

- 2.1.3 **Temporary site office for vendor use:**
Vendor shall necessarily establish Site Office for their own purpose. Site offices for BHEL shall be arranged by BHEL.

2.1.4 **Electrical power / water for construction, drinking water**

- 2.1.4.1 The Vendor will be provided with a 415V, 3 Phase, 50 HZ Power Supply at one point in each of the project locations for construction purpose free of charge from BHEL/NLC power distribution network. Further distribution within the solar power plant area shall be made by the vendor at his own cost.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-II Scope of Works

- 2.1.4.2 Water supply will be provided by BHEL/NLC for construction and maintenance purpose of solar power plant at one point in each of the project site locations and further distribution is included in the Vendors's scope. The Vendor shall arrange for storage sumps, pumps and distribution piping to various locations within the solar power plant. Water will be provided to the vendor free of charge by BHEL/NLC for Solar Power Plant during construction and during the O&M period also.
- 2.1.5 The detail scope of work covered above is not a comprehensive list of items of work involved. The detail scope of work may vary considerably depending on the actual construction requirements.

2.2.0 ALSO INCLUDED IN THE SCOPE

Unless otherwise specified, the work to be provided by the contractor for the items mentioned in the "Schedule of items", shall include but not be limited to the following.

- 2.2.1 Furnishing all labour, materials, supervision, construction plans, equipment, supplies, transport, to and from the site, fuel, electricity, compressed air, water, ~~transit and storage insurance~~ and all other incidental items and temporary works not shown on specified but reasonably implied or necessary for the proper completion, maintenance and handling over the works, except in accordance with the stipulations laid down in the contract documents and additional stipulations as may be provided by the engineer during the course of works.
- 2.2.2 Furnishing samples of all materials required by the engineers for testing/inspection and approval for use in the works. The samples may be retained by the engineer for final incorporation in the works.
- 2.2.3 Furnishing test reports for the products used or intended to be used, if called for the specifications or if so desired by the engineer.
- 2.2.4 Giving all notices, paying all fees, taxes etc., in accordance with the general conditions of contract, that are required for all works including temporary works.
- 2.2.5 Arranging manufacturer's supervision for items of work done as per manufacturer's specifications when so specified.
- 2.2.6 Providing all incidental items not shown or specified but reasonably implied or necessary for the successful completion of the work in accordance with contract.

2.3.0 WORK BY OTHERS

No work under the specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

**FOR FURTHER DETAILED SCOPE OF WORKS REFER RELEVANT
TECHNICAL SPECIFICATIONS PROVIDED IN THE SUBSEQUENT
CHAPTERS IN THE TCC**

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Chapter – III: Facilities in the scope of Contractor/BHEL

S. No.	Description PART I	Scope / to be taken care by		Remarks
		BHEL	Bidder	
3.1	ESTABLISHMENT			
3.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office (as per availability)	Yes		Location will be finalized after joint survey with customer(NLC)
B	Open space for storage (as per availability)	Yes		Location will be finalized after joint survey with customer(NLC)
C	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	
D	Bidder's all office equipments, office / store / canteen consumables		Yes	
E	Canteen facilities for the bidder's staff, supervisors and engineers etc		Yes	
F	Firefighting equipments like buckets, extinguishers etc		Yes	
G	Fencing of storage area, office, canteen etc of the bidder		Yes	
3.1.2	FOR LIVING PURPOSES OF THE BIDDER			
A	Open space for labour colony (as per availability)	Yes		Can be provided as per availability
B	Labour Colony with internal roads, sanitation, complying with statutory requirements		Yes	
3.2.0	ELECTRICITY			
3.2.1	Electricity For construction purposes		Yes	Electricity @ free of charge for construction purpose will be provided by BHEL at one point, further distribution is in the scope of vendor
3.2.2	Electricity for the office, stores, canteen etc. of the bidder		Yes	
3.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors etc		Yes	
3.3.0	WATER SUPPLY			

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Chapter – III: Facilities in the scope of Contractor/BHEL

S. No.	Description PART I	Scope / to be taken care by		Remarks
		BHEL	Bidder	
3.3.1	For construction purposes		Yes	Water @ free of charge for construction purpose will be provided by BHEL at one point, further distribution is in the scope of vendor
3.3.2	<u>Water supply for bidder's office, stores, canteen etc</u>		Yes	
3.3.3	<u>Water supply for Living Purpose</u>		Yes	
3.4.0	LIGHTING			
A	For construction work (supply of all the necessary materials) 1. At office/storage area 2. At the preassembly area 3. At the construction site /area		Yes	
B	For construction work (execution of the lighting work/ arrangements) 1. At office/storage area 2. At the preassembly area 3. At the construction site /area		Yes	
C	Providing the necessary consumables like bulbs, switches, etc during the course of project work		Yes	
D	Lighting for the living purposes of the bidder at the colony / quarters		Yes	
3.5.0	COMMUNICATION FACILITIES FOR SITE OPERATIONS OF THE BIDDER			
A	Téléphone, fax, internet, intranet, e-mail etc.		Yes	
3.6.0	COMPRESSED AIR wherever required for the work		Yes	
3.7.0	Demobilization of all the above facilities		Yes	
3.8.0	TRANSPORTATION			
A	For site personnel of the bidder		Yes	
B	For bidder's equipments and consumables (T&P, Consumables etc)		Yes	

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Chapter – III: Facilities in the scope of Contractor/BHEL

Sl. No	Description PART II 3.9.0 CONSTRUCTION FACILITIES	Scope / to be taken care by		Remarks
		BHEL	Bidder	
3.9.1	Engineering works for construction:			
A	Providing the construction drawings for all the works covered under this scope	Yes		
B	Drawings for construction methods	Yes	Yes*	*For package being designed by vendor
C	As-built drawings – where ever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes		Yes	In consultation with BHEL
D	Shipping lists etc. for reference and planning the activities		Yes	In consultation with BHEL
E	Preparation of construction (Concreting B/W, etc.) schedules and other input requirements		Yes	In consultation with BHEL
F	Review of performance and revision of site construction schedules in order to achieve the end dates and other commitments	Yes	Yes	In consultation with BHEL
G	Weekly construction schedules based on S. No. e. hard copy to Construction manager, by email to HO.		Yes	In consultation with BHEL
H	Daily construction / work plan based on S. No. g. hard copy to Construction manager, by email to HO.		Yes	In consultation with BHEL
I	Periodic visit of senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two Weeks.		Yes	
J	Arranging the materials required for Work		Yes	

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Chapter – III: Facilities in the scope of Contractor/BHEL

Sl. No	Description PART II 3.9.0 CONSTRUCTION FACILITIES	Scope / to be taken care by		Remarks
		BHEL	Bidder	
K	Coordination for inspection & checking and getting clearance from customer		Yes	
L	Preparation of formats for completion of activities		Yes	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter – IV: T&Ps to be deployed contractor

4.0. LIST OF TOOLS AND PLANT:

The following tools and equipment but not limited to, are required for the efficient execution of the BOS works. The contractor shall make them available for construction purposes, including all consumables likely to be used at his own cost at the time of mobilization.

These tools and tackles shall be maintained by vendor at 40MW block and 25MW block separately during the erection & commissioning activities.

BHEL will not provide any tool, plants or any testing facility/apparatus for the work. It will be contractor's responsibility to arrange all required tools, plants and other testing apparatus, etc. at their own cost. The prices quoted & finalized are inclusive of the charges towards providing such T&P. No extra payment will be entertained on account of this.

S.No.	Description	Minimum Quantity	Remarks
1	Hydra	1	Need based
2	JCB	1	Need based
3	Tractor	1	Need based
4	Cable unwinding Machines, rollers etc	1 No	
5	MC4 connector tool kit containing (1) crimping plier MC4, (2) open end spanner set MC4, (3) stripping plier MC4, (4) socket wrench insert to tighten, (5) socket wrench insert to secure, inserts for both 4 sq-mm and 6-sqmm (of both pliers).	2 Set	
6	Electrical measuring Instruments		
	a) Megger-500V	1No	
	b) HV Tester-5000V	1No	
	d) Logic probe	1No	
	e) Modbus communication check kits	1No	
	f) Digital Multi meter	3 No	
7	Tong Testers	3 No	
8	Digital power meters	1 No	
9	Phase sequence meter	1 No	
10	OFC termination kit, Splicing kits	1 Set	
11	Primary /secondary injection kit	1 No each	Need based
12	Transformer oil filtration unit	1 No	Need based
13	Earth resistance measurement kit	1 No	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter – IV: T&Ps to be deployed contractor

14	Lugs, glands as in scope of supply	1 set	Need based
15	Transmission line stringing equipment	1 No	
16	Cable jointing kit and associated tools	2 Set	
17	Welding equipment	1 No	
18	Flood lights	5 No	
19	Set of screw drivers	1 Set	
20	Set of Allen keys (mm & inch)	1 Set	
21	Small size hacksaw & fraksaw	1 Set	
22	Cutting pliers	2 No	
23	Nose pliers	2No	
24	Insulation stripers	2No	
25	Dry cable jointer	1 No	
26	Number punches	1 No	
27	Alphabet punch	1 No	
28	Embossing machine with cassettes (Numbers and alphabets)	1 No	
29	Portable drilling machine up to 1-1/2”	1 Set	
30	Soldering gun	1 No	
31	Soldering Iron	1 No	
32	Continuity tester	5 No	
33	Double ended spanner Set of sizes 10-11, 12-13, 14-15, 16-17, 17-18	2 Nos each	
34	Screwdriver Set	1 Set	
35	Crimping tool with Dye range 50-400sq- mm cable, mechanical gear power, hand operated	1 Set	
36	Crimping tool up to 6 sq-mm cable	1 set	
37	Drilling machine AC, hand operated, with bit size up to 20 mm	1 set	
38	Measuring Tape, 5m	2 Nos	
39	Measuring Tape, 50 m	2 Nos	
40	Allen Key set	1 Set	
41	Adjustable spanner 2-inch size	1 No	
42	Hammer	2 Nos	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter – IV: T&Ps to be deployed contractor

43	Rough file kit	1 Set	
44	Cutting Pliers	2 Nos	
45	Nose Pliers	2 Nos	
46	Vacuum cleaner, of industrial type, for control room sweeping / cleaning.	1 No	
47	Blowers for cleaning the panels	2 Nos	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-V: T&Ps to be deployed by BHEL on sharing basis

5.0 T&PS TO BE DEPLOYED BY BHEL ON SHARING BASIS:

BHEL will not provide any tool, plants or any testing facility/apparatus for the work. It will be contractor's responsibility to arrange all required tools, plants and other testing apparatus, etc. at their own cost. The prices quoted & finalized are inclusive of the charges towards providing such T&P. No extra payment will be entertained on account of this.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-VI: Time Schedule

6.1 TIME SCHEDULE

6.1.1

The entire work of Supply, E&C of Balance of System items as detailed elsewhere in the Tender Specification shall be completed within 5 (Five) months from the date of commencement of work at site and the work O&M of 65MW Solar power plant to be completed within 5 (Five) Years from the date of completion of Trial run.

6.1.2

During the total period of contract, the contractor has to carry out the activities in a phased manner as required by BHEL and the program of milestone events.

6.1.3

The work shall be commenced on the mutually agreed date between the bidder and BHEL engineer and shall be deemed as completed in all respect only when the unit is in operation. The decision of BHEL in this regard shall be final and binding on the contractor. The scope of work under this contract is deemed to be completed only when so certified by the site Engineer.

6.2 COMMENCEMENT OF CONTRACT PERIOD

The date of commencement of contract period shall be the mutually agreed date between the bidder and BHEL engineer to start the work. In case of discrepancy the decision of BHEL engineer will be final.

6.3 MOBILISATION

6.3.1

The activities for Excavation, structural & Erection & Commissioning works, etc. shall be started as per directions of Construction manager of BHEL.

6.3.2

The contractor should mobilize man power in order to complete the work in 5 months for Design, Supply, I&C of Balance of System items (BOS) and for 5 years of O&M of 65MW solar power plant after trial run

6.3.3

Requisite Material, men and machinery should be arranged in order to complete the project within stipulated time period.

6.3.4

The contractor has to augment his resources in such a manner that following major milestones of the project are achieved on specified schedules:

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-VI: Time Schedule

TENTATIVE SCHEDULE

S.No.	Activity/Mile stone	Duration in months	
		Start	Finish
1	AC Cable Laying	Oct 16	DEC 16
2	DC Cable Laying	Oct'16	DEC'16
3	Erection of Metering yard and OH line up to the Gantry	Dec'16	JAN'16
4	Earthing	Oct'16	Jan'17
5	Erection and testing of Equipment	Oct'16	Dec'16
6	CEIG/CEA Approval	Feb'17	Feb'17
7	Commissioning	Oct'16	Feb'17
8	Trail run & Stabilization	Feb'17	Feb'17
9	O&M	Mar'17	Feb'22

In order to meet above schedule in general, and any other intermediate targets set, to meet customer/project schedule requirements, contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL.

6.4 CONTRACT PERIOD

For the purpose of contract, the period shall be taken as 5 (Five) months for Design, Supply, I&C of Balance of System items and the work O&M of 65MW Solar power plan to be completed within 5 (Five) Years from the date of completion of Trial run . Completion of the work shall be as per BHEL Bar Charts revised from time to time. In order to expedite the work, the contractor has to deploy manpower on two-shift basis during erection and during pre-commissioning and commissioning period manpower should be provided round the clock basis as per site requirement without any extra cost to BHEL.

6.5 PROTECTION OF WORK

The contractor shall have total responsibility for protecting his works till it is taken over by the Employer. No claim will be entertained by the Employer or the representative of the Employer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-VI: Time Schedule

Works occur because of other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned.

If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be rectified. The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

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Chapter-VII: Term of Payment

7.1

The progressive payment for the work on accepted price of contract value will be released on the basis of running account bills & other bills as per the provisions of relevant clauses of GCC and SCC.

7.2

The following documents are to be submitted along with the Running Account Bills for process of payment

- 7.2.1 Tax Invoice with details of TIN number of BHEL and contractor.
- 7.2.2 Measurement books duly filled and signed officials of BHEL and contractor
- 7.2.3 Provident Fund Remittance challan of previous month.
- 7.2.4 ESI Remittance challan of previous month.
- 7.2.5 Invoice submitted along with running bills to indicate the service tax amount charged and bear the Service tax Number.
- 7.2.6 Bill submitted subsequently to be accompanied with a declaration that service tax liability on the earlier bill has been discharged.
 - 7.2.6.1 By paying money to the Government (along with Tax paid Challan Copy)
 - 7.2.6.2 By utilization of Input Service tax Credit

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-VIII: Taxes and other duties

8.0 TAXES, DUTIES, LEVIES

8.1. For all types of supply items:

8.1.1

Excise duty – exemption available for certain items as per MNRE. For items in negative list (list of ineligible items), the excise duty is inclusive, i.e not reimbursable from customer.

As an indicative list, the following items are entitled for excise exemption

- Cable glands
- Cable lugs
- HDPE pipe
- Module washing system
- Surge suppressor
- ACSR
- 33KV insulator
- CT & PT

However, bidder shall ascertain the items eligible for exemption as per circular issued by MNRE is attached in Annexure-III of TCC.

In genuine cases, where bidder has considered the excise exemption for certain items during tender quote but due to some reason not attributable to bidder, the excise exemption is not passed by MNRE/Customer, then such excise amount may be claimed extra at actual from BHEL.

Post order, successful bidder shall also provide the Purchase order copies for items which are excise exempted and provide sub vendor details as required so that excise exemption letter can be arranged.

8.1.2

Sales tax – Form C will be issued. Sales tax @ 2% and VAT (wherever applicable for dispatches within same state) is included in sale price, not reimbursable. However, sale in transit procedure to be followed for bought out items.

8.1.3

Entry tax – Will be borne by employer (NLC) if applicable

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-VII: Taxes and other duties

8.2. For All types of works

8.2.1

The contractor shall pay all (save the specific exclusions as enumerated in this contract) taxes, fees, license charges, deposits, duties, tools, royalty, commissions or other charges which may be levied on the input goods & services consumed and output goods & services delivered in course of the Contractor's operations in executing the contract. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from contractor's bills or otherwise as deemed fit.

However, provisions regarding Service Tax, Swachh Bharat Cess, Krishi Kalyan Cess and Value Added Tax (VAT) on output services and goods shall be as per following clauses.

8.2.2 Service Tax, Swachh Bharat Cess & Krishi Kalyan Cess on Output Services:

Contractor's price/rates shall be **exclusive** of Service Tax and Swachh Bharat Cess on Services. In case, it becomes mandatory for the contractor under provisions of relevant act/law to collect the Service Tax, Swachh Bharat Cess & Krishi Kalyan Cess from BHEL and pay the same to the concerned tax authorities, such applicable amount will be paid by BHEL at the prevailing Service Tax Rate, presently Service Tax 14%, Swachh Bharat Cess 0.5% and Krishi Kalyan Cess 0.5% on the admitted Service value against submission of documentary evidence of their remittance.

Contractor shall submit to BHEL documentary evidence of Service Tax registration certificate specifying name of services covered under this contract. Contractor shall submit serially numbered Service Tax and Cess Invoice, signed by the Contractor or a person authorized by the Contractor in respect of taxable service provided, and shall contain the following, namely,

- 1.The name, address and the registration number of the contractor,**
- 2.The name and address of the party receiving taxable service,**
- 3.Description and value of taxable service provided and,**
- 4.The Service tax, Swachh Bharat Cess & Krishi Kalyan Cess payable thereon.**

All the above four conditions shall be fulfilled in the invoice before release of service tax, Swachh Bharat Cess and Krishi Kalyan Cess payment.

Wherever, more than one route/option are available for discharge of Service Tax, Swachh Bharat Cess & Krishi Kalyan Cess, liability under a particular service, (e.g. "works contract Service"), contractor shall obtain prior written consent from BHEL before billing the amount towards Service Tax and Cess

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-VII: Taxes and other duties

8.2.3 VAT (Sales Tax /WCT)

As regards Value Added Tax (VAT)/CST on transfer of property in goods involved in Works Contract (previously known as Works Contract Tax) if applicable as per local laws, the price quoted by the contractor shall be **inclusive** of the same and in no case input or output VAT/CST will be reimbursed extra by BHEL.

In any case the Contractor shall register himself with the respective Sales Tax authorities of the State (where the project is located) and submit proof of such registration to BHEL along with the first RA bill. The contractor shall issue the tax Invoices to BHEL as per the Tax laws of respective State and also issue to BHEL the prescribed forms/undertakings/certificate/any other documents prescribed under the respective State VAT laws for enabling BHEL to avail input credit for the output VAT paid by the Contractor or for claiming set-off/deduction for the value of work executed by the Contractor, wherever applicable.

Deduction of tax at source (if applicable) shall be made as per the provisions of law and is to be construed as an advance tax paid by BHEL on behalf of the contractor and no reimbursement thereof will be made by BHEL.

Further, if BHEL, at the instance of customer or otherwise adopts the specific route for discharging output VAT liability itself, benefit of the reduction in liability of the contractor has to be passed on to BHEL.

In case, BHEL is forced to pay any VAT liability on behalf of the contractor, the same will be recovered from contractor's bill or otherwise as deemed fit.

8.3 New Taxes/Levies - For All types of works

In case the Government imposes any new levy/tax on the output service/ goods/work after award of the contract but before the scheduled completion date as per contract, the same shall be reimbursed by BHEL at actual against documentary evidence/proof.

In case any new tax/levy/duty etc. becomes applicable after the date of Bidder's offer, the Bidder/Contractor must convey its impact on the bidder's price duly substantiated by documentary evidence in support of the same **before opening of Price Bid**. Claim for any such impact after opening the Price Bid will not be considered by BHEL for reimbursement of tax or reassessment of offer.

No reimbursement/recovery on account of increase/reduction in the rate of taxes, levies, duties etc. on **input** goods/services/work of the Contractor shall be made by BHEL. Such impact shall be taken care of by the Price Variation/Adjustment Clause (PVC) if any. In

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Chapter-VII: Taxes and other duties

case PVC is not applicable for the contract, Bidder has to make own assessment of the impact of future variation if any, in rates of taxes/duties/ levies etc. in the price bid.

8.4 GST: For All types of works excepting works covered under sl no 8.2

As and when GST becomes applicable to this contract, the net differential (negative or positive) financial liability of the Contractor to the Authorities (as compared to such liability prior to applicability of GST), if any, shall be to the account of BHEL. For this purpose, all available options under the GST shall be explored, and the decision of BHEL in this regard shall be final and binding on the Contractor.

