Bharat Heavy Electricals Ltd.,

(A Government of India undertaking)

Electronics Division

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

Quotations are invited under two part bid system for Quotations are invited under two part bid system for Battery energy Storage system (BESS) package include Design, engineering, sizing calculations, manufacturing, training to BHEL and NLCIL, pre-shipment testing at supplier's works, packing, transportation, delivery at site, unloading, storage, installation and commissioning, comprehensive insurance, successful completion of facilities inclusive of supply of mandatory spares, performance and guarantee testing of complete BESS system at AttamPahad and at Dolly Gunj, Port Blair, South Andaman and integration with BHEL's 2x10MW Solar PV power plant at same location.

RFQ NO and date	CEMKTG001 dated 17.03.2018
RFQ due date & time	23.03.2018 up to 13.00 hrs (IST)
Date, Time & Venue of Part-I Bid Opening	NEB 2nd Floor, BHEL-EDN, Bangalore,13.30 hrs (IST)
Date, Time & Venue of Price Bid opening	Will be intimated later for technically accepted vendors
Bid Guarantee Amount	**Rs. 1,00,00,000/- or** **Or equivalent international currency**
Address for Communication & Contact Person in BHEL	Mr. S.Pankaj Kumar (08126333426)/ Mr. Chendhil Kumar R (09449869644), SC&PV MM Department, BHEL Elecrtronics Division, PB NO 2606, Mysore road, Bangalore-560 026. INDIA Email: spankaj@bhel.in, chendhil@bhel.in Telephone number: +91 80 26989667, +91 80 26998391

For further details please please visit our web site: www.bheledn.com or www.bhel.com, or www.tenders.gov.in. All corrigenda, addendum, amendments, time extensions, time extensions, clarifications, etc (if any) to the Tender will be hosted on these websites www.bheledn.com or www.bhel.com only. Bidders should regularly visit websites to keep themselves updated.

Note: Registration procedure for items required by BHEL is always open at https://suppliers.bhel.in. Prospective suppliers (including MSEs and owned by SCs / STs (may visit this site and apply for registration in the respective Unit.

PRELUDE:

NLCIL, Neyveli has floated ICB tender installation of 2 x 10 MW (AC) Grid interactive Solar PV Power Project integrated with 8 MWhr. Battery Energy Storage System at Attam Pahad and at Dolly Gunj, Port Blair, South Andaman with associated 33 KV Switchyard and grid interconnection at the take-off points of Electricity Department of Andaman & Nicobar Administration including Design, Engineering, Manufacture, Inspection at supplier's works, supply, insurance, transportation, delivery at Site, storage, erection, testing, commissioning. The scope of work also includes Operation and Maintenance of the entire system for ten years including one year warranty period.

BHEL-Electronics Division, Bangalore is participating in the ICB tender floated by NLCIL and through this tender seeks to enter into a Consortium Agreement with Techno-Commercially and price wise best Vendor of Battery energy Storage System Manufacturer / Supplier to Associate with BHEL for Participating in the above Tender of NLCIL along with BHEL who will be the lead Bidder.

The Bidder's scope of work for the Battery energy Storage system (BESS) package include Design, engineering, sizing calculations, manufacturing, training to BHEL and NLCIL, preshipment testing at supplier's works, packing, transportation, delivery at site, unloading, storage, installation and commissioning, comprehensive insurance, successful completion of facilities inclusive of supply of mandatory spares, performance and guarantee testing of complete BESS system at Attam Pahad and at Dolly Gunj, Port Blair, South Andaman and integration with BHEL's 2x10MW Solar PV power plant at same location.

The scope of work also includes Operation and Maintenance of the BESS system for (10) ten years including one year warranty period as detailed under Technical Specification.

Bidder's scope for this tender shall also include coordination with BHEL for arriving at the best configuration of BESS to ensure Guaranteed Generation as committed to NLCIL, carry out any routine, preventive and breakdown maintenance immediately to ensure availability of the system and preventing Generation Loss, effect and deploy immediately any replacements / additional supplies and services that may be required during the 10 year O&M period to ensure guaranteed generation.

Bidder shall also provide services to BHEL-EDN as detailed in the Technical specifications

QUALIFYING REQUIREMENTS

PRE-QUALIFICATION REQUIREMENTS (PQR):

Bids of only such bidders who meet all the following criteria, shall be evaluated.