8.5

BUILDING & OTHER CONSTRUCTION WORKERS (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 (BOCW Act) AND RULES OF 1998 READ WITH BUILDING & OTHER CONSTRUCTION WORKERS CESS Act, 1996 & CESS RULES, 1998.

In case any portion of work involves execution through building or construction workers, then compliance to the above titled Acts shall be ensured by the contractor and contractor shall obtain license and deposit the cess under the Act. In the circumstances it may be ensured as under:-

- i. It shall be the sole responsibility of the contractor in the capacity of employer to forthwith (within a period of 15 days from the award of work) apply for a license to the Competent Authority under the BOCW Act and obtain proper certificate thereof by specifying the scope of its work. It shall also be responsibility of the contractor to furnish a copy of such certificate of license / permission to BHEL within a period of one month from the date of award of contract.
- ii. It shall be the sole responsibility of the contractor as employer to ensure compliance of all the statutory obligations under these act and rules including that of payment / deposit of 1% cess on the extant of work involving building or construction workers engaged by the contractor within a period of one month from the receipt of payment.
- iii. It shall be the responsibility of the sub-contractor to furnish the receipts / challans towards deposit of the cess together with the number, name and other details of beneficiaries (building workers) engaged by the sub-contractor during the preceding month.
- iv. It shall be the absolute responsibility of the sub-contractor to make payment of all statutory payments & compensations to its workers including that is provided under the Workmen's Compensation Act,1

TECHNICAL CONDITIONS OF CONTRACT (TCC)

PART-II-Chapter-I General

1.1

The work covered under this specification is of highly sophisticated nature, requiring the best quality of workmanship for construction, engineering and construction management. The Bidder should ensure timely completion of work. The Bidder must have adequate quantity of tools, construction aids, equipment's etc., in his possession. He must also have on his rolls adequate, trained, qualified and experienced supervisory staff and skilled personnel.

1.2

The work shall be executed under the usual conditions affecting industrial construction and in conjunction with numerous other operations at site. The Bidder and his personnel shall co-operate with the personnel of other agencies, co-ordinate his work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

1.3

All the work shall be carried out as per the instructions of BHEL engineer. BHEL engineer's decision regarding the correctness of the work and method of working shall be final and binding on the Bidder.

1.4

The Bidder shall at his cost perform any services, tests etc, although not specified but nevertheless required for the completion of work.

1.5

Contractor shall execute the work as per sequence prescribed by BHEL at site. The sequence of activities, methodology will be decided by the BHEL engineers depending upon the availability of material, drawings, work fronts etc. No claims for extra payment from the Contractor will be entertained on the grounds of deviation from the methods and sequence of construction advised and agreed by BHEL engineer or for any reasons whatsoever.

1.6

All the necessary certificates and licenses required to carry out this work are to be arranged by the Contractor expeditiously at his cost.

1.7

The work to be carried out under the scope of these specifications covers, temporary storing of contractor's own construction material, using the same in the work, carrying out all other activities, viz. survey, excavation, backfilling, erection, commissioning and all the other activities as defined in the scope of work enumerated in chapter-2, Part-I of TCC document, Bill of Quantities and elsewhere till handing over of the entire work. The work shall conform to dimensions and tolerances specified in the various drawings, documents etc. That will be provided during the course of construction. If any portion of the work is found to be defective in workmanship or not conforming to drawings or other

TECHNICAL CONDITIONS OF CONTRACT (TCC)

PART-II-Chapter-I General

specifications, the Contractor shall dismantle and re-do the work duly replacing the defective materials at his cost failing which the work will be got done by BHEL at the cost and risk of the contractor.

1.8

The terminal points as decided by BHEL shall be final and binding on the Contractor.

1.9

During the course of execution of this work, certain rework/ modification/ rectification/ repairs/ fabrication/dismantling etc. will be necessary on account of feedback from customer/BHEL on account of design discrepancies and manufacturing defects and site operation/maintenance requirements. Contractor shall carryout such rework/ modification/rectification/fabrication/repairs etc., promptly and expeditiously. Claims of contractor, if any, for such works will be dealt as per relevant clauses of General Conditions of Contract.

1.10

Daily log sheets indicating the details of work carried out, man-hours, consumables used etc, shall be maintained by the Contractor and got signed by BHEL engineer every day.

1.11

All tools and tackles, fixtures, equipment, materials, manpower, supervisors/ engineers, consumables etc. required for this scope of work shall be provided by the Contractor. All expenditure including taxes and incidentals in this connection will have to be borne by him unless otherwise specified in the relevant clause.

1.12

The contractor shall make adequate security arrangements including employment of security personnel and ensure protection from theft, fire, pilferage, damage and loss of materials/equipments issued to him for the work. Special care will have to be taken to guard against pilferage / theft of steel and/or cables, conductors other materials/equipments.

1.13

Contractor shall ensure proper housekeeping and remove all scrap materials periodically from various work area covered in the scope and deposit the same at the place earmarked for this purpose. In case of contractor's failure to do the same, BHEL reserves the right to remove scrap at contractor's cost and risk.

1.14

Access to site for inspection by BHEL and customer engineers shall be made available by the contractor at all times.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

PART-II-Chapter-I General

1.15

As Built Drawings: Contractor shall be supplied with two extra copies of the layout & detailed drawings. Contractor to incorporate in one of the copy with Red ink all the changes / deviations / alterations etc carried out at site due to various reasons, with site engineer's endorsement. Marked up drawings shall be submitted to BHEL for approval.

1.16

Site Inspection: The owner / employer or his authorized agents may inspect various stages of work during the execution of the contract awarded to him. The contractor shall make necessary arrangements for such inspection and carry out the rectification pointed out by the owner / employer without any extra cost to the owner / employer. No cost whatsoever such duplication of inspection of work be entertained.

1.17

BHEL will not supply any materials unless otherwise specified.

1.18

Makes of supply of steel ,cables, Transmission Yard equipments, 33kV Metering yard equipments ,earthing materials including back fill and chemical earthing, Miscellaneous items ,safety items ,Water wash system equipments and bore wells equipments, painting materials etc. which are in Vendor scope of supply shall be as per approved material list by NLC/BHEL.

1.19

The Contractor shall carry the work as per the Field Quality Plan issued by BHEL/NLC.

1.20

Calibration of equipment's should be done by NABL/NPL accredited laboratories.

1.21

Welding procedure to be followed as per Field Quality plan. (Welding procedure and prequalification of welder required to be produced)(If required).

1.22

Indicative Field Quality Plan attached with the NIT.

1.23

Field Quality Assurance Formats: It is the responsibility of the contractor to collect and fill up the relevant concrete pour card/FQA Log sheets and present the same to BHEL after carrying out the necessary checks as per the log sheets and obtaining the signature of BHEL / Customer in token of their acceptance. Monthly Running Bill Payment to the contractor will be linked with the submission of these Log sheets.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Part-II -Chapter-II Supply,I&C and O&M scope for BOS works

2.0 SCOPE

Vendor scope includes:

- Design, supply, installation, commissioning, operations and maintenance that includes activities but not limited to design, engineering, drafting of drawings, obtaining BHEL approvals for the design / drawings/ other technical/quality documents, manufacture / testing / inspection at manufacturer's works, packing, supply, transportation, ~~transit insurance~~, delivery to site, unloading/ safe storage of vendor supplied items., and erection/commissioning of electrical panels.
- Coordination / liaison activities (related to clearance / approval) with concerned state / central authorities such as CEIG/CEA etc, including renewal of CEIG license every year as applicable.
- Operations and maintenance of the complete plant for a period of five years after successful trial run for cumulative 72 hours of trouble-free operation following successful commissioning of the plant (export of generated power to 33kV grid).

2.1 DETAILED SPECIFICATION

Vendor scope – breakup of supply, E&C, O&M

The table below indicates the scope of work for the vendor, as briefly outlined.

a)	Supply
1	Design and supply of 33kV metering yard as per clause 4.1, 4.2 &4.7
2	Design and supply of 33kV Overhead transmission line from Metering yard to Gantry as per clause 4.0 & 4.2.
3	Design and supply module cleaning system as per clauses 4.5.
4	Supply of miscellaneous items as per clauses 4.9 to 4.15.
5	Supply of safety related items as per clauses 4.16 to 4.17.
6	Supply of backfilling materials of earthing system as per clause Cl.4.6
7	Supply of Lightning protection system accessories as per clause Cl.4.3.
b)	Erection and commissioning
1	E&C: Construction of bore wells including hydro survey, water analysis, piping network, electrical cabling, earthing of equipment and plumbing works etc. as per clause 4.5. (1 AU = activity equivalent to one bore well)
2	E&C: Interconnection of SPV modules, erection of SMB mounting structures, installation of string monitoring boxes including power cable terminations etc. as per clauses 4.20 to 4.26.
3	I&C: Excavation for burying of underground cables & laying of cables for LT AC/DC power cables, HT (33kV) cables, data communication / control / SCADA / OFC cables as

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Part-II -Chapter-II Supply,I&C and O&M scope for BOS works

	per clause 4.33.
4	I&C in PCSS: Erection & commissioning of indoor electrical panels (PCUs, VCB breaker panels, ACDB/DCDB panels, UPS panels, Batter & Battery Charger, Fire alarm panel SCADA etc.) in the 11 Prefab PCSS rooms, laying & fixing of cable trays, routing and terminations of DC/AC cables (HT, LT, data / control) at the electrical panels up to LV side of inverter/auxiliary transformers, laying of earth grids (external underground / internal within the rooms), installation of earth pits, earthing connections etc. as per clauses 4.27 to 4.31 ,4.35,4.36 and 4.6. Note: 1 AU = activity equivalent to 1 of the 11 inverter rooms.
5	I&C in PESS: Erection & Commissioning of indoor electrical panels (VCB breaker panels, ACDB/DCDB panels, UPS panels, Battery & Battery charger, LDB's, Fire alarm panel, SCADA, Inergent gas fire protection system, Weather Monitoring system, IP based Telephone exchange rack etc.) in the main PESS control room, laying & fixing of cable trays, routing and terminations of DC/AC cables (HT, LT, data/control) at the electrical panels up to LV side of auxiliary transformers, laying of earth grids (external underground / internal within the rooms), installation of chemical earth pits, earthing connections etc. as per clauses 4.27 to 4.31,4.35,4.36 and 4.6. 1 AU = activity equivalent to 1 of the 2 PESS rooms.
6	I&C: Erection of 33kV transformer yards (attached to the 11 inverter rooms), laying of underground earth mat grid, installation of earth pits, erection of inverter/auxiliary transformers, underground cable trenches, routing and terminations of 33kV/LT/ data/control cables at inverter/auxiliary transformers as per clause 4.32 & 4.33. Note: 1 AU = activity equivalent to 1 of the 11 inverter rooms.
7	I&C: Erection of 33kV transformer yards (attached to the PESS rooms), laying of underground earth mat grid, installation of earth pits, erection of inverter/auxiliary transformers, underground cable trenches, routing and terminations of 33kV/LT/ data/control cables at inverter/auxiliary transformers as per clause 4.32 & 4.33. Note: 1 AU = activity equivalent to 1 of the 2 PESS rooms.
8	I&C: Erection and commissioning of 33kV metering yard and Overhead line from metering yard to gantry (attached to the main control room - PESS) as per clauses 4.1 & 4.2.
10	I&C: Erection and commissioning of Weather monitoring station and SCADA system –as per clause 4.37
11	I&C: Erection and commissioning of Earthing system as per clause 4.6
12	I&C: Erection and commissioning of lightning protection system as per clause 4.3
13	I&C: Erection and commissioning of illumination system as per clause 4.38
14	I&C: Erection and commissioning of IP based telephone system as per clause 4.8
15	I&C: Erection and commissioning of module cleaning system as per clause 4.5,4.39
16	I&C: Erection and commissioning of miscellaneous and safety items as per clauses 4.7,4.9 TO 4.17.

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Part-II -Chapter-II Supply,I&C and O&M scope for BOS works

17	I&C: Pre-commissioning inspections / checks / site tests, MRT tests as per clause 4.40.
18	I&C: Coordination with state / central departments / CEA/ CEIG etc. for necessary approvals / clearances for commissioning as per clause 4.40.
19	I&C: Synchronization with grid and post-commissioning operation of the plant as per clause 4.40.
c)	Operation and Maintenance
1	Operation and maintenance of complete 65MW SPV plant for a period of 5 years as per clause 6.0

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Part-II -Chapter-III General Technical Specifications

3.0 General technical requirements

3.1	<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>								
3.2	<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 BHEL to determine that the products proposed are equivalent to those named.</p>								
3.3	<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 / NLC. Sufficient amount of information for justifying such proposals shall be furnished to BHEL / NLC along with the bid to enable BHEL / NLC to determine the acceptability of these proposals.</p> <p>However, discretion for accepting alternative proposals strictly lies with BHEL / NLC.</p>								
3.4	<p>Supply of items as per NLC approved vendor lists</p> <p>Vendor shall supply the materials / components / panels / equipment etc. as per NLC approved sub-vendor lists as per listed below.</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 10%;">Sl.No</th> <th style="width: 20%;">Equipment list</th> <th style="width: 30%;">Category -I (Approved)</th> <th style="width: 40%;">Category -II (To be Approved-Subjected to submission of PTR as per Note-1 below)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1.</td> <td>33kV CT</td> <td>ABB AE BHEL CGL</td> <td>Alstom ECS EMEES GAYRO</td> </tr> </tbody> </table>	Sl.No	Equipment list	Category -I (Approved)	Category -II (To be Approved-Subjected to submission of PTR as per Note-1 below)	1.	33kV CT	ABB AE BHEL CGL	Alstom ECS EMEES GAYRO
Sl.No	Equipment list	Category -I (Approved)	Category -II (To be Approved-Subjected to submission of PTR as per Note-1 below)						
1.	33kV CT	ABB AE BHEL CGL	Alstom ECS EMEES GAYRO						

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Part-II -Chapter-III General Technical Specifications

		EMCO JYOTI LTD. KAPPA PRAGATI Prayog PRECISE Schneider Southern Electric	Gemini Heptacare HI VOLTRANS ELECTRICAL PVT LTD. ITC JSL Kalpa KAPCO LAXMI ENGINEERING Megawin MEHRU Mehru ELECTRICALS NARAYAN POWERTECH Paras PRIMEIDEN RECO RISHAB SCT LTD. Silcon TOSHIBA VIDHYUT VIJAYA POWER SYSTEM Vishal VISHAL TRANSFORMERS VOLTAMP
2.	33kV PT	ABB AE BHEL CGL JYOTI LTD Kappa PRAGATI Prayog PRECISE Schneider Southern Electric	Alstom ECS EMCO EMEES GAYRO Gemini Heptacare HIVOLTRONS ELECTRICAL PVT LTD. ITC JSL Kalpa KAPCO LAXMI ENGINEERING Megawin Mehru Mehru ELECTRICALS NARAYAN POWERTECH PARAS PRIMEIDEN

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Part-II -Chapter-III General Technical Specifications

			RECO RISHAB SCT LTD. Silcon TOSHIBA VIDHYUT VIJAYA POWER SYSTEM Vishal Vishal Transformers VOLTAMP
<p><u>Note-1 (Category-II Vendors)</u></p> <p>Bidder to furnish documentary evidence to show that similar or higher capacity component /equipment / system has been supplied by the vendor or their associate/collaborator and the same has been operating satisfactorily for minimum six months as on the original scheduled date of Tender opening (14.03.16). The documentary evidence shall be in the form of Performance certificates furnished by the end user.</p> <p>3. Structural Steel</p> <p style="padding-left: 40px;">i. It should conform to relevant Indian / International Standards.2.</p> <p style="padding-left: 40px;">ii. It should be of reputed make of supplier to similar construction / infrastructure projects.</p> <p style="padding-left: 80px;">The Bidder should furnish documentary evidence to prove (i) and (ii) above.</p> <p>4. 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/NLC approval before supply.</p> <p>5. For those Cat-II vendors/Vendor list for those items not appearing in the specification, it is sole responsibility of the vendor to obtain the approval by submitting necessary documents. In case any delay on account of approval from NLC shall be Bidder's responsibility and shall not be attributed to BHEL.</p>			
3.5	Completeness of technical requirements of the items supplied <p>All the materials / components / panels / equipment 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.</p>		

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Part-II -Chapter-III General Technical Specifications

	<p>Further, all similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.</p>
3.6	<p>Codes and standards</p> <p>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:</p> <ul style="list-style-type: none">(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) Regulations of the Central Pollution Control Board, India(g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India(h) Pollution Control Regulations of Department of Environment, Government of India(i) State Pollution Control Board.(j) Rules for Electrical installation by Tariff Advisory Committee (TAC).(k) Any other statutory codes / standards / regulations, as may be applicable. <p>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:</p> <ul style="list-style-type: none">(a) National Fire Protection Association (NFPA)(b) International Electro-Technical Commission (IEC) <p>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 / NLC 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.</p> <p>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</p>

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Part-II -Chapter-III General Technical Specifications

	<p>proven standards of manufacturers shall also be considered.</p> <p>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.</p> <p>In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, BHEL / NLC 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.</p>
3.7	<p>Design of components / systems and maintenance considerations</p> <p>The vendor shall be responsible for the selection and design of appropriate components, layout, schemes, panels / equipment etc. so as to provide the best coordinated 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.</p> <p>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 / equipment and systems that are in their scope of supply.</p>

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Part-II -Chapter-IV Technical Specification for Design, Supply
and Installation & Commissioning

4.0 Technical specification for design, supply, installation and commissioning

S.No	BHEL specification
4.0	<p>Overhead Transmission line - Scope of work</p> <p>The design, supply, testing, erection and commissioning of 33kV transmission line from metering yard to gantry including gantry, poles, conductor, all type of insulators, cross arms, complete material for earthing, MS channels, clamps, phase plates, danger plate, no. plate, anti-climbing, nuts, bolts, SAFETY NET FOR LINE, all other accessories and erection hardware etc. Transmission line, LA, GOS etc. shall be in line with metering layout enclosed with this tender. Design shall be in line with relevant REC standards/codes, Indian electricity rules and requirements of concerned state/central electricity board, CEA/CEIG etc.</p> <p>There shall be two transmission lines, from 40MW metering yard to gantry. Each line shall be rated for 40MW and one transmission lines, from 25MW metering yard to gantry.</p> <p>Design scope Vendor shall carry out the complete design of 33kV overhead transmission line as per “33kV Overhead line equipments” sections of this specification and shall submit below documents for BHEL approval.</p> <ol style="list-style-type: none"> a) GA of steel mounting structures, single/ double/ four pole structures etc. b) Bill of material of complete package c) Erection key diagram d) Stringing chart e) Sag calculation f) Force calculation g) MQP h) Submission for approval of following details for 33 kV GOS isolators, 33 kV surge suppressors, Insulators and other items: <ol style="list-style-type: none"> (i) OGA and Bill of materials for 33 kV GOS isolator, 33 kV surge suppressor (ii) Drawing (section view) showing the assembly of 33 kV GOS isolator, including fabrication drawing for frame (iii) Earthing (iv) MQP and Type approval certificates for 33 kV GOS isolator, 33 kV surge suppressor etc. i) Drawings of civil foundations for the 1-pole, 2-pole/4-pole structures (as the case may be), outdoor electrical equipments such as CTs, PTs, GOS isolators, surge arrestors etc. and electrical earth pits as per relevant clauses of “General civil works” section of this specification. Civil foundation design shall be in vendors’ scope, based on vendor drawings civil work shall be done by BHEL.

TECHNICAL CONDITIONS OF CONTRACT (TCC)
**Part-II -Chapter-IV Technical Specification for Design, Supply
and Installation & Commissioning**

- j) Earthing scheme for each pole and BOM of items
- k) GA/ datasheet/ MQP of individual electrical items/ equipments such as GOS isolators, earth switches, surge arrestors, insulators, marshaling boxes, conductors, clamps, connectors, steel structures, earthing items etc.
- l) Any other related documents for erection and commissioning of Overhead transmission line.

2) Supply scope

- a) The approximate distance from metering yard to gantry will be 200Mtrs.

Supply of all items of 33kV overhead transmission line shall be in vendor scope. This shall include all necessary items (as per BHEL approved drawings/schemes during detailed engineering) such as GOS isolators, surge arrestors, marshalling boxes, conductors, clamps & connectors, single/double/four pole structure materials, disc insulators, steel structures, mounting / fastening hardware items, earthing material (electrodes, MS/GI flats/GI wire etc.), earthing chamber items etc. Miscellaneous items to be supplied by vendor shall include but not limited to anti-Climbing Devices, Danger Boards, Epoxy paint, Clamps, Nuts & Bolts and other Erection Hardware etc.

3) Erection scope

Erection scope of vendor shall include but not limited to:

- (a) Clearance of area of shrubs / jungle
- (b) Erection of steel mounting structures for LA / GOS
- (c) Erection of single/ double/ four pole structures. However, civil foundation work shall be carried by BHEL.
- (d) Looping to main transmission line.
- (e) Provision of earth for two-pole structure
- (f) Laying/termination of ACSR conductors with clamps, connectors, and phase plates, danger plate, no. plate, anti-climbing, hardware etc.
- (g) Laying of earth mat grid, earthing electrodes, earthing connections to equipments
- (h) Back filling of earth chambers/ pits, installation of electrodes etc. Earth pit construction shall be in BHEL scope. Earth pit drawings shall be provided by the vendor.
- (i) All other relevant erection works as per relevant standards, Indian electrical rules, requirements of state/central approving authorities such as Electricity boards, CEA, CEIG etc.
- (j) Erection shall be carried out by vendor as per the approved FQP that shall be furnished to the successful bidder after the award of contract.

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	<p style="text-align: center;">4) Commissioning</p> <p>Commissioning and handing over of 33KV Overhead transmission line is in vendor scope.</p>
<p>4.1</p>	<p>33kV metering yard - Scope of work</p> <p>Design, supply, erection, commissioning of electrical equipment of the two parallel 33kV metering yards for 40MW block and one metering yard for 25MW block in line with AC SLD (enclosed with this tender) is in vendor scope. Over Head line from Metering yard (both 40MW & 25MW) up to the Gantry nearby PESS building is also in the scope of bidder. Design shall be in line with relevant standards/codes, Indian electricity rules and requirements of concerned state/central electricity board, CEA/CEIG etc.</p> <p>33kV metering yard scope of work shall include the following:</p> <p>1) Design scope</p> <p>Vendor shall carry out the complete design of 33kV metering yard as per “33kV Metering yard” sections of this specification and shall submit below documents for BHEL approval.</p> <ol style="list-style-type: none"> a. Drawing showing locations, coordinates, natural/finished ground levels of control room/ metering yard. For this purpose, BHEL shall provide the needed inputs to vendor. b. Plan/ section/ elevation drawings of metering yard showing equipment locations, BoM etc. c. Drawings of civil foundations for the 2-pole/4-pole structures (as the case may be), outdoor electrical equipment such as CTs, PTs, GOS isolators, LAs, Gantry etc. as per relevant clauses of “General civil works” section of this specification. d. GA of steel mounting structures, single/ double/ four pole structures of the above electrical equipment. e. GA/ datasheet/ MQP of individual electrical items/ equipment such as CT, PT, GOS isolators, earth switches, surge arrestors, insulators, marshaling boxes, metering panels, conductors, clamps, connectors, cables, steel structures etc. f. Type test reports g. Cable schedules h. GA drawings of fence, gate, stone pitching / retention wall as applicable. i. Any other related documents for erection and commissioning of metering yards. <p>2) Supply scope</p> <p>Vendor supply shall include all necessary items (as per BHEL approved drawings/schemes during detailed engineering) such as CTs, PTs (VTs), GOS isolators, earth switches, surge arrestors, bus post insulators, marshalling boxes,</p>

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	<p>ACSR conductors, clamps & connectors, single/double/four pole structure materials, disc insulators, steel structures, mounting / fastening hardware items etc. ACSR conductor associated hardware and supporting structure from Metering yard to Gantry is also in the scope of vendor.</p> <p>Quantity of Clamps ,Connectors, nuts & Bolts is approximately 4950 Kg(i.e 3300kg for 40 MW Site & 1650kg for 25 MW site approximately)</p> <p>3) Erection scope Vendor erection scope shall also include:</p> <ol style="list-style-type: none"> a. Erection of steel mounting structures b. Erection of single/ double/ four pole structures c. Erection of electrical equipment of metering yard d. Laying/termination of ACSR conductors with clamps, connectors, hardware etc. e. Laying of earth mat grid, earthing electrodes, earthing connections to equipments f. Laying and terminations of 33kV cable, LT power, control, communication cables. Number of cable terminations for LT, Control and signal cables is around 60000 nos. Approximately 37000 nos. of cable termination will be there for 40 MW site and 23000 nos. will be for 25 MW g. All other relevant erection works as per relevant standards, Indian electrical rules, requirements of state/central approving authorities such as Electricity boards, CEA, CEIG etc. h. Erection shall be carried out by vendor as per the approved FQP that shall be furnished to the successful bidder after the award of contract. <p>4) Commissioning Commissioning and handing over of 33KV Metering yard is in vendor scope.</p>
<p>4.2</p>	<p>Technical specification of 33kV Metering yard equipment and Overhead line</p> <p>This section covers specification of various mechanical/electrical items of the two parallel 33kV metering yards near PESS room and 33kV Overhead Transmission line.</p> <p>1.0 DESIGN PARAMETERS:</p> <ul style="list-style-type: none"> • System voltage :33kV • Bus bar rating :800A in 40MW and 500A in 25MW blocks • Conductor type :ACSR • Short circuit current :25kA / 1 sec • Max. temperature of Conductor :75 deg • Wind speed :160km/hr • Seismic : Zone II as per IS-1893 <p>2.0 CONDUCTOR This specification covers design, manufacture, testing before dispatch, supply and delivery of Aluminum Conductors Steel Reinforced (ACSR) Conductors.</p>

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3.0 APPLICABLE STANDARD

The Conductor shall strictly comply with the following Indian Standard Specification relevant to the conductor.

- a) IS : 398- Aluminium Conductors for Overhead Transmission Purposes (Part-I):
Aluminium Stranded Conductors
- a) IS:398- Aluminium Conductors for Overhead Transmission Purposes (Part-II):
Aluminium Conductors Galvanized steel reinforced
- b) IS:398- Aluminium Conductors for Overhead Transmission Purposes (Part-
Specification for Aluminium Alloy (Aluminium, Magnesium ,Silicon Type)

4.0 MATERIAL

The conductors shall be of best quality and workmanship. The steel reinforced aluminum conductors shall be manufactured of hard drawn EC grade aluminum wires and high tensile galvanized steel wires of the sizes and with mechanical and electrical properties as specified in the Standard. The coating on the galvanized steel wires may be applied by the hot process or electrolytic process in accordance with IS: 4826-1968 (specifications for galvanized coating on round steel wires). The wires shall be smooth and free from all imperfections such as spills and splits and rolling and wire drawing defects etc. resulting in reduction in cross-sectional area over the entire length.

Physical properties shall conform to the relevant IS specifications.

I. POLES DESIGN PARAMETERS

All the 33kV poles shall be Rail poles or RSJ poles of appropriate grade and size. Poles shall be painted by Epoxy based aluminum paint as per the REC specification.

Maximum span of HT Lines with proposed conductors shall be as per REC construction standards or as specified in the table below.

Design Parameters

- a) Factor of safety 2.0 in normal condition for 33 kV
- b) Wind Pressure on Pole & conductor- As per IS 802. Basic wind speed to be considered as 160km/hr
- c) Wind load on cross-arms, insulators guy-wire etc. shall be considered.
- d) Wind load on full projected area of conductors and pole is to be considered for design.
- e) Ground clearance shall be minimum 5.2m for 33 kV line

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- f) All other clearance shall be as per IE Rules.
g) The live metal clearance shall be as per IS: 5613 and shall be min.330 mm for 33 kV line.

Pole accessories like danger plates, phase plates, anti-climbing device, shall be provided.

2. The planting depth of pole shall be 1500 mm in the ground except in wet soil and black cotton soil where depth shall be increased by 0.2 mtr. to 0.3 mtr. with reduced wind span.

3. EARTHING OF POLES

In 33 kV, each pole shall be earthed with spike type earthing as per REC Construction Standard J-2. All DP & Four pole structures & the poles on both sides of railway, Telecommunication, road, drain & river crossing shall be earthed by pipe earthing as per enclosed REC Construction Standard J-2.

4. PROVIDING OF GUYS/STRUT POLES TO SUPPORTS

The arrangement for guys shall be as per REC Construction. Strut poles/flying guys wherever required shall be installed on various pole locations as per REC construction standards. For selection of guying locations REC guidelines & construction practices & IS: 5613 shall be followed. The stay rod should be placed in a position so that the angle of rod with the vertical face of the pit is $30^{\circ}/45^{\circ}$ as the case may be.

5. CROSS ARMS

Cross Arms for 33 kV Overhead Power Lines shall be made out of 100x50x6 mm M.S. channel.

For 33 KV line, cross arms a MS strip of 100x50x5 mm shall be welded for providing additional mechanical strength at the seat of the pin insulator.

Fixing of Cross Arms

After the erection of supports and providing guys, the cross-arms are to be mounted on the support with necessary clamps, bolts and nuts.

II. CLAMPS AND CONNECTORS

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The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic.

The material of clamps and connectors shall be Galvanized mild steel for connecting to shield wire.

Bolts, nuts and plain washers shall be hot dip galvanized mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanized mild steel. The spring washers shall be electro-galvanized mild steel.

All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last at least till erection time.

III. GOS ISOLATORS

The isolators and accessories shall conform in general to IEC 62271-102 (or equivalent Indian standard) except to the extent explicitly modified in specification.

Earth switches shall be provided on isolators wherever called for.

Operating mechanism of Isolator and earth switch	Manual Operated
Nominal system voltage	33kV
Highest system voltage	36kV
Type	Outdoor
Rated short time current of isolator and earth switch	25 kA (rms) for 1 sec.

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Rated dynamic short time withstand current of isolator and earth switch	62.5kA (peak)
Impulse withstand voltage with 1.2/50 micro sec. wave	170kVp to earth 195 kVp across isolating distance
One minute power frequency withstand Voltage	70 kV (rms) to earth & 80 kV (rms) across isolating distance
Temperature rise	As per Table-IV of IS: 9921
Rated mechanical terminal load	As per 62271-102
Creepage distance (Total)	900 mm
Line charging breaking capacity	6.3 A
Transformer off-load breaking capacity	6.3 A

Isolator shall be gang operated (GOS) for main blades and earth switches. The Open/Close status of the isolator to be provided in SCADA. The operation of the three poles shall be well synchronized and interlocked.

The design of linkages and gears shall be such so as to allow one man to operate the handle with ease for isolator and earth switch.

They shall be constructed such that they do not open under influence of short circuit current and wind pressure together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa.

In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of failsafe type. Suitable individual interlocking coil arrangements shall be provided.

IV. INSTRUMENT TRANSFORMER

a) General Requirement

The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units.

The tank as well as top metallics shall be hot dip galvanised or painted Grey color as per RAL 9002.

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The instrument transformers shall be oil filled hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.

Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

The insulators shall have cantilever strength of more than 500 kg.

b) MARSHALLING BOX

The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box in such a manner so that it is visible and it does not deteriorate with time. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals.

c) CURRENT TRANSFORMERS (CTs)

The CTs shall have single primary of either ring type or hair pin type or bar type. In case of "Bar Primary" inverted type CTs, the following requirements shall be met:

The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.

The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.

The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome.

The CT shall be provided with oil sight glass.

Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.

The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT.

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The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box.

The secondary terminals shall be terminated on stud type suitable no's of non-disconnecting and disconnecting terminal blocks inside the terminal box of degree of protection IP:55 at the bottom of CT.

The CTs shall be suitable for horizontal transportation.

The CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT.

The CT shall have provision for measurement of capacitance and tan delta as erected at site.

d) PARAMETERS FOR CURRENT TRANSFORMERS

GENERAL PARAMETERS

Highest system Voltage(Um)	36 kV
Rated frequency	50 Hz
System neutral earthing	effective earthed
Installation	Outdoor
Rated short time thermal current	25 kA for 1 sec
Rated dynamic current	63 kA (Peak)
Rated min power frequency withstand voltage (rms value)	70kV
Rated lightning impulse withstand voltage (peak value)	170kV
Partial discharge level	10 pico Coulombs max.
Minimum Creepage distance	25 mm/kV of highest system voltage
Temperature rise	As per IEC 60044
Type of insulation	Class A
Accuracy,Number of cores and CT ratio	As per AC SLD
Number of terminals in marshalling box	All terminals of control circuits wired upto marshalling box plus 20 terminals spare

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e). VOLTAGE TRANSFORMERS (VTs)

Voltage transformers shall be electro-magnetic (EMU) type and shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.

The secondary shall be protected by HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP55. The access to secondary terminals shall be without the danger of access to high voltage circuit.

The accuracy of metering core shall be maintained through the entire burden range upto 50VA on all three windings without any adjustments during operations.

f) PARAMETERS FOR VOLTAGE TRANSFORMERS

GENERAL PARAMETERS

Highest System Voltage(Um)	36 kV
System neutral earthing	effective earthed
Installation	Outdoor
System Fault level	25 kA
Rated min power frequency withstand voltage (rms value)	70kV
Rated lightning impulse withstand voltage (peak value)	170kV
Standard reference range of frequencies for which the accuracy are valid	96% to 102% for protection and 99% to 101% for measurement
Rated voltage factor	1.2 continuous & 1.5 for 30 sec
Class of Accuracy Core and PT ratio	As per AC SLD
Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:358
One Minute Power frequency withstand voltage for secondary winding	2 kV rms
Temp. rise over an ambient temp. of 50 deg. C	As per IEC 60044

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Number of terminals in control spare.	All terminals of control circuits wired Cabinet upto marshalling box plus 10 terminals
Rated total thermal burden	350 VA
Partial discharge level	10 pico Coulombs max.

V. SURGE ARRESTOR

The surge arrestors (SAs) shall conform in general to IEC 60099-4 or IS: 3070 except to the extent modified in the specification. Arresters shall be of hermetically sealed units, self-supporting construction, suitable for mounting on lattice type support structures. Bidder shall furnish the technical particulars of Surge arrester.

The SAs shall be of heavy duty station class and gapless Metal Oxide type without any series or shunt gaps. The SAs shall be capable of discharging over-voltages occurring during switching of unloaded transformers, and long lines.

Arrestors shall be complete with insulating base for mounting on structure. Self-contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit with necessary connection. Suitable leakage current meters should also be supplied within the same enclosure. The reading of millimeter and counters shall be visible through an inspection glass panel

The surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4

Rate System Voltage	36 kV
Rate Arrester Voltage	30 kV
Nominal discharge current	10 kA of 8/20 micro-sec wave
Minimum discharge capability	5 kilo joule/kV(referred to rated arrester voltage corresponding to minimum discharge characteristics)
Maximum continuous operating	24 kV rms
Max. residual voltage (1 kA)	70 kVp
Max. residual voltage at 10 kA nominal discharge current (8/20 micro sec wave)	85 kVp
Max. switching impulse residual Voltage at 500A peak	70 kVp
Max. steep current residual Voltage	93 kVp at 10kA

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High current short duration test Value (4/10 micro-sec-wave)	100 kAp
Current for pressure relief test	25kA rms

VI. INSULATORS

Porcelain insulator shall comply IS: 731-1976 or equivalent international standard and shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage

Pin insulators shall be used on all poles in straight line and disc or shackle insulators on angle and dead end poles.

DISC INSULATOR

The disc insulator shall meet the following parameters:

- a. Type: Antifog type insulator
- b. Size of insulator: 255x145
- c. Electro mechanical strength: 120kN
- d. Leakage distance (mm): 430mm minimum or as required to meet the total creepage.
- e. Power frequency withstand voltage : 85 kV (dry), 50kV (wet)

Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.

Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.

Glazing of the porcelain shall be uniform brown in colour, free form blisters, burns and other similar defects.

When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when

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operating at normal rated voltage.

The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.

Contractor shall make available data on all the essential features of design including the method of assembly of shells and metal parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.

Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.

In accordance with the requirements stipulated under Chapter-G0, bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards.

Insulator shall also meet requirement of IEC - 60815 as applicable, having alternate long & short sheds.

VII. SPACERS

Spacers shall conform to IS:10162. They shall be of non-magnetic material except nuts and bolts, which shall be of hot dip galvanised mild steel.

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	<p>Spacers shall generally meet the requirements of clamps and connectors as specified above. Its design shall take care of fixing and removing during installation and maintenance.</p> <p>In addition to the type tests as per IS:10162, clamp slip test should have been conducted. In this test the sample shall be installed on test span of twin/quad bundle string at a tension of 44.2 kN (4500 kg). One of the clamps when subjected to a longitudinal pull of 2.5 kN (250 kg) parallel to the axis of conductor shall not slip, i.e. permanent displacement between conductor and clamp after the test shall not exceed 1.0 mm. This test should have been performed on all other clamps of the sample.</p> <p>VIII. TYPE TEST REQUIREMENTS</p> <p>All equipment of metering yard to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests carried out as per relevant standards 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.</p> <p>However if 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.</p> <p>All acceptance and routine tests as per relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.</p>
<p>4.3</p>	<p>Lightning protection system for SPV power plant - Scope of work</p> <p>Following equipment are free issue to vendor for erection and commissioning</p> <ol style="list-style-type: none"> a) ESE type lightning protection system for solar array as per NFC 17-102. b) Lightning protection for metering yard, Inverter rooms and PESS building (Faraday rod) as per IS-2309 / IEC 62305. <p>However, vendor shall supply the test links (30 nos.) for lightning protection system (faraday rod) as indicated above for Sl.No.(b) above</p> <p>1. Erection & commissioning scope</p> <ol style="list-style-type: none"> a. Erection and commissioning of lightning protection system including erection of

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	<p>poles/mast, down conductors, all related accessories and hardware, earth connections, earth pits etc. shall be in vendor scope. However, construction of foundation / earth pit shall be in BHEL scope. Earth pit back filling with salt and charcoal is in the scope of vendor.</p> <p>b. Erection shall be carried out by vendor as per the approved FQP that shall be furnished to the successful bidder after the award of contract.</p> <p>4. Commissioning Commissioning and handing over of Lightning protection system is in vendor scope.</p>
4.4	Deleted
4.5	<p>Water washing arrangement for cleaning of SPV modules – Scope of work</p> <p>1) Design scope Module washing system: Vendor shall carry out complete design of water washing arrangement for cleaning of SPV modules and shall submit Piping and instrumentation diagram P&ID of water washing arrangement including the physical sequence of branches, reducers, valves, pressure gauge, cleaning points and location of pumps and water storage tanks to BHEL for approval during detailed engineering. The diagram shall show locations of tube wells/ bore wells, sumps, pipelines, valves, delivery tap 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 approval during detailed engineering.</p> <p>In this project module cleaning system consist of two no. sumps 45M³(Main sump) and 20M³(aux. sump) in 40MW plant and two no. sumps 30 M³ (main sump) & 15 M³ (aux. sump) in 25MW plant. Construction of sumps in the scope of BHEL. Input water to main sumps shall be provided by NLC customer. However, piping arrangement from for supply of water from main sump to auxiliary sump shall be done vendor. Back to these sumps, there shall be bore wells for supply of water for module cleaning system which is in the scope of vendor.</p> <p>There shall be two/three piping networks for module cleaning system in each plant. Each network shall consist of main storage sump, auxiliary sump, syntax tanks, bore wells, piping network, valves, booster pumps with starter arrangement, submersible pumps with starter arrangement, isolation valves, other miscellaneous items. Complete scheme with pressure / discharge calculations, sizing / selection of pumps shall be carried out by vendor.</p> <p>Bore wells for Module washing system: Complete layout/scheme of bore well water supply with supporting discharge / pressure calculations, sizing / selection of pumps/valves etc., bill of materials shall be submitted to BHEL during detailed engineering.</p> <p>2) Supply scope Supply of module cleaning system shall include submersible pumps (bore wells) with starter arrangement, Heavy duty rigid PVC network, water storage tanks, booster</p>

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pumps (min.3HP) with starter arrangement for sumps & syntax tanks including level control system, associated cabling (vendor terminal point shall be at Purchasers ACDB), HDPE / GI pipes with fittings, valves, water meters, Tap off points from the PVC supply pipe network with manual isolating valves shall be provided at number of locations to enable the cleaning of modules using hoses of adequate length, all other related accessories and hardware for complete module cleaning system etc.
 Supply of Valves for Module Cleaning system:

Pipe Fitting Accessories and Valves supplied by vendor shall include but not limited to:

PIPING BOM FOR MODULE CLEANING SYSTEM -								
S. No.	Description	Line size (NB)	Ends/ facing	Sch/ thk/ Rating	Unit	Qty 40M W	Qty 25M W	Remarks
1	Pipe, material GI, ERW as per Dimension standard IS 1239.	100	Screwed to NPT (m)	Heavy class	M	185	115	Road crossing Hume Pipe
		40			M	123	77	
		15			M	185	115	
2	Elbow 90°, material GI, as per Dimension standard IS 1239.	50	Screwed to NPT (f)	Heavy class	Nos	18	12	
		15			Nos	369	231	
3	Reducing Couplings, material GI, as per Dimension standard IS 1239.	40 x 15	Screwed to NPT (f)	Heavy class	Nos	369	231	
4	Ball valve, material Body IS 318 Gr.2, Stem OS & Y, Screwed Bonnet, Disc IS 318 Gr.2 as per dim std ASME B16.10	50	Screwed to NPT (f)	Heavy class	Nos	18	12	
		32			Nos	9	6	
		25			Nos	18	12	
		15			Nos			
5	Threaded Flanges, 125 AARH face finish, IS 2062	50	FF	150#	Nos	123	77	
		40			Nos	18	12	
		32			Nos	18	12	

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	Gr.A Galvanised as per ANSI B 16.5	25			Nos			
						92	58	
6	Gaskets, material Neoprene Rubber, thk 3 mm, type Full Face as per ANSI 16.21	50	FF	150#	Nos	62	38	
		40			Nos	9	6	
		32			Nos	9	6	
		25			Nos			
						49	31	
7	Stud / Bolts & Nuts, Stud fully threaded with 2 washers IS 1367 CL4.6, GI. Hexagonal nuts IS 1367 CL 4.0, GI as per Dimension standard IS 1367	M14 x 75	-	-	Nos			
						1046	654	
8	Standard U Bolt, material GI with four Hexagonal nuts (M6), IS 1367 CL 4.0, GI, with washers as per Dimension standard IS 1367	50	-	-	Nos			
						31	19	
9	Equal Tee, material HDPE NB 50				Nos			
						369	231	
10	Steel Channel, ISMC 50				m			
						6	4	

3) Erection scope

Erection of module cleaning system including trenches for pipelines, laying of pipe lines from bore wells to storage tanks to solar array field, erection of submersible / booster pumps, starters, laying and termination of cables, erection of valves, flow meters, terminations of earth connections, and erection of all other related accessories and hardware etc.