Exclusivity criteria:

The bidder who is selected in this Bid as BHEL's Associate shall preferably not participate in this NLCIL's Bid either directly or as an associate of any other Bidder. Else, the Bidder shall at least mandatorily agree to participate as BHEL's Associate as a preferred partner and provide preferential pricing to BHEL. An undertaking to this effect shall be submitted by Bidder on Company letter head and seal stating the above. If at a later date it is found that Bidder has violated this requirement, then BHEL may ban the Bidder from bidding to BHEL for any product or services in future.

Technical Criteria

Bidder should have executed contracts of Design/Engineering, Supply, Erection/Supervised erection, commissioning of Battery Energy storage system with cumulative capacity of 1.0MWhr. or above as on the original scheduled date of tender opening and out of which at least one Battery Energy Storage System shall be of minimum 0.5MWhr. capacity or above and should be in successful operation for at least one year within the last 7 years as on the original scheduled date of tender opening.

Financial and other qualifying Criteria

Please check the detailed Commercial Specification

TECHNICAL SPECIFICATION FOR BATTERY ENERGY STORAGE SYSTEM FOR GRID CONNECTED SOLAR PV POWER PLANT

Approved by : BB		
Revision details: R01	Prepared GRR	Date 16/03/2018

SECTION 1.0
PROJECT INFORMATION

1.1 Project Site:

The project site for the installation of 2x10 MW (AC) Grid Interactive Solar PV power plant integrated with 8MWHr (minimum) Battery Energy Storage System (BESS) is situated in Attam Pahad and at Dolly Gunj, Port Blair, South Andaman. General information of the project site is as follows:

1. High tide level: 2 Meters
2. Low tide level: 0 Meters
3. Access road: 250 Meters away from Andaman Trunk Road (ATR- NH 4).
4. Nearest Airport: The distance from Veer Savarkar International Airport, Port Blair to Attam Pahad/Dolly Gunj is 4.1 KMS.
5. Nearest Seaport: Port Blair is the main Harbour to receive all mainland vessels
6. Latitude of Attam Pahad site: 11.62^0N
   Longitude of Attam Pahad site: 92.7^0E
   Latitude of Dolly Gunj site: 11.627901^0N
   Longitude of Dolly Gunj site: 92.711303^0E
7. Climate:
   Monthly Average Maximum Temperature-29.89^0C
   Monthly Average Minimum Temperature-22.42^0C
   Relative Humidity: 90% (Maximum)
   Relative Humidity: 70% (Minimum)
   Average Annual rainfall: 254.75 cms
   Basic Wind speed: 5.3 m/s
   Seismic zone: V

SECTION 2.5
BATTERY ENERGY STORAGE SYSTEM (BESS)

The provision for a Battery Energy Storage System (BESS) with the Solar PV Project has been incorporated in the Scheme with the objective of improving the quality of power injected into the grid by Solar PV plants that rely on an intermittent energy resource like Solar radiation and thus, contribute to stable and secure operation of transmission grid. Specifically, the proposed Energy Storage System is intended to be used for PV Power Smoothing application. The utility of BESS for ancillary services including features such as Active Power Regulation services (primary control or Frequency response) etc., shall also be included which is only for demonstrative purpose.

The BESS shall remain connected to the grid as per Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments and its components shall be designed

accordingly. BMS shall ensure safe operation and mitigate fire risk. The BESS shall be configured to perform multiple charge discharge cycles.

2.5.1 PEAK SMOOTHING:-
The Prime application of BESS shall be smoothing of power output from the Solar PV plant due to fluctuation in solar radiations. Peak smoothing shall be demonstrated within the deployed battery capacity in MW, for above 75% of the instances within the specified assessment window i.e., when a need for response is detected. BESS should respond in a manner that the combined Solar PV and BESS output at the Point of Common Coupling (PCC) targets the 15 minutes moving average value of the Solar PV array output. BESS shall charge and discharge power at appropriate ramp rate such that the smooth power output from the combined BESS and Solar plant is injected into grid.

For the purpose of smoothing assessment, this BESS application shall be carried out for during solar hours every day. The upper and lower SOC for BESS operation shall be set as per the system requirements. The Battery manufacturer's specification and operating instructions shall be selected in such a way to suit the above requirements. Temporal resolution of the data provided shall be minimum 1 second.