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Minimum 11 (7 in 40MW & 4 in 25MW) bore wells shall be dug at locations as identified by hydrological survey and as certified by BHEL. Exact number of bore wells shall be decided based on consumption of water for various utility requirements such as cleaning of inverter/control rooms, cleaning of toilets, gardening, cleaning of SPV modules on daily basis, filling water in all storage tanks etc.

Erection shall be carried out by vendor as per the approved FQP that shall be furnished to the successful bidder after the award of contract.

4) Commissioning Scope:

Commissioning and handing over of Water wash system and bore wells is in vendor scope.

Technical details for 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, requisite storage arrangement (storage water tanks of adequate size capacity etc) and laying network of HDPE pipe conforming to IS: 4984 and other relevant codes. The module washing shall be complete in all respect and the details shall conform to the relevant IS codes. Accordingly, system shall include booster pumps, valves, non-returnable valves, HDPE pipelines/ bends/ joints/ couplers, tap assemblies (at delivery points), nozzles, hose pipes etc. Opening from the HDPE pipe with manual isolating valves should be provided at regular intervals. The opening pipes or fixing the movable/ hose pipes for spraying water on SPV modules shall be made of GI pipe. Vendor shall install flow meter for measurement of water consumption. Water level indicator shall be provided for automatic stopping of water pumping. Pressure gauge shall be installed at every pump end.
- 3) The HDPE pipes shall be suitably protected against any impact load. The HDPE pipes shall be covered higher diameter GI pipe at roads crossing for protection against any heavy loads etc at roads section. The same protection shall also be provided wherever higher loads are expected. The vendor may also propose some other protection system for HDPE pipes subject to approval by BHEL during detailed engineering.
- 4) The HDPE pipes shall be buried in ground by at least 150mm deep from NGL/FGL. Only in case of rock at surface and difficulty in cutting the surface rocks, pipes may be accepted at surface at some locations. The same shall be subject to approval by BHEL during detailed engineering.
- 5) The water used for cleaning should be of appropriate quality fit for cleaning purpose as per the recommendations of module manufacturer and if necessary the vendor shall install a suitable water treatment plant for this purpose.

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- 6) Suitable RCC foundations shall be provided for storage tanks placed at ground level. Suitable RCC pedestals shall be constructed for mounting the booster pumps that shall be housed within suitable shed/shelter arrangement. Drawings shall be submitted for these arrangements for BHEL approval.
- 7) Supply, laying and termination of electrical cables shall be in vendor scope. Cables from inverter/PSS rooms to the pumps/motors shall be laid underground as per “**cable installation methodology**” section of this specification.

Bore wells

- 1) Hydrological survey shall be carried out by vendor for identifying the right locations for bore wells.
- 2) Bore wells shall be of necessary depth based on water table at the identified locations.
- 3) Water analysis shall be carried out at a reputed laboratory. Report on its constituents, potable quality etc. shall be submitted to BHEL.
- 4) Bore wells shall be fitted with submersible AC centrifugal pump of appropriate capacity/rating with local starter and all necessary electrical cabling up to main ACDB panel of PSS 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 and accessories of appropriate rating and cores shall be in vendor scope of supply. Glands shall be double compression nickel plated brass along with PVC shroud and lugs shall be tinned copper heavy duty.
- 7) Cables shall be directly buried as per relevant clauses of “**Cable installation methodology**” section of this specification.
- 8) Details of cable (type, rating, size, applicable standard etc.) shall be submitted to BHEL for approval during detailed engineering.

4.6 Earthing – Scope of work

- 1) **Supply**
BHEL scope of Supply:

Sl.No	Item Description	Unit	Qty 40MW	Qty 25MW
1.	75x10mm earth strip Laying of earth strip below ground -	Mtrs	3600	2400
2.	75x10mm Earth strip-Laying of earth strip above ground with equipment connections	Mtrs	1500	1000
3.	50x6 mm earth strip-Laying of earth strip above ground with equipment connections	Mtrs	1440	960
4.	25x3mm earth strip-Laying of earth strip	Mtrs	9000	5000

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	below ground			
5.	25x3mm earth strip-Laying of earth strip above ground with equipment connections	Mtrs	16000	9000
6.	8swg-Laying of earth wire above ground with equipment connections	Mtrs	3000	2000
7.	35x6 mm earth strip-Laying of earth strip above ground for lightning protection system	Mtrs	800	500
8.	65mm GI Pipe electrode-Installation of Earth Pit including filling with charcoal and salt	Mtrs	95	65
9.	40mm GI Rod electrode-Installation of Earth Pit including filling with charcoal and salt	Mtrs	65	50
10.	Installation of vertical air termination rods	Nos.	18	12
11.	Installation Lightning Protection(ESE)	Nos.	32	20

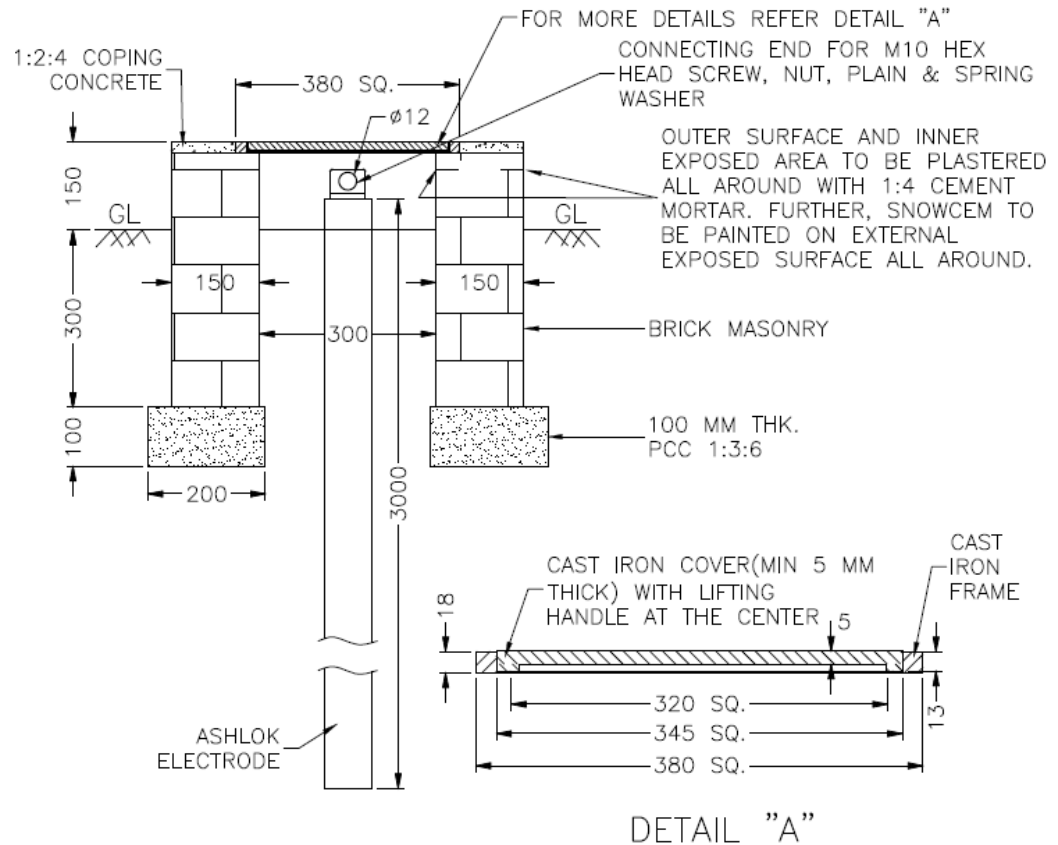
Supply of following is in the scope of vendor:

- Back filling material for all the treated earth pits in plant area.
Qty of earth pits for back filling: 275 no. approx.
- All glands supplied by BHEL will be provided with locking nut, earth tag and PVC cable shoe/shroud. These Cable glands shall be earthed by using PVC insulated earth continuity conductors of appropriate size (size will be informed during detailed engineering) to the main earth bars at terminations of cables. The earth tags shall be individually connected to the Earth Terminals and Looping of conductors through more than one tap is not permitted. The supply and installation of PVC insulated earth conductor is in the scope of vendor.

2) Erection & commissioning

Erection and commissioning of complete earthing system shall be in vendor scope. However, Construction of earth pits shall be in the scope of BHEL. Excavation and laying of underground earth mat, Installation of electrodes and other accessories inside earth pits, back filling of pits, Earthing of solar array structures, string monitoring boxes, electrical panels in PCSS rooms / PESS rooms, control room electrical wiring circuits, transformer yard equipments, support steel structures of metering yard equipment and other panels, lightning arrestors, weather monitoring equipments, transformer yard / metering yard fencing / lighting poles/motors/Starter/IP based telephone system / equipments / metallic structures, as applicable shall be by vendor. All necessary hardware (Nuts, bolts etc.) for earthing of solar array structures shall be supplied by vendor. Water has to be poured by vendor for first 15 days after installation and then once in six month.

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Technical details for Earthing system

A. Earthing for AC system

A2. Technical details

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

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For outdoor switchyard, earthing system network/ earth mat shall be interconnected mesh of mild steel rods buried in ground in the plant. For other areas in the solar plant such as transformer yard, switchgear room, the earthing system shall consist of minimum two parallel conductors interconnected together. Overhead poles earthing shall be done as per details mentioned under Transmission lines works covered elsewhere in the specification.

(2) The material of the earthing conductors shall be as follows:

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

(3) 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	Switchgear / outdoor substation	75x10 GI Flat	75x10 GI Flat
2	33kV switchgear equipment	--	75x10 GI Flat
3	415 V MCC/ Distribution boards / Transformers	--	50 x 6mm GI flat
	1KW to 25 KW	--	25 x 3mm GS flat
	Fractional Horse 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	--	50 x 6mm GS flat

(4) 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. Portable tools,

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appliances and welding equipment shall be earthed by flexible insulated cable.

- (5) 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.
- (6) 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.
- (7) 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.
- (8) 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.
- (9) Connections between equipment earthing leads and between main earthing conductors shall be of welded 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.
- (10) Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.
- (11) 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.
- (12) Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.
- (13) 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.
- (14) Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.
- (15) 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.
- (16) Chemical earthing arrangement:

Chemical earthing arrangement shall meet the earthing resistance requirements. Chemical earthing compound shall have pH between 6-8. It shall be used with compatible electrode (Cu, cu bonding) as per the guidelines of compound manufacturer. It shall not shrink or expand over the period of time and shall be maintenance free.

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(17) 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.

(18) 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.

(19) Other Requirements of Earthing System:

Standard/Code	IEEE 80, IS 3043
Earthing System	
Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, channels, rail tracks etc. it shall be at least 300mm below them.
Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor. Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.

B. Solar array earthing

Each Module mounting structure (MMS), SPV Module frames, mounting arrangement for String Monitoring Boxes, Metallic Junction Boxes, Metal frames/Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system for solar array shall consist of earth mat/Earth grid to be laid at the depth of 600 MM below the ground. Earth mat shall be a mesh of interconnected Galvanizing Steel (GS) flat laid in the solar farm for the purpose of earthing/grounding. Equipment and structure in the solar farm shall be earthed in compliance to the IS: 3043 (Code of Practice for Earthing) and Indian Electricity Rules/Acts.

a. **MODULES MOUNTING STRUCTURES:** The 10-module mounting structures (mms) shall be inter-jointed using 25x3mm GI flat. A number of MMS structures thus jointed will be jointed to the central grid running along the periphery of the entire array. Jointing to the Main grid to be done by welding. Joining of 25x3 flat with MMS shall be bolted type not by welding. Necessary nut bolts for fixing of 25x3 flat with MMS is also included in the scope of vendor.

At a number of locations connection from the Main grid shall be connecting to the Chemical electrode.

b. String Monitoring Boxes: Each SMB (SMU) shall be earthed by two separate and distinct GI links to the Main grid.

c. Chemical electrodes shall have an Earth pit chamber with provision of lid for adding

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water.

d. System Requirement for the solar array:

Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, channels, rail tracks etc., it shall be at least 300mm below them.
Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor. Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.

e. Connection of riser to the structures shall be bolted or welded type. Portion of galvanized structure which undergoes welding at site shall be coated with two coats of cold galvanizing and anti-corrosion paint afterwards. .

f. Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection, 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.

g. Earth conductor shall be laid in the ground in manner that distance of any metallic part of the object to be earthed from the earth conductor is not more than 15 Meter. A continuous earth path is to be maintained throughout the PV array.

h. Each PV Module frame shall be earthed in accordance with module manufacturer guidelines. In case module frame earthing is to be separately provided, it shall be earthed with minimum 2.5 SQMM flexible copper cable with lug at suitable location of module frame. There shall not be more than 12 nos. of PV modules in single loop of earthing connection to module frame. Both ends of the loop of copper cable for earthing shall be connected with nearest earthed structure or earth conductor.

i. Contractor shall seek owner's approval for connecting solar array earth mat with any other earth mat/earth grid of the solar PV plant.

j. Earth pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 6000mm. Earth pits shall be treated with salt and charcoal if average resistance of soil is more than 20 ohm meter. Earth pit back filling material shall be vendor's scope.

k. 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.

Size of earth conductor, nos. of earth pits given in this clause is applicable for solar

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	<p>array earthing only. Method and practice of laying of earthing conductor, earth pits and riser not mentioned herewith but given elsewhere in this specification is applicable to solar array earthing also.</p>
<p>4.7</p>	<p>ABT Metering System –Scope of work</p> <p>1) Supply Supply in BHEL scope. Energy meters (main, check, standby) of 0.2s accuracy class, suitable for ABT requirement conforming to TANGENCO requirement shall be supplied. There total 9 nos. ABT meters (3 nos. for each outgoing feeder).The ABT meter will be mounted in standalone enclosure which will be free issue to the vendor.</p> <p>2) Erection & commissioning</p> <p>3) Complete erection and commissioning and handing over of ABT meters shall be in the scope of vendor</p> <p>4) All the meters shall be calibrated in approved calibration centers of respective RLDC/State power utilities/CTU. It is the responsibility of the vendor to get ABT meters sealed by RLDC/ state power utilities/CTU.</p> <p>5) Vendor shall obtain the approval from RLDC/ state power utilities/CTU for the metering scheme in the energy export zone. The responsibility of arranging for the meters, its inspection/calibration/testing charges etc. from statutory authorities rest with the vendor and all charges incurred on meter testing shall be borne by the contractor.</p> <p>6) 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. ABT meters shall be suitable to accept PPM signal from master clock. All the accessories and hardware required for time synchronization shall also be in the scope of vendor.</p>
<p>4.8</p>	<p>IP based Telephone system:</p> <p>Design & Supply: BHEL Scope</p> <p>Erection and commissioning:</p> <p>Erection of cables pertaining to IP based telephone system. Any minor civil work shall be done by vendor. Erection of IP based telephone exchange at PESS building is in the scope of vendor.</p>

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4.9	<p>Cable markers and cables tags</p> <p>Supply, E&C:</p> <p>Supply, erection and commissioning of the following are in vendor's scope.</p> <p>(1) Cable markers and joint markers for underground cables shall be provided along the route of the cables as per section "Cable installation methodology" of this specification.</p> <p>(2) Cable tags shall be provided at either of the cable (at the entry point to the panel / equipment to which it is connected / terminated) shall be provided as per section "Cable installation methodology" of this specification.</p> <p>Vendor shall submit the respective schemes of marking and tagging for BHEL approval during detailed engineering.</p>																																										
4.10	<p>Display boards and sign boards</p> <p>Supply, E&C:</p> <p>Supply, erection and commissioning of the following are in vendor's scope.</p> <table border="1"> <thead> <tr> <th>Sl.No.</th> <th>Item description</th> <th>40MW</th> <th>25MW</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Board displaying instruction chart for restoration of person from Electric Shock</td> <td>9 Nos</td> <td>6 Nos.</td> </tr> <tr> <td>2.</td> <td>Board displaying instruction chart for artificial respiration</td> <td>9 Nos</td> <td>6 Nos.</td> </tr> <tr> <td>3.</td> <td>Board displaying dos and don'ts.</td> <td>9 Nos</td> <td>6 Nos.</td> </tr> <tr> <td>4.</td> <td>Board displaying fire extinguishers details and operations</td> <td>9 Nos</td> <td>6 Nos.</td> </tr> <tr> <td>5.</td> <td>"No smoking" board</td> <td>10 nos.</td> <td>6 Nos.</td> </tr> <tr> <td>6.</td> <td>Board showing list of O&M staff with name, qualification and work responsibility</td> <td>1 No</td> <td>1 No.</td> </tr> <tr> <td>7.</td> <td>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.</td> <td>2 nos.</td> <td>2 Nos.</td> </tr> <tr> <td>8.</td> <td>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.</td> <td>48 Nos.</td> <td>30Nos</td> </tr> <tr> <td>9.</td> <td>Identification boards, of suitable sizes, within and outside control room such as control room 3MW, control room 2MW, executive lounge, store room,</td> <td>16 Nos.</td> <td>10Nos</td> </tr> </tbody> </table>			Sl.No.	Item description	40MW	25MW	1.	Board displaying instruction chart for restoration of person from Electric Shock	9 Nos	6 Nos.	2.	Board displaying instruction chart for artificial respiration	9 Nos	6 Nos.	3.	Board displaying dos and don'ts.	9 Nos	6 Nos.	4.	Board displaying fire extinguishers details and operations	9 Nos	6 Nos.	5.	"No smoking" board	10 nos.	6 Nos.	6.	Board showing list of O&M staff with name, qualification and work responsibility	1 No	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.	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.	48 Nos.	30Nos	9.	Identification boards, of suitable sizes, within and outside control room such as control room 3MW, control room 2MW, executive lounge, store room,	16 Nos.	10Nos
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	security room, gents / ladies toilets etc. BHEL will provide the list.																																																														
10.	Hoarding board for the overall power plant shall be fabricated in consultation with BHEL and installed at a suitable location near the main entrance gate of the plant.	1 no	1 No.																																																												
<p>(a) 5mm thick sun board with LG make vinyl sticker (computerized cutting and pasting) shall be used for Sl.Nos 4, 5, 8 and 9.</p> <p>(b) For others, flex banner with design & printing shall be used.</p>																																																															
4.11	<p>Supply of SCADA office furniture Following list of furniture items (for Both 40MW & 25MW) shall be supplied by vendor. Make shall be reputed make and shall be approved by BHEL during detail engineering</p> <table border="1"> <thead> <tr> <th>Sl.No.</th> <th>Item Name</th> <th>Unit</th> <th>Qty 40MW</th> <th>Qty 25MW</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Executive steel table with glass top and 3 sliding drawers for office</td> <td>Nos.</td> <td>2</td> <td>2</td> </tr> <tr> <td>2.</td> <td>Height adjustable cushioned chair with arm rest for office</td> <td>Nos.</td> <td>4</td> <td>3</td> </tr> <tr> <td>3.</td> <td>Steel table with 3 sliding drawers for stores</td> <td>Nos.</td> <td>3</td> <td>2</td> </tr> <tr> <td>4.</td> <td>SCADA workstation table (Modular design)</td> <td>Nos.</td> <td>3</td> <td>3</td> </tr> <tr> <td>5.</td> <td>Computer station chair with hand rest, back and height adjustment</td> <td>Nos.</td> <td>2</td> <td>2</td> </tr> <tr> <td>6.</td> <td>Standard filing Cabinet</td> <td>Nos.</td> <td>2</td> <td>2</td> </tr> <tr> <td>7.</td> <td>Standard steel cupboard</td> <td>Nos.</td> <td>2</td> <td>2</td> </tr> <tr> <td>8.</td> <td>Slotted angle racks for stores</td> <td>Nos.</td> <td>5</td> <td>4</td> </tr> <tr> <td>9.</td> <td>Slotted angle racks for tools and tackles</td> <td>Nos.</td> <td>3</td> <td>2</td> </tr> <tr> <td>10.</td> <td>Workers locker (6 compartment design)</td> <td>Nos.</td> <td>2</td> <td>2</td> </tr> <tr> <td>11.</td> <td>Printer Table for scada</td> <td>Nos.</td> <td>3</td> <td>3</td> </tr> </tbody> </table>			Sl.No.	Item Name	Unit	Qty 40MW	Qty 25MW	1.	Executive steel table with glass top and 3 sliding drawers for office	Nos.	2	2	2.	Height adjustable cushioned chair with arm rest for office	Nos.	4	3	3.	Steel table with 3 sliding drawers for stores	Nos.	3	2	4.	SCADA workstation table (Modular design)	Nos.	3	3	5.	Computer station chair with hand rest, back and height adjustment	Nos.	2	2	6.	Standard filing Cabinet	Nos.	2	2	7.	Standard steel cupboard	Nos.	2	2	8.	Slotted angle racks for stores	Nos.	5	4	9.	Slotted angle racks for tools and tackles	Nos.	3	2	10.	Workers locker (6 compartment design)	Nos.	2	2	11.	Printer Table for scada	Nos.	3	3
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10.	Workers locker (6 compartment design)	Nos.	2	2																																																											
11.	Printer Table for scada	Nos.	3	3																																																											
4.12	<p>Electrical insulation mat</p> <p>Supply, E&C:</p> <p>Supply, erection and commissioning of the following are in vendor's scope.</p> <p>Electrical insulating mats as per below specifications is in bidders scope.</p> <p>(a) Reputed make as shall be approved by BHEL.</p> <p>(b) Insulating Mat Material including composition, Design, Workmanship &</p>																																																														

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	<p>Finish, Physical Properties and all other features shall be strictly comply with the IS 15652.</p> <p>(c) Class-A, Thickness: 2.0mm (Min), Voltage up to 3.3kV ac (rms), Qty: 50 no.'s</p> <p>(d) Class-C, Thickness: 3.0mm (Min), Voltage up to 33kV ac (rms) (i.e >11kV & < 33kV) Qty: 17 no.'s</p> <p>(e) Size = 10M (L) X 1M (W) Sheet. To be confirmed by BHEL during details engg.</p> <p>(f) Category: Category-III, Acid, alkali, oil and low temperature resistance</p> <p>(g) Preferred Color: to be confirmed by BHEL during detail engg.</p> <p>(h) The Insulating mat should be marked with the BIS Standard Mark Valid test report as per IS-15652 which are listed below, not older than 5yrs, from CPRI/ERDA/NABL accredited testing laboratories shall be submitted for review along with the offer. In case any valid test reports are not available, same shall be conducted without any time and cost to BHEL.</p> <p>(i) Adhesive of reputed make for fixing Insulating mat.</p> <p>These mats shall laid in front of all the indoor electrical panels' viz. PCUs, VCB panels, ACDB / DCDB panels, SCADA panels, UPS panels, battery banks etc.</p>
<p>4.13</p>	<p>Fire proof sealing material: Mortar Seal</p> <p>1) Supply BHEL scope</p> <p>2) Erection and commissioning</p> <ul style="list-style-type: none"> • All entry and exit openings for cables passing through GI/PVC conduits /Cable trenches in substation, control room etc. shall be provided with fire barrier. • Erection and commission shall be carried out strictly as per manufacturer recommendation.
<p>4.14</p>	<p>Checkered plates</p> <p>Supply, E&C:</p> <p>Vendor shall supply and install checkered plates made of MS for closing the cable trenches (a) behind the panels such as PCUs, LT panels, ACDB panels etc. in inverter rooms / PESS room and also (b) other open trench areas.</p> <p>Approximate quantity of checkered plate: 1950kg approx.</p> <p>(1) MS plates shall have a suitable handle (welded to the plate) to facilitate ease of lifting and movements.</p>

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	<p>(2) Plate thickness = 6 mm minimum (3) Width and length of checkered plates shall be selected so that the cable trenches are neatly sealed without any gaps. (4) Plates shall be red oxide coated followed by black painting. BHEL approval shall be obtained for overall arrangement of checkered plate.</p>																																																						
4.15	<p>Structural Steel for cable tray supports and panel supports on trenches</p> <p>Supply :</p> <p>BHEL will supply following supports and are free issued to vendor.</p> <p>Hot dipped Galvanized structure steel channel (ISMC) 100mm*50mm*6mm, qty 12MT Hot dipped Galvanized structure steel Angle (ISA) 50mm*50mm*6mm, qty 5MT</p> <p>E&C: E&C of above structural material is in the scope of vendor.</p>																																																						
4.16	<p>Fire-fighting system</p> <p>Design BHEL scope.</p> <p>Supply</p> <p>(a) Following items pertaining to inert gas fire extinguishing system are free issued to vendor. This system is provided for SCADA room of PESS building.</p> <table border="1"> <thead> <tr> <th>Sl. No.</th> <th>Item description</th> <th>Unit</th> <th>Q'ty for 40MW block</th> <th>Q'ty for 25MW block</th> <th>Remarks</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Inert Gas cylinder with all accessories</td> <td>Nos.</td> <td>2</td> <td>2</td> <td></td> </tr> <tr> <td>2.</td> <td>Discharge Hose</td> <td>Nos.</td> <td>2</td> <td>2</td> <td></td> </tr> <tr> <td>3.</td> <td>Electric Actuator</td> <td>Nos.</td> <td>1</td> <td>1</td> <td></td> </tr> <tr> <td>4.</td> <td>Check Valve</td> <td>Nos.</td> <td>1</td> <td>1</td> <td></td> </tr> <tr> <td>5.</td> <td>Manifold release valve</td> <td>Nos.</td> <td>1</td> <td>1</td> <td></td> </tr> <tr> <td>6.</td> <td>Header vent plug</td> <td>Nos.</td> <td>1</td> <td>1</td> <td></td> </tr> <tr> <td>7.</td> <td>Pressure switch</td> <td>Nos.</td> <td>1</td> <td>1</td> <td></td> </tr> <tr> <td>8.</td> <td>Manifold orifice</td> <td>Nos.</td> <td>1</td> <td>1</td> <td></td> </tr> </tbody> </table>	Sl. No.	Item description	Unit	Q'ty for 40MW block	Q'ty for 25MW block	Remarks	1.	Inert Gas cylinder with all accessories	Nos.	2	2		2.	Discharge Hose	Nos.	2	2		3.	Electric Actuator	Nos.	1	1		4.	Check Valve	Nos.	1	1		5.	Manifold release valve	Nos.	1	1		6.	Header vent plug	Nos.	1	1		7.	Pressure switch	Nos.	1	1		8.	Manifold orifice	Nos.	1	1	
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9.	Pipe	Mtrs	18	18	
10.	Discharge Nozzles	Nos.	4	4	
11.	Structural steel	Lot	1	1	
12.	Fittings	Lot	1	1	

- (b) 'Supply of DCP type 9kG capacity Fire Extinguishers with SBC powder cartridge operated (200GM, IS 4947) with controllable discharge mechanism class B rating 34B as per IS 15683. including all necessary statutory certificates in scope of vendor.

Total quantity: 28 sets.

Erection and commissioning

- (a) The SPV plant shall be equipped with suitable passive fire protection system for protection of electrical panels / equipment in PESS rooms, main control room (PESS), 33kV transformer yards, 33kV metering yard as per CEIG requirements.
- (b) Vendor shall install and commission the 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, associated cabling as per the below scope:
- Inside PESS building and in Areas outside the PESS and PCSS / security rooms.
 - Commissioning of complete fire alarm system for 65MW SPV. However, supervision of commissioning for fire alarm system will be by BHEL/OEM.
- (c) The Installation and commissioning DCP type 9kG capacity Fire Extinguishers with SBC powder cartridge operated (200GM, IS 4947) with controllable discharge mechanism class B rating 34B as per IS 15683. including all necessary statutory certificates in the scope of vendor
- (d) Inert Gases (IG 541/IG 55) used for extinguishing of fire in SCADA room in PESS shall be stored in Inert gas cylinders housed in the SCADA room. On detection of fire by Multisensor detector, the signal is sent to the Fire Alarm panel. The fire Alarm panel then sends a signal after time delay to the control module which in turn activates the SOV mounted on the cylinder. On actuation of the SOV, the gas is released into SCADA room through nozzles. Complete Installation and commissioning of inert gas system as per BOQ as mentioned under supply scope shall be carried out by vendor. However, commissioning supervision for inert gas system will be will be by BHEL/OEM

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4.17	<p>Other safety related items</p> <p>Supply, E&C: Vendor shall supply the following safety related items. Make / part number of each item shall be submitted to BHEL for approval prior to procurement.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%; text-align: center;">1</td> <td style="width: 75%;">Gas Mask</td> <td style="width: 20%; text-align: center;">10 No's</td> </tr> <tr> <td style="text-align: center;">2</td> <td>First Aid Box with essential medicines and bandage cotton, antibiotic cream, Dettol, etc.</td> <td style="text-align: center;">2 set</td> </tr> <tr> <td style="text-align: center;">3</td> <td>Hand Gloves 33 KV for GOS operation</td> <td style="text-align: center;">10 sets</td> </tr> <tr> <td style="text-align: center;">4</td> <td>Hand Gloves 1KV for Maintenance of SMB</td> <td style="text-align: center;">10 sets</td> </tr> <tr> <td style="text-align: center;">5</td> <td>Discharge rod</td> <td style="text-align: center;">5 No's</td> </tr> <tr> <td style="text-align: center;">6</td> <td>Safety Helmet</td> <td style="text-align: center;">20 No's</td> </tr> </table>	1	Gas Mask	10 No's	2	First Aid Box with essential medicines and bandage cotton, antibiotic cream, Dettol, etc.	2 set	3	Hand Gloves 33 KV for GOS operation	10 sets	4	Hand Gloves 1KV for Maintenance of SMB	10 sets	5	Discharge rod	5 No's	6	Safety Helmet	20 No's
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4.18	<p>Construction of open yards/ covered sheds for safe storage of 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 temporary yards/sheds for safe storage of vendor supplied items.</p> <p>(a) Open storage yard (without roof) with fencing all around and a gate. This shall be for storage of items supplied by the vendor.</p> <p>(b) Covered shed with a lockable door for storage of light-weight items such as spare parts, tools, other lighter construction materials.</p> <p>(2) Area of storage yards/cabins shall be selected based on sizes of storage items. Vendor shall submit drawings/ sketches/ dimensions etc. to obtain approval from BHEL.</p> <p>(3) Wherever applicable, suitable raised platforms / arrangements shall be provided to ensure that the items are not affected by water at the ground level during rain, storm, flood etc.</p> <p>(4) Storage yards shall have clearance (within the yard) for movement of concerned transportation vehicles/ equipment such as forklifts, hydra, trucks etc as applicable.</p>																		
4.19	<p>Unloading, safe storage and movement of supply items received at site:</p> <p>A. Items supplied by vendor</p> <p>(1) Vendor shall organize all necessary resources such as labour, machinery and tools (cranes, hydra, forklifts, transportation trucks/ trolleys, lifting accessories etc) for unloading the items (supplied by the vendor) received at site and subsequent movement to storage yards.</p> <p>(2) Similar arrangements shall also be made by vendor for movement of the stored items from storage yards to the exact construction locations within the project site.</p> <p>(3) Vendor shall maintain proper documentation / compilation of all the records related to shipping (invoices, LRs, delivery challans, material receipt certificates etc) and shall take verification and approval from BHEL site engineer for every consignment. The documents shall be suitably preserved for further handing over to BHEL/NLC.</p> <p>(4) Registers shall be maintained for the yard to keep track of incoming / outgoing</p>																		

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	<p>items.</p> <p>(5) Safety of items shall be in vendor scope. Accordingly, suitable watch and ward shall be deployed on round-the-clock basis.</p> <p>B. All other items (supplies from BHEL and other vendors)</p> <p>(1) Receipt, unloading, safe storage, security guards shall be in scope of BHEL.</p> <p>(2) However, movement of these items from their respective storage locations to the points of construction is in scope of vendor. Accordingly, vendor shall organize all necessary resources such as labour, machinery and tools (cranes, hydra, forklifts, transportation trucks/ trolleys, lifting accessories etc) for this purpose.</p> <p>(3) Vendor shall draw the material from BHEL stores only after authorization from BHEL engineer and Vendor shall maintain proper documentation / compilation of all the records</p>
<p>4.20</p>	<p>Series interconnection of SPV modules to form strings</p> <p>Supply of SPV modules is in BHEL scope.</p> <p>Type of module: L24270P (~290-310Wp) as per BHEL drawing enclosed with tender.</p> <p>Total quantity = approximately 238600 Nos</p> <p>Vendor shall interconnect the modules as follows:</p> <p>(a) Each module is fitted integrally with a junction box having positive and negative polarity cables (6 sq-mm).</p> <p>(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. MC4 connectors shall be supplied by BHEL.</p> <p>(c) This way, 20 modules shall be connected in series. Each set of connections is called as a series string. Thus, a total of ~11930 strings will be used to achieve ~11930x 20x ~295Wp = ~72.284 MWp.</p> <p>(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.</p>
<p>4.21</p>	<p>Installation of string monitoring boxes including erection of mounting structures</p> <p>(1) Supply of string monitoring boxes (SMB), 549 sets and mounting structures is in BHEL scope. These are 24-in and 1-out type whereby maximum 22 inputs are used with the balance two being spares.</p> <p>(2) However, vendor shall supply the canopy for SMB based on the actual SMB drawing that shall be submitted by BHEL during detailed engineering.</p> <p>(3) Erection of mounting structure and installation and commissioning of SMB is in the scope of vendor.</p> <p>(4) All necessary labour, tools, machinery etc. for the above erection work shall be in vendor scope.</p>

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4.22	<p>Interconnection of SPV module strings to 4/6 sq-mm cable:</p> <ol style="list-style-type: none"> (1) Each SPV module string shall be connected to SMB using 1Cx 6sq-mm cable (copper, XLPO insulation, PVC outer sheath, as per TUV 2pfg 1169/08.2007) supplied by BHEL. (2) SPV module is provided with positive and negative cables (6 sq-mm) having male and female parts of MC4 type connectors. (3) BHEL 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. (4) Total quantity of MC4 connector sets = 13200 sets (each set having a male and a female part) (5) 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 6 sq-mm and 6-sqmm (of both pliers). (6) Note: For any other equivalent make of MC4 plug connectors and tool sets, BHEL/NLC approval shall be taken prior to procurement.
4.23	<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 suitably routed along the module mounting structure members. (2) Cable ties, nylon polyamide 6.6 UV stabilized black, UL94 flammability rating V2, operating temperature up to 85 deg C, shall be used to arrest any possibility of movement or sagging. Cable ties shall be of make: 3M, Phoenix contact, Weidmuller, Hellermannntyton, Panduit. Width of the cable ties shall be a minimum of 4.5 mm. Length shall be so appropriate as to ensure that the bunched cables are held firmly to the mounting structure. BHEL approval shall be obtained for the selected brand and sizes of cable tie. (3) Cables laid shall be dressed using UV resistant nylon cable ties of appropriate dimension. (4) Spacing between two adjacent cable ties shall be so appropriate as to ensure that there is no loose hanging of cables.
4.24	<p>Underground laying of 1Cx 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, sand ,brick etc 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 approval. (5) Cables with HDPE pipe shall be directly buried underground as per trench dimensions below: <ol style="list-style-type: none"> (a) Trench depth = 500 mm minimum (b) Trench width = 200 mm minimum

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	<p>(c) Bottom layer shall be sand of IS: 383 with 100mm thick.</p> <p>(d) HDPE conduit with cables shall be laid over the sand layer.</p> <p>(e) Another layer of sand of 100 mm thick.</p> <p>(f) Trench shall, then, be filled with refill soil and compacted</p> <p>Cable installation procedures under “Cable installation methodology” section of this specification shall also be referred for this.</p> <p>(6) Total length of HDPE DWC pipe shall be as required.</p>
4.25	<p>Termination of 1Cx 6 mm² cables on input side of SMBs</p> <p>(1) 1Cx 6 mm² cables of positive and negative polarities originating from SPV module strings shall be terminated at the input side of SMBs.</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 terminal block (connector) within the SMB. Cables shall enter the SMB through the cable glands that are part of the SMBs supplied by BHEL.</p> <p>(3) Cable lugs and glands for 6 mm² cable will be free issued to vendor by BHEL.</p> <p>(4) Any other hardware, if necessary for fulfilling the connection, such as bolts, nuts, screws, washers 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 shall be within vendor scope.</p>
4.26	<p>Termination of 1Cx240 mm² DC power cables on output side of SMBs</p> <p>(1) Cables of 1Cx240 mm² (Aluminium, armoured, XLPE insulation, PVC sheathed, as per IS: 7098) 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 lugs & Glands 1Cx240 sq.mm cable will be free issued to vendor by BHEL.</p> <p>(4) Hardware such as bolts, nuts, plain washers and spring washers shall be in vendor scope of supply.</p> <p>(5) Selection hardware shall also be as per relevant clauses of “Cable installation methodology” section of this specification.</p> <p>(6) All necessary tools such as pliers, strippers, crimping tool shall be within vendor scope.</p>
4.27	<p>Installation (indoor) of electrical panels within PCSS rooms and PESS room</p> <p style="text-align: center;">Panel installation within 11 PCSS rooms:</p> <p>Vendor shall organize necessary resources such as labour, cranes, hydra, forklifts, transportation trucks / trolleys and other accessories for movements and positioning of the panels as below (Quantities mentioned are per PCSS room):</p> <p>(a) 1250 kW PCU panels : 4 sets</p> <p>(b) 33kV VCB panels: 1 sets (2 incomers + 1 outgoer) for in PESS room</p>

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	<p>(c) 415V ACDB and 110V DCDB power supply distribution boards/converter panels (wall mounted or floor mounted as the case may be) – 1 No each</p> <p>(d) SCADA panel – 1 No</p> <p>(e) 230V UPS with battery bank / Isolation box / UPSDB (for PCU control circuit/SCADA / emergency utilities support) – 1 no.</p> <p>(f) 110V DC Battery and Battery charger - 1 no.</p> <p>(g) Fire alarm panels-1 no. & DCP type Fire extinguisher-1 no.</p> <p>(h) Power supply panel- 1 set</p> <p>Panel installation within PESS rooms (2 nos):</p> <p>Vendor shall organize necessary resources such as labour, cranes, hydra, forklifts, transportation trucks / trolleys and other accessories for movements and positioning of the panels as below (Quantities mentioned in each PESS room):</p> <p>(i) 33kV VCB panels: 15 sets (9 incomers + 2 outgoers + 2 Bus PTs + 1 Bus coupler+ 1 Spare) for 40MW 9 sets (6 incomers + 1 outgoer + 1 Bus PTs + 1 Spare) for 25MW</p> <p>(j) ACDB main panel: 1 set</p> <p>(k) SCADA data station panel for SCADA: 1 Set</p> <p>(l) HMI SCADA control desk with PCs and accessories: 1 set</p> <p>(m) UPS with battery bank / Isolation box / UPSDB (for SCADA/emergency utilities support) – 1 No</p> <p>(n) Fire alarm panel- 1 no.</p> <p>(o) 110V DC Battery / Battery Charger with Isolation box – 1 No</p> <p>(p) IPBX Telephone exchange-1 set</p> <p>(q) Inert Gas fire extinguishing system for Scada room-1 set</p> <p>(r) Weather Monitoring station- 1 Set</p> <p>(s) Wall mounting DB- 1 Set</p> <p>(t) 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.</p> <p>(u) PCUs, VCB panels shall be placed on cable trench of PCSS / PESS rooms, with cable entry from bottom side.</p> <p>(v) 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.</p>
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4.28	Installation of cable trays, cable laying/dressing etc. in PCSS rooms / PESS room				
	A. Installation of cable trays				
	Supply: Cable Trays will be free issued to vendor by BHEL				
	Sl.no.	Material Description	Unit	Qty for 40MW	Qty for 25MW
	1.	600W Ladder type GI cable	Mtrs	900	600

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	tray including support erection			
2.	300W Peforated cable tray including support erection	Mtrs	480	320

Erection and commissioning

- (1) Vendor shall install cable trays, fittings and accessories within for laying 33kV HT, DC/AC LT, control, communication cables etc. as per “**Cable installation methodology**” section of this specification. These shall include corner-bend trays wherever applicable. Cable trays shall be free issued to vendor by BHEL.
- (2) Vendor shall place and fit these cables trays over the steel support structure (angles, sections etc.) that are provided in the cable trenches of PCSS/PESS rooms by BHEL.
- (3) Suitable cut outs, wherever applicable, shall be made in the cable trays to provide path for the cable to reach the lower level trays.
- (4) Adjacent cable trays shall be interconnected using suitable hardware items
- (5) Cable trays shall be earthed as per “**Earthing system**” section of this specification.