2.5.2 The PV smoothing Index Calculation shall be as follows:

The PV smoothing Index shall be dynamically calculated in the EMS and if it is less than 0.75, then alarm shall be initiated. As per grid operator requirement or under special emergency grid condition requirement the smoothing of solar PV plant output power intermittency. For this, the detailed control logic shall be submitted for NLCIL approval and finalized during detail engineering.

Criteria Code	**Description**	**Criteria**
M1	Measure/Count of Instances when the BESS is expected to respond for the smoothing application	Count those records in the 10 hour assessment period (Minimum temporaL resolution of one second), where BESS is expected to respond
M2	Count of those instances out of M1 when the BESS successfully responded as required	Count of the instances when power output at PCC (Solar PV output + BESS output) lies within +/- 2% of the 15 minutes moving average of Solar PV Power Output
M3	M2/M1	M3=Ratio between M2 and M1
M4	PV Smoothing index, PVS: The metric for Smoothing Assessment	M3 value of above 0.75 shall be acceptable. At least 90% of the days in a Contract year shall have M3 above 0.75

The BESS shall provide energy up to 30 min by providing immediate injection of a large amount of energy for a short duration during the recovery period after any sudden loss of generation within the power rating of BESS for example due to a passing cloud cover.

2.5.3 FREQUENCY REGULATION:-

Frequency regulation provision shall be incorporated in BESS and the contractor shall not consider any additional battery sizing for this application requirement. The BESS shall be able to support grid during very low or high grid frequency by supplying or absorbing power to/from grid. The power support shall be based on power vs frequency droop characteristic for system frequency outside of the predefined frequency dead band (say 49.5 to 50.5 Hz). The operation in this mode shall be initiated by detection of low or high grid frequency while the BESS is in any other mode. After normalization of grid frequency to normal operating range, the BESS shall return to the mode in which it was operating at the start of frequency regulation mode. Within the dead band frequency range the BESS do not have to participate for frequency regulation operation. During detail engineering the actual value of dead band frequency range shall be finalized based on CEA grid regulation.

2.5.4 ANTI-ISLANDING MODE:-

The BESS shall have anti-islanding protection as per IEC 62116 or equivalent international standard.

2.5.5 The digital inputs from Inverters, SMUs, Power Conversion System (PCS) of BESS, Outgoing feeders, grid parameters and using other required inputs, the EMS shall ensure that none of the solar fluctuation and intermittency shall affect the grid parameters. Based on the history of data of various grid parameters available in Port Blair including existing 5 MWp Solar Power Project , the forecast shall be finalised during detailed engineering to achieve the above functions in a coordinated way.

2.5.6 Components required to support reactive power shall also be taken into consideration for design of EMS and BESS

2.5.7 The critical parameters such as Response time, Discharge duration, Depth of discharge, Frequency of Discharge, Cycle life, round trip cycle efficiency, performance degradation, self discharge characteristics, short time discharge ratings, transient response characteristics, auxiliary systems requirements etc. shall be finalized during detailed engineering to meet system requirements.

2.5.8 Simulation studies shall be done for various conditions of Solar Generation, Grid condition and fault conditions during detailed engineering. Necessary documents required for obtaining the grid parameters available with Electricity Department. ANI shall be provided by NLCIL. However it is the contractor's responsibility to carry out simulation studies based on available grid parameters and appropriate assumptions. The simulation results shall be the basis for the design of the system and it shall be submitted for approval by NLCIL and Electricity Department, ANI.

2.5.9 The contractor shall submit complete design documents and expected performance of the BESS calculations, drawings, reports and data and other submittals for NLCILapproval during detailed engineering

2.510 Prior to the dispatch of BESS, a unit part of the system which shall represent the final BESS system to be installed at site, shall be taken into Factory Acceptance Test (FAT). It shall be arranged by the contractor in any test place of convenience in the presence of NLCIL and Electricity Department, ANI authorities. This test is envisaged with an aim to minimize malfunctions during installation at site. The tests that cannot be built during FAT shall be simulated and tested as close as possible in a manner corresponding to the final functioning.