B. Cable routing, laying, dressing

- (1) Cables entering into the control rooms from outside shall be bunched appropriately. The multiple bunches shall be routed through conduit pipes (PVC/hume pipes etc.) of appropriate type, diameter and length that shall be fixed below the plinth level.
- (2) Cables (HT, LT, communication, control etc.) shall be laid on cable trays in separate tiers with appropriate spacing. HDPE pipes of appropriate type and size shall be used all along the length of control and communication cables for routing up to panel entry.
- (3) Cables shall be dressed using appropriate cable ties at appropriate intervals to ensure firmness of their position over the trays.
- (4) Trefoil clamps shall be used wherever single core cables are used for three phase system. These clamps shall be at appropriate intervals to ensure firmness of bunching of cables.
- (5) All cable entry openings of conduit pipes, after laying/ termination of the cables, shall be sealed using fireproof sealing material.
- (6) All cable accessories such as cable conduits/pipes, ties, trefoil clamps, sealants etc. for the above purpose shall be in vendor scope of supply.
- (7) All the supply and above installation works as mentioned above shall be as per “**Cable installation methodology**” section of this specification and as per drawings approved by BHEL during detailed engineering.

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4.29	<p>Termination of 1Cx240 sq-mm DC power cables at PCUs in PCSS rooms / PESS room</p> <p>(1) On DC side, for each PCU, vendor shall carry out the cable terminations for 10 positive and 10 negative inputs connections including unsleaving, crimping and connecting.</p> <p>(2) BHEL shall supply the DC cables (1Cx240 sq-mm aluminium, armoured, XLPE insulation, PVC sheath). Also, cable glands (double compression type), cable lugs, bolts, nuts and washers shall be in BHEL scope of supply.</p> <p>(3) Vendor shall carry out drilling/punching of holes in cable gland plates of the PCUs. Gas cutting method shall not be adopted. For this purpose, all necessary machines / tools shall be made available at site by vendor.</p> <p>(4) Cables glands shall be fixed on the gland plate holes. Cables shall be routed through the glands that shall in turn be tightened to hold the cables firmly in place.</p> <p>(5) All tools and accessories required to carry out the termination shall be within scope of vendor.</p> <p>All applicable/relevant clauses under “Cable installation methodology” section of this specification shall be adopted.</p>
4.30	<p>Termination of AC power cables at PCUs, 2.7MVA transformers, VCB breaker panels, aux transformer, UPS / Battery / ACDB/DCDB panels etc.</p> <p>All applicable/relevant clauses under “Cable installation methodology” sections of this specification shall be adopted for all aspects of these cables cable installation, cable accessories etc.</p> <p>(1) Supply of all cable accessories (for the above requirements) such as ferrules, nuts/bolts/washers, cable dressing ties etc. shall be in vendor scope.</p> <p>(2) Laying of above cables, fixing of cable glands, and cable termination at the respective terminal bus bars shall be in the scope of vendor.</p> <p>(3) All resources such as labour, machinery, tools and accessories to carry out the above electrical works shall be within scope of vendor.</p>
4.31	<p>Scope of Control / data / instrumentation / OFC cables and terminations</p> <p>All applicable/relevant clauses under “General specification of LT cables” and “Cable installation methodology” sections of this specification shall be adopted for all aspects of these cables such as technical specifications (ratings, sizes, calculations etc.), cable selection, tests on cables, cable installation, cable accessories etc.</p> <p>(1) BHEL will supply the following data communication cables</p> <p>(a) PCSS room SCADA panels to PESS room SCADA panels (OFC cables)</p> <p>(b) SMBs to PCSS/ PESS room SCADA panels (RS485, 2Px0.5 cables)</p> <p>(c) PCUs to SCADA panels in respective PCSS/ PESS rooms (Ethernet/LAN cables)</p> <p>(d) Protection relays of VCB panels to SCADA in PCSS/PESS rooms (Ethernet/LAN)</p>

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- (e) MFM meters of VCB/ACDB/DCDB panels to SCADA in PCSS / PESS rooms (RS485, 2Px0.5)
 - (f) LAN cables within SCADA network
 - (g) CCTV Rack in PESS to Inverter rooms (OFC cables)
 - (h) Main Fire alarm panel in PCSS to local fire alarm panel in PCSS rooms (OFC cables/signal cable)
- (2) All the cable installation accessories such as cable conduits, cable glands, ferrules, cable ties, bolts, nuts, washers etc. shall be in vendor scope of supply, based on cable size details that will be provided from BHEL at an appropriate time after placement of PO on vendor. Cable laying and cable terminations shall be in vendor scope. All necessary resources such as labour, tools and accessories required to carry out laying and termination works etc. shall be within scope of vendor.

The list of signal cables for which cable glands are to be supplied by vendor are :

S.No	Description	Scope of supply for BOS vendor
1	Fiber optic cable for SCADA OFC cable: six fiber multi tube construction	Cable Glands-60 nos. (PG25)
2	LAN cables	Cable Glands-120 nos. (PG25)
4	RS 485 cables 2Px0.5 Sq.mms	Cable Glands-100 nos. (PG25)

- (3) All the other Cable laying and cable terminations such as (i) control cables from inverter transformer marshaling boxes to relay circuits in VCB panels (transformer trip signals), (ii) control cables from inverter transformer marshaling boxes to SCADA (transformer alarm signals), (iii) control cables from SCADA panels to relay circuits in VCB panels (VCB on/off status, VCB close/open command signals), (iv) instrumentation cables from inverter transformer marshaling boxes to SCADA panels (WTI, OTI values), (v) control cables from 33kV metering yard CTs/ PTs to respective marshalling boxes, (vi) control cables from 33kV metering yard CTs, PTs to metering panels, (vii) RS485 data cables from ABT meters to SCADA, (viii) control cables from fire alarm system to SCADA etc. shall be within vendor scope :
- (a) 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 supplied by BHEL.
 - (b) All the cable installation accessories such as cable trays, cable conduits, cable glands, 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 NLC approved vendor list. Lugs and glands for control cable shall be supplied by

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	<p>BHEL.</p> <p>(c) All necessary resources such as labour, tools and accessories required to carry out laying and termination works etc shall be within scope of vendor.</p>
<p>4.32</p>	<p>Erection of 33kV transformer yards attached to PCSS rooms and PESS control room</p> <p>(1) Each of the 11 inverter rooms is attached to two inverter transformer yards each having one inverter transformer and one aux transformer yard having two aux. transformers.</p> <p>(2) Each PESS room one transformer yards each having two inverter transformer and two aux transformers. Thus, there are total 26 inverter transformers, 26 aux transformers: a) Two inverter transformers (per room) of 2.7MVA 33kV/xxx-xxx V transformer (oil-immersion type) - BHEL scope of supply, and b) Two auxiliary transformers (per room) of outdoor, oil-immersion, approx. 25 kVA, xxxV/433V, 22nos. and 75kVA, xxxV/433V, 4 nos. that is in BHEL scope of supply.</p> <p>(3) Vendor shall provide the yard with an underground earth mat grid of appropriate design as per relevant clauses under the “Earthing system” section of this specification.</p> <p>(4) Hardware arrangements (transformer track rails, angles, steel bolts, plates, nuts, washers etc.), which will be part of foundation pedestal, shall be as per transformer GA drawing that will be provided by BHEL.</p> <p>(5) Vendor shall erect the transformers on RCC foundation as per transformer GA details from BHEL. Vendor scope of I&C of transformers</p> <p>(6)</p> <p>(7) radiators, cable boxes, hardware etc from storage yard and placement on foundation pedestal. b) Assembly of transformer parts. c) All activities applicable to oil filling and filtration including measurement of oil BDV and PPM. Particularly for inverter transformers, filtration of oil shall be carried out to such an extent as to obtain the desired BDV (>60 kV) and PPM (< 15ppm) values. Arrangement of Oil Filtration equipment is in Vendor Scope d) Testing of transformers as per “pre-commissioning checks” section of this section.</p> <p>(8) Vendor shall provide applicable earthing connections to transformers, yard fencing / gates etc. in the yard as per relevant clauses under the “Earthing system” section of this specification.</p> <p>(9) All other items (if any, other than the above) that are required to meet the technical requirements of transformer yard as per applicable standards / electricity rules shall be incorporated by the vendor.</p>
<p>4.33</p>	<p>Underground ground excavation for burying cables and laying of cables in solar</p>

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	<p>array field, transformer yards, metering yard etc. for HT 33kV, LT DC power, LT AC power, data communication, control, SCADA, OFC cables:</p> <p>Applicable/relevant clauses under “Cable installation methodology” section of this specification shall be adopted for burying the cables underground. Accordingly, following cables shall be laid underground by way of direct burying using appropriate layers of sand, 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 PESS/PCSS rooms. (b) AC aux supply cables from aux transformers to the respective ACDB panels of individual PESS/PCSS rooms. (c) HT cables (33kV) / Control cable between PCSS rooms and PESS rooms. (d) AC aux supply cables from ACDB panels of the nearest PESS/PCSS rooms to (i) the respective lighting poles of solar array / transformer yard / boundary fencing, and (ii) submersible bore well pumps, booster pumps. (e) Fire alarm system control / Instrument / OFC cables from PESS room to PCSS rooms. (f) Instrumentation / data communication cables, as applicable, from pyranometers (located in open solar array field) to PESS room. (g) OFC cables from SCADA station in PESS room to SCADA panels of PCSS rooms. (h) OFC cables from IP based exchange in PESS room to IP based telephones/JBs of PCSS rooms. (i) HT cables (33kV), LT cables, data communication / control / SCADA cables from 33kV transformer yards to the related panels in the respective PESS/PCSS rooms. (j) HT cable (33kV)/LT/Control cables from PESS room to Metering yard. (k) LT cables, control / instrumentation / data communication cables from 33kV metering yard to metering panels of PESS room. (l) Any other cables (other than the above) to meet the constructional requirements. (m) All RS 485 cables from SMB to SMB, SMB to SCADA shall be laid in the HDPE DWC conduit and further HDPE DWC conduits including all termination accessories, termination shall be by Vendor. BHEL approval shall be taken for the make / type / size of the HDPE conduit. (n) OFC cable termination accessories and OFC cable termination will be by BHEL.
<p>4.34</p>	<p>Cable installation Methodology</p> <p>1. CODES AND STANDARDS</p> <p>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.)</p>

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	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 Code 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.

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IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal - arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 6.6kv upto and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial & commercial power Systems
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, type ring ,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.
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	

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constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

2. DESIGN AND CONSTRUCTIONAL FEATURE

Inter Plant Cabling

Interplant cabling for main routes shall be laid in Cable trenches/duct banks. Cables from main plant to control room shall be laid in Cable trenches/duct banks. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering.

Trenches

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

Construction of trenches within PESS, PCSS rooms is in BHEL Scope.

General

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

3. Cable accessories

Pipes, Fittings & Accessories

- a) Hume pipes with collar joints shall be NP3 type as per IS 458. Supply of Hume pipes is in the scope of Vendor.

3.1 Cable glands for communication cables

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.

3.2 Cable lugs/ferrules

Cable ferrules for control and signal cables shall be supplied by vendor. The ferrules shall

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conform to relevant standard.

3.3 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.

3.4 Cable Clamps & Straps

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

3.5 Galvanising

- a) Galvanising of steel components and accessories shall conform to IS: 2629, IS: 4759 & IS: 2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.
- 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

3.6 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) Cable tray mounting structure shall be welded to the plate inserts or to steel structural beams/members. Welding of cable tray mounting structure to steel structural beams/members shall be done with prior approval of BHEL/NLC.

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- c) Wherever embedded plates or steel structural beams/members are not available for welding the cable tray mounting structure, electrical contractor shall supply the M.S. plate and fix it to floor slab by four anchor fasteners of minimum 16 mm dia. with holding power of at least 5000 kg.
- d) Spacing between cable tray mounting structures shall be 2000 mm for horizontal straight run of cable trays unless otherwise noted.
- e) Spacing between horizontal support arms of vertical cable tray runs shall be 1000 mm unless otherwise noted.
- f) Width of the horizontal arms of the mounting structures shall be same as the tray widths required in the cable layout drawings plus length required for welding to the vertical supports.
- g) 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.
- h) 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 aluminum 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

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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).	Spac ing
Upto 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm and above	3.0 M

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

4.3 Junction Boxes Installation

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

4.4 Cable Installation

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

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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, Cables shall be laid as voltage grades on as per approved layouts. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two meter. All multi core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with self-locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multi core power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multi core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.
- e) Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.
- f) Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/HDPE pipe.
- g) No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits.

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Also joints in critical equipment in main plant area shall not be permitted.

- h) In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to be made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
- i) Wherever few cables are branching out from main trunk route troughs shall be used.
- j) Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.
- k) 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

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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

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

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

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

5. Cable Terminations & Connections

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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>f) All cable terminations shall be appropriately tightened to ensure secure and reliable connections.</p>
<p>4.35</p>	<p>UPS system for SCADA and emergency utility loads</p> <p>Vendor shall install and commission UPS systems – one for each PCSS room and one for each PESS room. Thus, there shall be a total of 13 UPS systems. Indicative capacity of UPS shall be 5kVA for PCSS room and 10kVA for PESS room.</p> <p>SITE TESTS TO CARIED OUT BY VENDOR ON UPS SYSTEMS</p> <p>The Contractor shall also carry out the site tests on equipments/systems as specified below. However, these shall not be limited to this specification only and in case any other site test is required to be conducted as a standard practice of the Contractor or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer, the</p>

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same shall also be carried out.

Functional Test

On completion of installation and commissioning of the equipment the following tests/checks shall be carried out with the max. available load, which does not exceed the rated continuous load. These tests/checks shall include but not limited to the tests as indicated below.

The details of the tests are as indicated below:

1. Light Load Test

This test is carried out to verify that the UPS is correctly connected and all functions operate properly. The load applied is limited to some percent of rated value. The following points should be checked:

- (a) Output voltage, frequency and the correct operation of meters;
- (b) Operation of all control switches and other means to put units into operation.
- (c) Functioning of protective and warning devices.
- (d) Operation of remote signaling and remote control devices.

2. Checking of Auxiliary Devices

The functioning of auxiliary devices, such as lighting, cooling, pumps, fans, annunciation, etc., should be checked, if convenient, in conjunction with the preliminary light load test.

3. Synchronisation Test

If possible, frequency variation limits should be tested by use of a variable frequency generator, otherwise, by simulation of control circuit conditions. If applicable the rate of change of frequency during synchronization shall be measured.

4. AC Input Failure Test

The test is performed with a fully charged battery and is carried out by tripping input circuit breakers or may be simulated by switching off all UPS rectifiers and bypass feeder as at the same time. Output voltage variations are to be checked for specified limits with an oscilloscope or equivalent. Frequency variation is defined as the steady state frequency of the UPS with and without AC input. The rate of change of frequency is measured by the time it takes to reach steady-state values.

5. AC Input Return Test

AC input return test is performed by closing AC input circuit breakers, or is simulated by energizing rectifiers and bypass feeders.

Proper operation of rectifier starting and voltage and frequency variations are to be observed.

Note: This test is normally performed with a fully or partially charged battery.

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6. Simulation of Parallel Redundant UPS Fault

This test is applicable for UPS with parallel redundant connections. Faults of rectifier or inverter units may be carried out by simulation. Output transients are to be observed.

7. Transfer Test

This test is applicable for UPS with bypass, particularly in the case of an electronic bypass switch. Transients shall be measured during load transfer to bypass caused by a simulated fault and load retransfer after clearing of the fault.

8. Full load test

Load tests are performed by connecting the actual load to UPS output.

Large UPS in parallel connection may be load tested by testing the individual UPS units separately. Load tests are necessary for testing output voltage and frequency, rated stored energy, recharge time, ventilation, temperature rise and determination of efficiency. Load tests are performed to prove transient voltage deviations specified under step load conditions.

9. Efficiency

Efficiency should be determined by the measurement of the active power at input and output.

10. Actual Load Test

Conditions under actual load may differ from those with a dummy load. Steady-state generation of current and voltage harmonics and transients at load switching conditions should be observed

11. Current Division in Parallel

Load sharing between the Modular DC power supply rectifier banks& UPS units shall be measured with actual load under conditions of parallel operation.

12. Rated Stored Energy Time (Battery Test)

This test is a load test to prove the actual possible time of battery operation.

If rated load is not available in the case of large UPS, it is possible to apply a partial load to check the actual battery discharge characteristics and compare these with characteristics specified by the battery manufacturer. Discharge time with rated load shall then be calculated. The test shall be performed with a fully charged battery and also may be done under other battery conditions to be specified, if so agreed. Active power output of the UPS and the battery voltage shall be recorded during the test.

Since new batteries often do not provide full capacity during a starting up period, the discharge test may be repeated after a reasonable recharge time if the original test has failed.

13. Rated Restored Energy Time

Restored energy depends on the charging capacity of the rectifiers and the battery characteristics. If a certain recharging rate is specified, it shall be provided by repeating the discharge test after the specified charging period.

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14. Battery Ripple Current

If battery ripple currents are specified, then the ripple current which depends on UPS operation shall be checked under normal operating conditions. Rough measuring methods are sufficient.

15. On site Ventilation Test

The test is performed with the actual load. Temperature conditions of all Modular DC power supply rectifiers & UPS cubicles are to be observed.

16. Overload Capability Test

Overload capability test is a load test. Specified values of short time overload or starting up sequences of actual load are to be applied for the time interval specified. Specified values of voltage and current are to be recorded.

17. Short Circuit Current Capability

If short-circuit current capability is specified, it may be tested by applicable of a short circuit to UPS output if necessary, via a suitable fuse, Short-circuit current is to be recorded.

18. Short Circuit Fuse Test

Fuse tripping capability of a UPS shall be tested, by short-circuiting the UPS output via a fuse of specified type.

The test shall be repeated to ensure against fuse non-uniformity and switching time during the cycle. The test is carried out at an appropriate UPS load, under normal operation, if not otherwise specified by Employer.

19. Restart

Automatic or other restart means are to be tested after a completed shut-down as specified.

20. Output Over voltage

Output over voltage protection is to be checked.

21. Periodic output voltage modulation

When this test is specified, it may be checked by voltage recording at different loads and operating conditions.

22. Harmonic Components

Harmonic components of output voltage shall be checked with the actual load. Methods of specification and checking shall be subject to Employer's approval.

23. Earth Fault Test

If the DC Power Supply/ UPS output is isolated from earth, then an earth fault can be applied to any output terminal. DC Power Supply/ UPS output transients (if any) shall be measured.

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	<p>If the battery is isolated from earth, then an earth fault can be applied to any output terminals. DC Power Supply/ UPS output transient (if any) shall be measured.</p> <p>The arrangement of Load bank for Load tests is in vendor scope</p>
<p>4.36</p>	<p>Battery & Battery Charger in PCSS and PESS Rooms:</p> <p>Vendor shall install and commission 110V Battery and Battery charger – one for each PCSS room and one for each PESS room. Thus, there shall be a total of 13 Battery and Battery chargers. Indicative capacity of Battery and Battery charger will be as per the below</p> <ul style="list-style-type: none"> ▪ PCSS room: 20A Battery charger & 55AH Battery (VRLA) ▪ PESS room 25MW:30A Battery Charger & 105AH Battery (VRLA) ▪ PESS room 40MW:50A Battery charger & 165AH Battery (VRLA) <p>SITE TESTS</p> <p>The Contractor shall also carry out the site tests on equipment/systems as specified below. However, these shall not be limited to this specification only and in case any other site test is required to be conducted as a standard practice of the Contractor or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer, the same shall also be carried</p> <p>On Battery Charger</p> <ol style="list-style-type: none"> 1) Complete physical examination 2) Checking of proper operation of annunciation system 3) Insulation resistance test 4) Automatic voltage regulator operation 5) Load limiter operation 6) Updation of charger status in DC Battery Health Monitoring system <p>Battery</p> <p>The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer’s recommendation shall also be carried out.</p> <ol style="list-style-type: none"> 7) Visual examination as per IS-15549/IEC 8) Checking of dimension as per manufacturer’s drawing 9) Test for capacity (C10 and C1 capacity)

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	<p>10) Test for capacity and test for voltage during discharge (C10 and C1 capacity).</p> <p>The arrangement of Load bank for Load tests is in vendor scope</p>
<p>4.37</p>	<p>Installation and commissioning of Weather monitoring and SCADA integration systems</p> <p>(1) SCADA system, supply of which shall be in BHEL scope, comprises of data station panels and PC based control desks with software to collect, store, process and report the data parameters of power plant and also to control the operations of the power plant by integrating the various equipment at five major segments as follows:</p> <ul style="list-style-type: none"> (a) String monitoring boxes (549 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 (52 Nos): DC input / AC output parameters of inverters, grid data, fault status and events logged, etc. (d) Inverter transformers (26 Nos): Alarm/Trip signals, WTI/OTI temperature values. (e) 33kV VCB breaker panels (~47 Nos): status of VCB breakers, status of protection relays of transformers, oil / winding temperatures, AC parameters at every 5MW level of the plant. (f) ACDB multifunction meters: AC auxiliary utility consumption parameters (g) ABT Metering panels at each of the two 40MW feeders in 40MW block and one 25MW feeder in 25MW block. (h) Fire alarm system (all PESS rooms & PCSS rooms): status signals (i) UPS system / Charger: status signals (j) Battery charger <p>(2) BHEL scope of SCADA:</p> <ul style="list-style-type: none"> (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 PESS room and intermediate (linking) panels at each PCSS 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. <p>(3) Vendor scope of supply and installation of SCADA system:</p> <ul style="list-style-type: none"> (a) Vendor shall install the BHEL supplied SCADA system in the air-conditioned SCADA room in PESS (main control) room. Vendor shall also install the SCADA / data station panels in each of the 11 PCSS rooms.

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- (b) Control / instrumentation cables as mentioned in other clauses of this specification.
- (c) Cable trenches (in solar array field and transformer yards), cable laying and terminations of all SCADA cables at respective panels / equipment shall be in vendor scope of supply. BHEL will provide the necessary cabling schedule.
- (d) 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 five years from the date of completion of trial run.
- (e) Installation of HMI works stations, 2 nos. in each PESS room shall be done by vendor. The cables (power/ control & communication cables) shall be laid & dressed properly inside the room by vendor. Signal input shall be taken from SCADA 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 –

4.2 549 Nos

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

4.3 Weather monitoring equipment – 2 Nos

Analog signals from the weather monitoring equipment viz. pyranometer (2 Nos), anemometer (1 No) and ambient temperature sensor (1 Nos).

4.4 Power conditioning units (PCUs) 1250kW: 52 Nos

RS485 modbus (RTU) signals from these PCUs comprising of DC /AC side / grid parameters such as current, voltage, frequency, phase, power factor, power (VA, Watt, Var), energy (VA-h, Watt-h, Var-h), fault details, other event logs with dates and times etc.

4.5 LT and HT equipments (Transformers, VCB panels, ACDB panels, metering

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	<p>panels etc)</p> <p>a) 2.7MVA inverter transformer oil temperature value: 4-20mA analog signal.</p> <p>b) 2.7MVA inverter transformer winding temperature value: 4-20mA analog signal.</p> <p>c) 2.7MVA inverter transformer protection fault signals: Buchholz alarm, Low oil level alarm, PRD alarm, OTI alarm &WTI alarm: potential free NO contact, Digital.</p> <p>d) HT Panel VCB On/Off status, open/command signals: potential free NO contact, Digital.</p> <p>e) Numerical relays of VCB panels of nine inverter rooms: Ethernet cables from relays to SCADA panel</p> <p>f) HT VCB panel multifunction meters: RS485 data (AC parameters)</p> <p>g) ACDB panel multifunction meters: RS485 data (AC parameters)</p> <p>h) ABT meters at 33kV side: RS485 data (AC energy generation parameters)</p> <p>4.6 Fire alarm system: Status signals</p> <p>4.7 UPS system: Status signals</p> <p>4.8 Battery charger:Status signal</p>																																								
4.38	<p>Plant illumination system</p> <p>Supply:</p> <p>Following illumination fixtures will be supplied by BHEL and free issued to vendor.</p> <table border="1" style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <thead> <tr> <th style="width: 10%;">Sl.No</th> <th style="width: 50%;">Fixture description</th> <th style="width: 10%;">Unit</th> <th style="width: 10%;">Qty for 40M W</th> <th style="width: 10%;">Qty for 25MW</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>120W LED Flood Light Fixture</td> <td>NO</td> <td>2</td> <td>2</td> </tr> <tr> <td>2.</td> <td>40 W LED Batton Fixture</td> <td>NO</td> <td>10</td> <td>10</td> </tr> <tr> <td>3.</td> <td>30 W LED street Fixture</td> <td>NO</td> <td>550</td> <td>407</td> </tr> <tr> <td>4.</td> <td>Poles 2.2 Mtrs & 4.2 Mtr Poles</td> <td>NO</td> <td>550</td> <td>410</td> </tr> <tr> <td>5.</td> <td>Poles 11 Mtrs Poles</td> <td>NO</td> <td>2</td> <td>2</td> </tr> <tr> <td>6.</td> <td>JBs/Welding receptacles/TPN Socket/Surface mounted board/</td> <td>NO</td> <td>20</td> <td>20</td> </tr> <tr> <td>7.</td> <td>Wiring</td> <td>Lot</td> <td>1</td> <td>1</td> </tr> </tbody> </table> <p>E&C:</p> <p>Installation of outdoor illumination system in peripheral roads, transformer yards, 33kV metering yard, inside roads, plant entrance including junction boxes cabling etc shall be in scope of vendor. Accordingly, relevant clauses of this section shall be adopted.</p>	Sl.No	Fixture description	Unit	Qty for 40M W	Qty for 25MW	1.	120W LED Flood Light Fixture	NO	2	2	2.	40 W LED Batton Fixture	NO	10	10	3.	30 W LED street Fixture	NO	550	407	4.	Poles 2.2 Mtrs & 4.2 Mtr Poles	NO	550	410	5.	Poles 11 Mtrs Poles	NO	2	2	6.	JBs/Welding receptacles/TPN Socket/Surface mounted board/	NO	20	20	7.	Wiring	Lot	1	1
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	<p>1. LIGHTING SYSTEM DESCRIPTION</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 be from emergency lightning.</p> <p>2. Earthing</p> <p>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.</p>
4.39	<p>General civil works</p> <p>1.0 Water Supply</p> <p>GI pipes of Medium quality conforming to IS 1239 (Part I-1990) shall be used for all water supply and plumbing works.</p> <p>The Syntax or equivalent make PVC storage water storage tank conforming to IS: 12701 shall be provided over the roof of the PESS with adequate capacity for 10 No person and 24 hr requirement, complete with all fitting including float valve, top cock etc. The capacity of the tank shall be minimum 500 litres.</p> <p>2.0 Plastering</p> <p>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 2013-13.11).</p> <p>White cement primer shall be used as per manufacturer's recommendation.</p> <p>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</p>

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applied with minimum 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.

3.0 Masonry Work

All brick works shall be using at least class designation 7.5 of approved quality as per IS: 1077, IS: 2212 and IS: 3495. All concrete blocks shall be of minimum compressive strength of 7.5 N/mm² and shall be of Grade-A as per IS: 2185. All stone masonry work shall be ashlar masonry work with stone of minimum compressive strength of 7.5 N/mm². The stone masonry work shall be in line with IS: 1597, IS: 1122 and IS: 1126.

The cement mortar for all kind of masonry work shall be in the ratio 1 cement and 5 sand by weight.

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

The external wall for the building shall be 230 mm thick walls and internal wall 230/115 thick as per requirements. The external wall of PESS facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.

Use of fly ash brick for masonry shall be subjected to approval of NLC.

Suitable damp proof course shall be provided the proportion of cement, sand & aggregate shall be 1:2:4 using 6 mm down stone chips with a water proofing admixtures. The thickness of damp-proof course shall be minimum 40 mm.

5.0 Structural Steel

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

6.0 Grouting

Cement mortar (1:2) grout with non-shrink additives shall be used for grouting below base plate of column. The grout shall be high strength grout

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	<p>having a minimum characteristic compressive strength of min 30 N/mm² at 28 days. The grout shall be chloride - free, cement based, free flowing, non-metallic grout.</p> <p>9.0 BORE WELL</p> <p>Boring and sinking by rig boring system of min 150 mm x 100 mm dia well to be drill to assess potentiality & quantity / availability of water level for deciding filter position through any type of soil, rock & boulders for. Bore well shall be min of 250 mm dia. Minimum 10 deep tube well and supply, installation of casing pipes, submersible pumping set including all mechanical & electrical accessories, fittings etc. complete at site for Solar Module cleaning systems and water supply to buildings requirement. PVC-U casing pipes shall be as per IS 12818.</p>
<p>4.40</p>	<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>1. 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, UPS, Battery, Charger, 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) Checks on Battery: Checks on Battery: Physical Examination, Dimensions, Mass & layout, Marking ,Polarity and absence of short circuit, Ampere - hour capacity, Retention of charge, Insulation Resistance, Test for capacities for 10 hrs discharge rate along with the test for voltage during discharge (6) Insulation resistance measurements (HV megger tests) for all the electrical equipment of control room and switchyard. (7) Functional checks for LT panels (Air circuit breakers): ACB on/off operations, spring charging, LED indications, etc. (8) Functional checks for PCUs: Vendor shall support the PCU commissioning engineer during the pre-commissioning tests. (9) Functional checks for transformer marshalling box: <ol style="list-style-type: none"> (a) Availability of AC power supply, (b) Responses of the relays at VCB panels by simulating the alarm / trip of Buchholz, PRV, WTI, OTI, LOLA at marshalling box. (10) Checks for HT Switchgear: Tightness checks of all clamps, bolts and connecting terminals, Earthing connections, cleanliness of insulator and bushings, space heater checks, HT test of complete board, alignment of busbars with

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	<p>insulator, interchangeability of breakers, continuity and IR value of space heaters, earth continuity for complete switchgear board.</p> <p>(11) Checks for Circuit Breakers: Alignment of trucks for free movement, correct operation of shutters, Control wiring for correctness of connections, continuity and IR values, Manual operation of breakers completely assembled, Power closing /opening operation manually and electrically, Closing and tripping time. Trip free and anti-pumping operation, IR values, resistance and minimum pick up voltage of coils, Simultaneous closing of all the three phases, Check electrical and mechanical interlocks provided, Checks on spring charging motor, correct operation of limit switches and time of charging</p> <p>(12) Functional checks for VCB panels:</p> <p>(a) Availability of AC/DC power supplies, (b) VCB on/off, (c) spring charging, (d) LED indications, (e) functioning of numerical relays, (f) responses at numerical relays of VCB panels to remote operations from SCADA station.</p> <p>(b) Verification of interlock operations related to incomer and outgoer VCBs.</p> <p>(13) 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.</p> <p>(14) Functional checks on SCADA software: mimic diagrams, trend graphs, remote accessibility etc.</p> <p>(15) Earth resistance measurements for solar array, control room panels and switchyard equipment.</p> <p>2. Pre-commissioning tests on transformers, CTs, PTs, Lightning arrestors, vacuum circuit breakers, relays, etc.:</p> <p>(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 / CEA / CEIG requirements.</p> <p>(a) Inverter transformers, Auxiliary transformers: IR tests, voltage ratio, winding resistance in all taps, magnetizing current, magnetic balance, vector group, tan delta (bushing, winding, oil etc.), Measurement of no load losses and current at 90%, 100% & 110% of rated voltage, Load Loss & Short Circuit Impedance measurement on principal & Extreme Taps, Separate Source Voltage Withstand Test, Induced overvoltage test, Repeat no load current/loss & IR after completion of all electrical test, Oil leakage test on completely assembled transformer along with radiators, Jacking test followed by D.P. test, IR measurement on wiring of Marshaling Box.</p> <p>(a) Indoor 33kV vacuum circuit breaker panels: IR tests and continuity tests for panels, IR values for CTs/PTs, secondary injection tests on CTs, primary injection tests for CTs, polarity test for CTs/PTs, ratio test for CTs/PTs, Magnetisation characteristics & secondary winding resistance for CTs. Shorting of spare CT cores, contact resistance measurement for VCB breakers, breakers on/off, breakers opening/closing commands, mechanical interlocks, electrical interlocks etc.</p>
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	<p>(a) Relays in VCB panels: relay calibration / primary injection tests, fault simulation tests (Transformer faults, OF/EF, OV/UV etc.)</p> <p>(b) Outdoor CTs/PTs: IR tests, Polarity tests, Ratio tests, Burden tests, Winding resistance tests, Primary injection tests, excitation tests.</p> <p>(c) Lightning arrestors: IR tests, leakage current tests.</p> <p>(d) Cable megger values</p> <p>(2) Appropriate testing agency shall be arranged for the tests.</p> <p>(3) Vendor shall coordinate/liaison with concerned state/central electricity board departments / CEA / CEIG etc., as the case may be, to fix up test schedules and witness by their representatives.</p> <p>(4) Vendor shall prepare and submit the reports to concerned departments and obtain their approval through necessary liaison activities.</p> <p>3. Vendor shall coordinate and liaison with concerned state / central electricity departments / CEA/ CEIG etc., as the case may be, prepare and submit the applications with necessary enclosures on behalf of BHEL/NLC and obtain their approval:</p> <p>(a) Approval for drawings</p> <p>(b) Approval for synchronization of plant with grid</p> <p>(c) CEA/CEIG inspection of power plant</p> <p>(d) Provisional CEA/CEIG clearance to proceed with commissioning</p> <p>4. 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.</p> <p>Note: Scope of coordinating with concerned state / central electricity departments, CEA/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 / NLC. All other expenses in the above process shall be in the scope of vendor.</p>
4.41	INSPECTION, TESTING AND ACCEPTANCE
	<p>1. Inspection procedure shall be as per approved quality plan by BHEL/NLC.</p> <p>2. Before raising inspection call, manufacturer shall submit all the test reports/ certificates for the equipment.</p> <p>3. During fabrication, the all the supply major items like switchyard items, Module cleaning system etc shall be subjected to inspection by Owner or by an agency authorized by the Owner. Manufacturer shall furnish all necessary information concerning the supply to Owner's inspectors. Owner/BHEL may make multiple visits during manufacturing and testing for review of progress, quality documents verification, verification of materials in compliance to specifications/standards. Owner/BHEL may make final visit for final inspection and verification of shipment documents. The same shall be included in the manufacturing quality</p>

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	<p>assurance plan. Actual visits and inspection shall be as per the approved manufacturing quality assurance plan.</p> <ol style="list-style-type: none">4. All routine and acceptance tests as per IS standards and Standard Manufacturing Quality Plan shall be carried out at manufacturer's works under his care and expense.5. All equipments supplied by vendor shall be of proven design and shall be type tested as per IS standards. The requisite type test certificates shall be submitted during technical bid submission and type test certificates shall not be older than 5 years from the date of bid submission. In case valid test certificates are not available or are older than 5 years, vendor shall conduct tests free of cost and without any delivery implications.6. For loose items such as (HDPE conduits, cable ties, trefoil clamps, PVC pipes etc.) test shall be carried out by vendor/sub vendor at their works and test certificate/COC shall be submitted to BHEL before dispatching the material and to obtain dispatch clearance from BHEL.
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5.0 General conditions applicable during supply, installation and commissioning phase

5.1	As already mentioned in previous clauses, three phase power supply will be made available by NLC free of charges at one point near solar power Plant at each site for construction purposes. Contractor has to make the required lines, power conversion, control and distribution network for meeting construction loads.
5.2	Water supply will be provided by NLC for construction purpose of solar power plant at one point in each project site locations and further distribution is included in the Contractor's scope. 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, Storage sumps, pumps and distribution piping to various locations within the solar power plant. Water will be provided to the Contractor free of charge by NLC for Solar Power Plant during construction and during the O&M period also
5.3	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.
5.4	All necessary tools and tackles such as crimping tool (including heavy duty tools for crimping copper/aluminium cables up to 300 sq-mm), screw driver set, power screw drivers, cutting pliers, nose pliers, spanner sets, adjustable spanners, hole saw cutter set, bending tools, torque wrenches, hack saw blades, pipe wrenches, flat / round files, HV termination tools, drilling machines, welding machines, concrete mixers, steel bar bending tools / templates for RCC works, spade, shovel, hammer etc shall be organized by the vendor.
5.5	All necessary measuring instruments such as digital multimeters, electrical testers, digital 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.
5.6	Vendor shall make their own arrangements for necessary food, drinking water and accommodation for their labour and employees posted at the site. Similarly, food and drinking water required at the site, during the construction operations, shall also be in scope of vendor.
5.7	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.
5.8	Vendor shall maintain updated labour register, with name, age, qualification, salary, attendance details etc at the site.
5.9	Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site.
5.10	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.
5.11	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.

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5.12	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.
5.13	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.
5.14	No child labour shall be employed for execution of the present contract.
5.15	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.
5.16	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.
5.17	BHEL / NLC shall witness routine / acceptance / type tests performed at manufacturer works for the items supplied by vendor. Vendor shall accordingly provide inspection call to BHEL with submission of quality assurance plan in advance. For the items bought out from dealers, test certificates, as per relevant IS / IEC standards, as issued by manufacturer shall be submitted to BHEL. However, prior approval shall be obtained from BHEL/NLC for procurement of the item from dealers.
5.18	Field Quality Plan / Quality control system Vendor shall set up a field quality control laboratory with full set up to facilitate testing of all construction materials in accordance with FQP (Field quality control plan) as approved by BHEL/NLC. Vendor shall deploy a well experienced quality control engineer to monitor all QC activities at site as per approved FQP.
5.19	Any deviations shall be discussed with BHEL / NLC site engineers and implementation shall be taken up only after approval from BHEL / NLC.
5.20	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.
5.21	Vendor shall, as and when required by BHEL/NLC, participate in the review meetings conducted by BHEL/NLC at project site, NLC head offices (New Delhi/Noida), BHEL offices (New Delhi / Bangalore).

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6.0 Operations and Maintenance

6.1	<p>General</p> <ol style="list-style-type: none">1. The Contractor shall carry out O&M for the entire Solar PV Power Plant including its associated civil structures, substations and control rooms buildings, Array Yard, Garden etc. for a period of 5 years including 1 year of Performance guarantee test period.2. Date of commencement of operations and maintenance 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 65MW solar photovoltaic power plant with synchronization / export of power to the grid. (Note: Trial run is considered as an event with trouble-free operation for a cumulative period of 24 generation hours).3. Operation work includes day-to day operation of Solar PV Power plant including maintenance of LT and HT System up to battery limit and maintenance of all Civil Works.4. The contractor shall furnish proposed maintenance (preventive) schedule for the operation and maintenance of power plant.5. The maintenance staff for the solar PV plant shall be available at all times in the PESS.6. The contractor shall maintain register for all their staff deployed for carrying out jobs on regular basis and shall be produced for verification on demand by authorized personal of NLC.7. The contractor shall ensure that all safety measures are taken at the site to avoid the accidents to his employees of his subcontractor employees.8. In order to ensure longevity, safety of the core equipment and optimum performance of the system, the contractor shall use only genuine spares of high quality standards
6.2	<p>SCOPE</p> <ol style="list-style-type: none">1. O& M Personnel-Technical / administrative / office personnel Vendor shall provide his operation and maintenance staff at the Solar Power Plant and PESS for day-to-day operation and maintenance. Vendor shall deploy following minimum personnel:<ul style="list-style-type: none">• 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

TECHNICAL CONDITIONS OF CONTRACT (TCC)

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operational / crisis problems.