2.5.11
Fire protection system (FPS) shall be designed for the BESS in line with NFPA or international norms regulations and CBIP guidelines as applicable and system requirements taking into consideration of the project site at island.

2.512
Power Conversion System (PCS) for BESS shall have efficient cooling and a more compact housing concept. The housing concept must be a closed-concept with an air-conditioning system or a ventilation system and shall be supplied either in a separate compartment or integrated system. The BESS shall be able to supply power at power factor of 0.95 lead-lag during normal operation and should be able to allow grid power factor until 0.8 lead-lag. During the period of back down/surrender, grid outage conditions, the BESS shall be capable of getting charged from Solar PV Power plant on stand alone basis.

2.5.13
The response of PCS shall be in such a way that it meets the requirements of Energy Management System (EMS) which is in the scope of the contractor as well as Energy Management Centre which is in the scope of Electricity Department, A & N Administration. The Energy Management System (EMS) shall function as the main command centre for the entire plant and receive inputs via SCADA, from Solar PV strings, inverters, HT transformers, Feeders, Battery Management system, Power conversion system, weather monitoring unit, grid parameters etc. the charging and discharging commands shall be issued accordingly.

2.5.14
Test certificates and test reports as per IEC 62133, IEC 61959 and IEC 61960 or other international equivalent standards applicable for the battery technology selected shall be submitted by the contractor for NLCIL approval during detailed engineering. All other test certificates and test reports as per international standards and norms for large scale Battery Energy Storage System shall be submitted for NLCIL approval during detail engineering

2.5.15
BESS replacements, repairs, substitutions, maintaining spares and consumables etc.,shall be programmed and carried out by the contractor so that the annual guaranteed net energy export is achieved. The tie up arrangements including after sales service support for the entire cycle life of the Battery shall be made by the contractor with Battery supplier and the same shall be submitted to NLCIL.

2.516
Load banks devices with dummy loads of capacity suitable for a unit part of BESS specially designed for battery discharge testing shall also be a part of BESS maintenance and testing system at project site..

2.5.17
The contractor shall install and integrate minimum 8MWhr with half hour backup.
BESS with 2 x 10 MW (AC) Solar Power Plant. The contractor shall install and integrate more capacity to achieve the annual guaranteed net energy export if required without any extra cost to NLCIL.

2.5.18
The BESS shall consists of components but not limited to the following:

- Battery cells /Modules/stacks
- Power Conversion System, Battery Management System, Control panels and HMI interfaces
- Lightning Arrestor, CT, PT, Protective relays, Control and Metering Panel, Surge Protection devices, Filters etc.
- Panels, Switch gears, cables and distribution boards
- Transformers
- Data communication units
- Auxiliary systems and ventilation systems
- Fire Protection system and suppression system, safety equipments
- Container unit
- Mounting structures and Dike structures
- Civil foundation works and platforms as per Battery Manufacturer's requirement

2.5.19
The contractor shall submit detailed technical particulars, drawings and documents of the above components for NLCIL approval.

2.5.20 BESS PARAMETER:
The following shall be the minimum BESS parameters. Bidder shall submit all technical parameters to assess all BESS functionalities.

S.No	**Parameter**	**Value**
1	Installed capacity of BESS	8 MWhr
2	Rated AC power at PCC	16 MW(45 deg C ambient temperature) at 0.95 PF
3	BESS Round trip AC/AC Efficiency at PCC	To be specified by EPC

		contractor as per their BESS system
4	Depth of Discharge (DOD)	To be specified by EPC contractor as per their BESS System
5	Battery Efficiency (DC-DC round trip)	To be specified by EPC contractor as per their BESS System
6	Guaranteed Minimum service life	minimum 11 years (including 1 year PG period and 10 years O&M)
7	Charging rate	To be specified by EPC contractor as per their BESS system
8	Power factor (Measure at PCC)	Four quadrant capability is required. Operating power factor shall be 0.95 lead or lag
9	Response time: It is the time interval between need for response (a command or grid event or Solar Plant power generation event, etc) is detected by the BESS and the time when power as measured at the grid has attained that level. This shall include all intermediate response time of system components	BESS shall have suitable response time to support smooth injection of solar PV plant output power into grid to achieve PVS above 0.75 at least 90% of the days in a Contract year.
10	Positive and Negative Ramp Rate	BESS shall have suitable positive and negative ramp rate to support smooth injection of solar PV plant output power into grid
11	BESS design temperature	0 – 45 degC ambient

Section 2.6
**TESTING, COMMISSIONING, PROVISIONAL TAKEOVER AND PG TEST **

2.6.1
On completion of erection, Contractor shall carry out testing, commissioning, operational checks, instrument and device calibrations, control loop checks, interlock and trip checks, etc, based on a systematically planned procedure. All manufacturers' specific recommendations for testing shall be included. All test results shall be provided to NLCIL for verification and acceptance during commissioning of the entire system.

2.6.2
The Contractor shall do clean up of all equipment and area within project site prior to preparing the equipment for trial run and start-up. The start up and commissioning of the entire system shall be executed by the Contractor in a planned coordinated sequence.

2.6.3
Power and control cabling shall be done as per approved scheme and in sections, taking adequate precautions against electrical shocks as the solar PV cells are capable of producing power on exposure to light. Necessary covers shall be supplied for covering the solar PV modules during cabling termination works. Safety precautions and manufacturers recommendations shall be strictly followed for BESS testing and commissioning activities.

2.6.4
Calibration and commissioning of all instruments and control equipment supplied under this contract shall be executed by the contractor. Hardware required for erection of all instruments and control equipment covered under this contract shall be supplied by the contractor.

2.6.5
Pre-commissioning checks, individual loop checks, power initialization, back charging, verification of system functioning, trouble shooting, final solutions to application and / or instrument problems etc., are contractor responsibility. All the required software and hardware changes shall be incorporated as required for successful commissioning to NLCIL's satisfaction. O&M activities from part commissioning up to provisional take over shall be carried out by the contractor at no extra cost to NLCIL. Part commissioning shall be planned in such a way that subblocks of Solar PV Plant integrated with sub – blocks of BESS shall be commissioned, interconnected and tuned with grid parameters. On any condition grid power shall not be used for charging BESS, however grid power shall be used for auxiliary system, during unavailability of solar power and BESS discharge power to feed the auxiliaries. The drawl of grid power shall be deducted from the export and the Net Energy Export can be calculated accordingly Energy required for initial charging shall be drawn from Solar PV Power plant.

2.6.6
Supply and erect metallic tags on the equipment / instruments and accessories supplied by the Contractor. The tags and connecting wires shall be of stainless steel and the size of the tags shall be adequate to accommodate tag number.

2.6.7
Follow up of all the required activities to obtain A&N Administration / Central Electrical Inspectors approval for the installation and carrying out any changes called for by the Inspector at no extra cost to NLCIL.

2.6.8
Provisional Take over: On successful completion of commissioning, the Solar PV Power Plant integrated with BESS along with Power Evacuation System shall be Provisionally Taken over with a list of major and minor defects and non conformities prepared jointly by the Purchaser and the Contractor. Differentiation of defects as major and minor shall be jointly discussed and agreed by the Purchaser andn Contractor. Upon the completion of commissioning, as soon as practicable, or at such time as may be otherwise agreed to by the parties concerned, the Contractor shall notify in writing to the Purchaser that the entire system is ready for Performance Guarantee Test only after liquidating all the major defects
.
2.6.9
The Provisional Acceptance Certificate (PAC) will be issued after necessary checks of works by NLCIL and the contractor fulfilling all contractual obligations. The plant will be operated and maintained by the contractor for one year from the date of issue of Provisional Acceptance Certificate i.e., Provisional Take Over under full warranty conditions for which no payment will be made for the contractor. Performance Guarantee test period of one year will be concurrent with the warranty period of one year. O&M period for balance 10 years shall commence from the date of Final take over i.e., after successful completion of PG test period for the entire plant and other related conditions and the O&M payment will be made as per corresponding price schedules. No O&M payment will be made for the PG test period/warranty period.