- Six working level staff with ITI / diploma level qualifications in engineering with competence for operating electrical / electronics / mechanical equipment, taking measurements, data logging / maintaining registers, preparation of reports in computer.
- Six unskilled persons for regular house-keeping (cleaning / mopping etc) and water cleaning of SPV modules.
- **Note:** At least one among the technical personnel shall essentially be a certified / licensed person for HT operations (33kV minimum). This is a mandatory requirement.
- The maintenance personnel shall be in a position to check and test all the equipment regularly, so that, preventive maintenance, could be taken well in advance to save any equipment from damage. Abnormal behavior of any equipment shall be brought to the notice of NLC not later than 2 hours for taking appropriate action.
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2. Security personnel

Security of Solar Power Plant and PESS will rest solely on vendor till the O&M period (i.e 5 years from the date of successful trial run) of the power plant. Deployment of security guards during O&M period shall be in scope of vendor.

3. All repairing & replacement works are to be completed by the Contractor within reasonable time from the time of occurrence of fault or defect. If it is not possible to set right the equipment within reasonable time, the Contractor shall notify NLC indicating nature of fault & cause of damage etc. within 12 hours from the time of occurrence of the fault.
4. During operation and maintenance, if there is any loss or damage to any component of the power plant due to miss-management/ miss-handling or due to any other reasons, what so ever, the Contractor shall be responsible for immediate replacement / rectification of the same. The damaged component may be repaired, if it is understood after examination that after repairing performance of the components shall not be degraded, otherwise the defective components shall have to be replaced by new one without any extra cost to NLC.

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6.2a	<p>The scope of maintenance work shall include the following:</p> <ol style="list-style-type: none">1. Regular operation and maintenance of the Solar PV Power Plant and including water supply system and submission of daily performance data of the power plant. The Contractor shall maintain log book in this respect to clearly record the date of checking & comments for action taken etc.2. The scope of operation and maintenance includes equipment up to Solar Power Plant. Proper records of operation of Power Plant System are to be kept as per direction of NLC.3. Cleaning of the Power Plant including array yard on regular basis.4. Normal and preventive maintenance of the Power Plant such as cleaning of module surface, tightening of all electrical connections, Line accessories, Transformers and associated Switchgear.5. Keeping & recording daily log sheet as per approved format for the Power Plant to be Supplied after commissioning of the Power Plant.6. Under no circumstances, the operator shall run the power plant damaging the substation or Grid.7. The Contractor shall submit monthly Performance report of Solar PV Power Plant indicating cumulative energy export data as per approved format within three days of the following month. The reporting shall also include any mismatch or abnormality in the performance of the power plant based on SCADA details review. Day to day coordination with TANGEDCO /RRVNL authorities (as the case may be) and sending details required by them are also under the scope of the O & M contract8. The Contractor shall preserve all recorded data in either manual or through computer format and shall submit to NLC every month.9. The Contractor shall develop & maintain the garden, which will be developed by the Contractor himself as per landscaping including daily watering and manuring as and when necessary and on regular basis.10. During operation and maintenance period, the Contractor shall refill the fire extinguishers as per manufacturer's recommendation before expiry.11. Vendor shall provide uniforms for the O&M staff.12. 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 safety13. Maintenance personnel shall be in position to check and test all the equipment regularly, so
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TECHNICAL CONDITIONS OF CONTRACT (TCC)

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that, preventive maintenance could be taken well in advance to save any equipment from damage. Abnormal behaviour of any equipment shall be brought to the notice of BHEL/ NLC not later than 2 hours for taking appropriate action.

14. Names, qualification, work responsibility of personnel shall be listed on a display board within control room.
15. Attendance register shall be maintained for both the teams.
16. Vendor shall ensure statutory requirements such as ESI, PF and labour license for their O&M personnel posted at site.
17. BHEL / NLC 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.
18. O&M personnel at site shall conform to general regulations in force at site and to any special instructions from local NLC administration.
19. O&M personnel at site shall be deemed to be aware of damages and risks incidental to conditions of NLC land & works from time to time and BHEL / NLC shall not be responsible for any injury to personnel arising there from.
20. 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.
21. 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.
22. 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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6.3	<p>SCOPE OF CIVIL MAINTENANCE</p> <ol style="list-style-type: none"> 1. Cleaning of surface drain, sewerage line, drainage outfall, down pipes, soil pipes, water pipe lines. 2. Repairing or replacement, whatever necessary, and cleaning of all joineries in the Pre Engineered Building of PCSS as and when necessary. 3. Repairing or replacement, whatever necessary, of doors, window fixtures, toilet accessories, etc in PESS and other buildings as and when necessary. 4. Cleaning & maintaining of power plant area clearing all weeds, leaves and other wood rejects. 5. Painting of iron parts of array structures posts once in a year. 6. Painting of PCSS, PESS, Security room, compound wall, fencing, gates, etc once in two years. 7. All minor repair maintenance in case of buildings and all other structures as and when required as per the instructions of Project Manager.
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6.4a	<p>Tools & Tackles , Measuring Instruments :</p> <p>Tools and Tackles are not supply items. Tools and Tackles which are required for O & M are to be supplied by the Contractor for use during the O & M period and the same can be taken back by the Contractor after completion of O & M period. The contractor shall maintain all regular operation and maintenance tools apart from the tools and tackles listed below.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Sl.No.</th> <th style="text-align: center;">Item Description</th> <th style="text-align: center;">Unit</th> <th style="text-align: center;">Quantity</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1.</td> <td>Insulation tester 500V (Megger)</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">2.</td> <td>Insulation tester 5000V (Megger)</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">3.</td> <td>Earth tester</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">4.</td> <td>Digital Tong tester</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">5.</td> <td>Digital Multi-meter with Graphic display</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">6.</td> <td>Tool box with D / Ring spanner sets, socket wrench with sockets, insulated cutting & nose pliers, insulated screw drivers, pipe wrenches, Allen key wrench set, MS files,hammer, crowbar, steel tape, etc.</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">7.</td> <td>Crimping tool (2.5 to 240sq mm)</td> <td style="text-align: center;">Set</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">8.</td> <td>Insulation stripper</td> <td style="text-align: center;">Set</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">9.</td> <td>Analog multi meter</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">10.</td> <td>Analog tong tester (AC/DC)</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">11.</td> <td>Relay Tools Kit</td> <td style="text-align: center;">Set</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">12.</td> <td>Electronic Relay Testing Kit</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">13.</td> <td>Torque Wrench</td> <td style="text-align: center;">Nos.</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="text-align: center;">14.</td> <td>Breaker lifting / handling truck of each type</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">15.</td> <td>Fuse pullers of each type</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">5</td> </tr> <tr> <td style="text-align: center;">16.</td> <td>PV Array Tester</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="text-align: center;">17.</td> <td>IR Hand-held Temperature Scanner</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">18.</td> <td>Temperature Indicator</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">19.</td> <td>Solar Module Cleaning Kit</td> <td style="text-align: center;">No.</td> <td style="text-align: center;">4</td> </tr> </tbody> </table>	Sl.No.	Item Description	Unit	Quantity	1.	Insulation tester 500V (Megger)	No.	1	2.	Insulation tester 5000V (Megger)	No.	1	3.	Earth tester	No.	1	4.	Digital Tong tester	No.	1	5.	Digital Multi-meter with Graphic display	No.	1	6.	Tool box with D / Ring spanner sets, socket wrench with sockets, insulated cutting & nose pliers, insulated screw drivers, pipe wrenches, Allen key wrench set, MS files,hammer, crowbar, steel tape, etc.	No.	1	7.	Crimping tool (2.5 to 240sq mm)	Set	1	8.	Insulation stripper	Set	1	9.	Analog multi meter	No.	1	10.	Analog tong tester (AC/DC)	No.	1	11.	Relay Tools Kit	Set	1	12.	Electronic Relay Testing Kit	No.	1	13.	Torque Wrench	Nos.	2	14.	Breaker lifting / handling truck of each type	No.	1	15.	Fuse pullers of each type	No.	5	16.	PV Array Tester	No.	2	17.	IR Hand-held Temperature Scanner	No.	1	18.	Temperature Indicator	No.	1	19.	Solar Module Cleaning Kit	No.	4
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20.	Rheostat	No.	1
21.	C.R.O	No.	1
22.	Function Generator	No.	1
23.	Inverter Testing Kit	No.	1

The contractor shall maintain all regular operation and maintenance tools apart from the tools and tackles listed above. Such special tools and tackles used by the contractor during operation and maintenance period shall be handed over to NLC at free of cost, to ensure smooth takeover of the plant by NLC from the contractor at the end of five years O& M period.

64b	Bidder shall provide all details of onsite testing instruments / equipment. Details of equipment / instrument, make, numbers, range, accuracy, etc. shall be furnished to NLC.
6.5	<p>Responsibility of vendor during PG test</p> <p>Vendor shall, in addition to the O&M activities (as per this specification), carry out the Performance Guarantee test (PG test) that commences on a date (as mutually decided by BHEL/NLC) after successful completion of trial run. PG test is the final acceptance test to prove the performance of the power plant in respect of energy generation as contractually guaranteed by BHEL to NLC.</p> <p>Vendor shall carry out the following activities during this period:</p> <ol style="list-style-type: none"> 1. O&M activities as per this specification 2. Monitoring of power plant parameters as per SCADA reports 3. Reporting power plant parameters to BHEL/NLC on daily basis
6.6	<p>O&M operations – daily basis</p> <ol style="list-style-type: none"> (1) Water cleaning of SPV modules (2) Inverter room / PESS 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/NLC in case of any problems / anomalies observed with any of the parameters. (7) Drinking water to be arranged for O&M personnel at site.

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6.7	<p>O&M activities – weekly basis</p> <p>(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.</p> <p>(2) Monitoring and logging of fire extinguisher levels / pressures as per BHEL formats</p>
6.8	<p>O&M activities – monthly basis</p> <p>(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.</p> <p>(2) Earthing resistance measurements for solar array structures, control room equipment, switchyard equipment, and lightning arrestors: measured values shall be recorded in registers and reported to BHEL as per BHEL approved recording formats.</p> <p>(3) Submission of values / status of plant parameters and events for the corresponding month, as below, as per BHEL approved formats:</p> <ul 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 generation d. Events (with date, time) of faults / tripping / breakdown of equipment e. Events (with date, time) of grid outage f. Events (with date, time) of equipment damages, accidents and thefts g. Activities of module cleaning <p>(4) Monthly reports shall be submitted to BHEL for all the above data.</p> <p>(5) The month wise net energy export calculation for first five years shall be furnished by the by the vendor in the following format.</p>

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Guaranteed Month-wise Energy Export of the project at 33 KV outgoing feeders in metering stations of NLC take off point as per below

Sl.No.	Month	Average Global Radiation on horizontal surface Considered (kWh /M ² / Day) Month wise.	1 st Year (kWh)	2 nd Year (kWh)	3 rd Year (kWh)	4 th Year (kWh)	5 th Year (kWh)
1.	January						
2.	February						
3.	March						
4.	April						
5.	May						
6.	June						
7.	July						
8.	August						
9.	September						
10.	October						
11.	November						
12.	December						
	Annual						

Note:

1. The basis and reference standards used for arriving at these data shall be furnished.
2. PV System Design Report with simulation parameters / variants, shading diagrams, production charts, loss diagrams, etc. shall be furnished correlating with the above month wise energy export data.
3. For each 33KV outgoing feeder, the above calculation shall be done separately and then by adding all the 33 KV outgoing feeder values of the project, the net energy Export value for the project shall be calculated.

6.9

O&M activities - quarterly basis

- (1) Cleaning of PCUs, LT panels, VCB panels, UPS panels etc to remove accumulated dust.
- (2) Monitoring and status review, followed by rectification / calibration / replenishment / replacement actions as necessary and applicable for following:
 - (a) Spare items of all electrical equipment
 - (b) First aid box items - medicines and accessories
 - (c) Safety gadgets
 - (d) Tool kits and measuring instruments
 - (e) Yard lights
 - (f) Pumps, starters
 - (g) Control room appliances: air conditioners, lights, fans, exhaust fans, switch boards etc
- (3) Pest control for control room (rats, snakes etc) – sprays, chemicals, medicines etc to be

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	<p>applied wherever required.</p> <p>(4) Submission of quarterly report on above activities to BHEL.</p>
6.10	<p>O&M activities – half yearly basis</p> <p>(1) Cleaning of water storage tanks.</p>
6.11	<p>O&M activities – yearly basis</p> <p>(1) BDV measurements for oil samples from all the transformers and submission of report to BHEL / NLC.</p> <p>(2) Filtration of oil to be arranged, if required, based on BDV measurement report.</p> <p>(3) Lubrication of moving contacts (VCBs etc) with appropriate grease etc</p> <p>(4) Cleaning of sewerage lines, septic tanks (if found necessary)</p> <p>(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.</p> <p>(6) Checking tightness of hardware in solar array structures and tightening wherever required.</p> <p>(7) Checking tightness of power cable terminations in SPV modules (MC4), SMBs, electrical panels of control room and switchyard.</p>
6.12	<p>O&M activities - as and when required (contextual basis)</p> <p>(1) Monitoring and operation of plant electrical equipment as and when required:</p> <p>(a) VCB on/off: local operations from outdoor VCB panel and remote operations from SCADA system.</p> <p>(b) Settings of numerical relays in VCB panels: review and revision in consultation with BHEL.</p> <p>(c) ACB and MCCB on/off operations on LT side</p> <p>(d) PCU operations: emergency close, LCD displays (selection of settings, monitoring the DC/AC/event/fault status parameters), operation of duct fans</p> <p>(e) UPS panels and Battery bank operations</p> <p>(f) Bore well pump operations to fill the water storage tanks</p> <p>(2) Seasonal tilting of SPV modules from one angle to the other (5, 15 and 30 degrees) based on seasonal tilting chart that will be finalized by BHEL/NLC during detailed engineering phase. This is a critical activity as energy generation is strongly affected by the angle. Vendor shall deploy the necessary tools/tackles, machinery, number of skilled/unskilled labour etc for this purpose.</p> <p>(3) Coordinating, on behalf of BHEL, and obtaining renewal of statutory licenses, clearances and approvals from state departments such as electricity boards, CEA/CEIG etc.</p> <p>(4) 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>(5) 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</p>

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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.

- (6) 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.
- (7) Coordinating with sub-station upon grid failures, line problems etc and implementing the needful steps to restore the plant to normal operation.
- (8) Theft incidents: immediate reporting to BHEL, filing FIRs with police stations on behalf of BHEL, coordination for site inspection by insurance companies and clearance of insurance claims, logging of events (date, time) and maintaining records.
- (9) Accidents: immediate reporting to BHEL, coordinating with hospitals, logging of events (data, time) and maintaining records.

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Part-II -Chapter-VII Document Submission

7.0 Document submission

7.1	<p>Documents to be submitted along with the offer:</p> <ul style="list-style-type: none">➤ Signed and stamped No deviations schedule➤ Signed and stamped Un price schedule format➤ Type test reports (as applicable)
7.2	<p>Documents to be submitted after award of Purchase order:</p> <p>Following documents shall be submitted by vendor after the placement of order.</p> <ul style="list-style-type: none">➤ MDL <p>Master document list shall be submitted by vendor within 1 week after the award of contract to BHEL for approval.</p> <ul style="list-style-type: none">➤ Design documents (GA, Calculations, layouts, Datasheets, erection drawings, schemes, BOM etc.) <p>Refer to respective package section of this specification for the list of documents to be submitted by vendor to BHEL for approval. However, in addition to these documents wherever BHEL finds applicability, vendor shall carry out design and prepare additional documents for BHEL approval.</p> <ul style="list-style-type: none">➤ Manufacturing Quality Plans for the vendor supplied items➤ Field quality plan for the field work➤ Detailed activity-time chart for project implementation.➤ Detailed manpower deployment schedule.➤ Operation and maintenance manuals of various panels and equipments supplied by vendor – such as tool kits, measuring instruments, lightning protection system, 33KV metering yard equipments, and 33kV Over Head transmission line equipments, fire extinguishers, etc.➤ As built documents

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Part-II -Chapter-VIII PREAMBLE TO THE SCHEDULE OF QTS.

PREAMBLE TO THE SCHEDULE OF QTS.

- 1) Details of the items in this Schedule shall be read in conjunction with the corresponding NLC specifications, drawings and other documents and shall have precedence over any contrary statement mentioned anywhere in this document.
- 2) The work shall be carried out as per BHEL approved drawings, specifications, the description of the items in this schedule and/or Engineer's instructions., Drawings enclosed with these documents are only indicative giving some idea of the type of work involved. Final drawings will be issued progressively during the execution of the work.
- 3) Items of work provided in this schedule but not covered in the specifications shall be executed strictly as per instructions of the Engineer.
- 4) Unless specifically mentioned otherwise in the contract, the bidder shall quote his rates for the finished items and shall provide for the complete cost towards fuel, tools, tackle, equipment, constructional plant , temporary works, labour materials, levies , taxes , transport, layout, repairs, rectification, maintenance till handing over, supervision, shops, establishments, services , , revenue expenses, contingencies, overheads, profits and all incidental items not specifically mentioned but reasonably implied and necessary to complete the works according to the contract.
- 5) Rates shall be quoted both in figures and in words in clear legible writing. No over writing is allowed. All scoring and cancellation should be counter signed by the bidder. In case of illegibility, the interpretation of the engineer shall be final. All entries shall be in English language.
- 6) Engineers decision shall be final and binding on the contractors regarding clarification of items in this schedule with respect to the other section of the contract.
- 7) In case of any discrepancy between item descriptions, relevant drawing and/ or specification clarification shall be sought at tender stage itself. Otherwise it shall be assumed that the bidder has quoted for the more stringent requirement.

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HIERARCHY

In case of any conflict/deviations amongst various documents, the order of precedence shall be as follows

- Statutory Regulations
- NLC specification
- Items in Schedule of quantities
- IS/BS/IEC standards
- BHEL's standard specification (with prior approval of Engineer-in-charge).

NOTE: The above technical specification is not exhaustive. In case for any item of work, technical specification is not available, such items of works will be carried out in conformance to technical specification of manufacturer's recommendations/best engineering practice. In case of any dispute between two specifications or non-availability of specifications, customer's specification will prevail. Decision on applicability of any particular specifications will rest with BHEL engineer and his decision in the matter will be final & binding on the contractor. Contractor has to make himself well conversant with the Customer specification.

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Chapter-IX ANNEXURES

Annexure-I

LIST OF DRAWINGS etc.

S.No	Title
1.	Vicinity map of project site
2.	AC single line diagram of overall Solar PV power plant (tender purpose only)
3.	Typical Array layout-40MW
4.	Typical Array Layout 25MW
5.	Typical PESS room Equipment Layout-40MW
6.	Typical PESS room equipment layout 25MW
7.	Typical PCSS room equipment layout
8.	Typical Metering yard Layout-40MW
9.	Typical Metering yard Layout-25MW
10.	Overall lightning protection layout
11.	Overall earthing layout
12.	PESS and PCSS earthing layout
13.	Soil investigation report-40MW(tender purpose only)
14.	Soil investigation report-25MW(tender purpose only)
15.	Overall area cable trench layout (tender purpose)
16.	Outdoor area illumination layout
17.	QAP format & Guidelines of filling up QAP format
18.	Typical MQP for Switchyard items
19.	Typical MQP for Module cleaning System
20.	Field Quality Plan for Electrical System

Annexure-II

LIST OF ITEMS BEING SUPPLIED BY BHEL

Refer Annexure-II of TCC

All items supplied by BHEL shall be as per Annexure-II.

Annexure-III

LIST OF INELIGIBLE ITEMS FOR ED EXEMPTION

Refer Annexure-III of TCC

The list of items ineligible for Excise duty exemption shall be as per Annexure-III.

TECHNICAL CONDITIONS OF CONTRACT (TCC)
Chapter-IX ANNEXURES

Annexure-IV

DEVIATION SCHEDULE (TECHNICAL)

Sl.No.	Cl.No./Page No./Sec No.	Description as specified	Deviation taken	Remarks/ Reason for Deviation

NOTES:

1. Bidder may give a consolidated list of deviations in this form only. Only the deviations listed here in conjunction with the original tender, shall constitute the contract document for the award of the job to the Bidder.
2. Deviation listed elsewhere shall be ignored & will be summarily rejected.
3. If there are no deviations, bidder shall submit signed copy of this format, mentioning “No Deviations” & it shall be henceforth implied that Bidder is complying with all the clauses of the bidding document.
4. Attach more sheets in this format, if required.

(Signature of the

Vendor)