2.6.10 **PERFORMANCE GUARANTEE TEST (PG TEST)**

Performance Guarantee Test shall be carried out for the entire system for one year after provisional take over. Guaranteed Net Energy Export in Kwhr from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points shall be as per the following table:

Year	**Annual Guaranteed Net Energy Export in Kwhr from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points**
PG Period(one year)	268,64,000
1st year O&M	2,65,95,360
2nd year O&M	2,63,26,720
3rd year O&M	2,60,58,080
4th year O&M	2,57,89,440
5th year O&M	2,55,20,800

6th year O&M	2,52,52,160
7th year O&M	2,49,83,520
8th year O&M	2,47,14,880
9th year O&M	2,44,46,240
10th year O&M	2,41,77,600

The procedure for PG test shall be as follows:

a) Minimum two nos. (2) calibrated Pyranometers shall be installed by the contractor at project location mutually agreed by the Contractor and NLCIL. The test report for the calibration shall be submitted by the Contractor for approval by NLCIL. The output of these Pyranometers for the PG test period shall be made available at data logger / SCADA and EMS.

b) "Net Energy Export" shall be recorded in the metering station and shall be taken into account for all contract durations. For this purpose, metering station shall be erected by the contractor as per the requirements of A&N Administration Electricity Department to measure the net energy export. Approval from the Andaman & Nicobar Electricity Administration Authorities in this regard is in the scope of the contractor.

c) "Base Net Energy Export" for a month is computed by correcting the month wise guaranteed net energy export finalised during detailed engineering in the Annexure-1 with a factor taking into account the actual average global solar insolation measured by the calibrated Pyranometer for the PG period as per sl.no. (a) above. The procedure for computation of "Base Energy Export" is detailed in Annexure-2.

d) The measured value of net energy export as per sl.no. (b) above arriving at the difference in net energy export for the PG period for one year, which shall be reported as + ve (or) -ve.
If the sum of difference in net energy export for the PG period is (-) ve, there is shortfall in net energy export, based on which the LD for performance will be calculated at the rate and levied as detailed in Annexure -2. No incentive will be paid if there is excess net energy export.

e) The month wise target of net energy export for 11 years with respect to the corresponding Global Horizontal Insolation of the project site shall be submitted along with the calculations for NLCIL approval as per **Annexure 1** format during detailed engineering and this shall be considered for the entire contract period for computing the "Base Net Energy Export".

2.6.11

Following factors shall be considered while computing the "Base Net Energy Export"

i) Actual insolation level at the project site shall be considered while computing the base net energy export. However, effect due to variation of metrological parameters viz., ambient temperature, wind speed, humidity etc., shall not be considered.
ii) During the period of grid outage, back down/surrender, the measured global solar insolation (for the period of Grid outage) shall be excluded to calculate average global solar radiation for the PG period.
iii) During the O&M period due to Battery replacements / substitutions if any shall fall occurs in Annual Net Energy Export in that year/years then the short fall in Annual Net Energy Export
shall be limited to maximum three years
iv) Along with Battery replacements/substitutions to meet the Annual Net Energy Export re-powering of Solar PV modules. If required shall also be included in the scope of work without any extra cost to NLCIL

2.6.12
The contractor shall furnish the following during detailed engineering in relation to
Annexure 1 for NLCIL approval.
a. The basis, reference standards and calculations used for arriving at the guaranteed month-wise net energy export data.
b. PV System Design Report with simulation parameters / variants, shading diagrams, production charts, loss diagrams, etc correlating with the above year wise net energy export data.
c. Guaranteed month-wise net energy export into the grid as per simulation carried out using PVSYST version 5.5 or higher version /Sun simulator/equivalent software for correlating with the guaranteed month-wise net energy export data.

2.6.13
The procedure as in 2.6.10 & 2.6.11 shall be followed for the balance 10 years O & M period to calculate the annual net energy export as per annexure 3. For the balance 10 years O&M period, if the sum of difference in annual net energy export for the O & M period is (-) ve, then there is shortfall in net energy export, based on which compensation for shortfall will be calculated at the rate and levied as detailed in Annexure - 3. No incentive will be paid if there is excess net energy export. During 10 years O & M contract period if any repowering of solar PV modules and battery replacement/substitution is required to meet the annual net energy export, the same shall be included in the scope of work without any extra cost to NLCIL.

SECTION 2.7
QUALITY ASSURANCE, INSPECTION AND TESTING

2.7.1 GENERAL
2.7.1.1 The documents related to Manufacturing Quality plan shall be submitted for NLCIL approval.

2.7.2 QUALITY ASSURANCE AND QUALITY CONTROL

2.7.2.1 The Contractor shall submit technical documents along with, comprehensive QA & QC documents proposed to be adopted for this project.
2.7.2.2 All major equipments shall be inspected in line with Manufacturing Quality Plan (MQP) issued by OEM.
2.7.2.3 No dispatches shall be made by the supplier without obtaining clearance for dispatch from NLCIL. Wherever reworks are involved re-inspections may be conducted and all expenditure towards the same shall be borne by the Contractor.

2.7.3
FIELD INSPECTION & TESTING
2.7.3.1 Field Quality Plans (FQP) shall detail out all the site tests / checks to be carried out during receipt, storage, erection of the equipments. The Contractor shall furnish copies of the erection & commissioning anuals, reference documents and inspection procedure through soft as well as hard copy. In the Field uality Plans, NLCIL will identify customer hold points (CHP), i.e. test/checks which shall be carried out in resence of NLCIL officials and beyond which the work will not proceed without consent of NLCIL in writing. After FQP finalization and approval, the same shall be submitted in compiled form.

SECTION – 2.8
SUB VENDORS & SUB CONTRACTORS

2.8.1 Sub Vendors
i. The Contractor is responsible for performance/guarantee of the complete project including bought out items and outsourced processes. The Contractor shall supply the equipment /Component system from the Sub vendors approved by NLCIL.
ii. Bidder shall furnish in their bid, the proposed list of sub vendors for each of the bought out items.
iii. The proposed list of sub vendors furnished by the successful bidder will be finalized before start of detailed engineering.

The categorization of Sub vendors are as follows:

a) **Category – I: Sub vendors accepted:**

The acceptance shall be based on past experience of NLCIL.

b) **Category – II: Sub vendors enlisted for future acceptance**:

Such acceptance shall be based on the various details regarding capacity, capability, and experience etc. of the sub-vendor proposed by the successful bidder. It is the responsibility of successful bidder to get the details and credentials of the sub vendors under category II, compiled and submitted to Purchaser for scrutiny and acceptance. The acceptance criteria are mentioned below. However, Purchaser reserves the right to accept or reject any of the proposed sub vendors based on information available with them.
iv. The consolidated list of sub vendors under category I and category II shall be made available to the successful bidder before start of detailed engineering.
v. Purchaser may consider the bidders proposal for inclusion of new sub vendors, if any, during the execution stage for approval, based on the merits, in the overall interest of the Project, after establishing that the sub vendor proposed meets the acceptance criteria specified. However, price advantage if any, arising

out of the inclusion of new sub vendor shall be passed on to the purchaser.
vi. For all other components/equipment/systems which are not figuring in the bought out items list, bidder's standard practice of selecting of vendors may be carried out.
vii. Acceptance criteria for Sub Vendors:
(a) For all Mechanical, Electrical and Control & Instrumentation:

1. For Class I Items:
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. The documentary evidence shall be in the form of Performance certificates furnished by the end user.

2. For Class II Items:
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. The documentary evidence shall be in the form of Material Receipt Certificate/Site Inspection Report/ Installation or erection report etc. from the end user, site/purchaser premises for having received the material.

(b) For structural steel :
1. The structural steel should conform to relevant Indian / International Standards.
2. It should be of reputed make and should have been used in similar construction / infrastructure projects.
3. The Contractor should furnish documentary evidence to prove (1) and (2) above.

(c)For Cement and reinforcement steel:
1. It should conform to Indian / International Standard
2. It should be of reputed makes supplied to similar construction/ infrastructure projects
3. The Contractor should furnish documentary evidence to
prove (1) and (2) above if required

1.8.2 List of Bought out Items for which bidder to propose sub vendors:

2.8.2.1 Class I items:

Sl.No	Equipment list for Class I items	Sub Vendor name
1	Power Conditioning Unit	
2	Array junction Box/Combiner Box with String Monitoring Unit	
3	HT Oil filled Power Transformer	
4	HT indoor switchgear	
5	HT CT	
6	HT PT	
7	UPS	
8	33 KV outdoor breaker	
9	33 KV outdoor CT	
10	33 KV outdoor PT	
11	Surge Arrestor	

12	Isolator
13	LT Transformer
14	HT cables
15	LT power cables/Control Cables
16	DC Cables
17	SCADA
18	Energy Management System
19	Solar PV Modules
20	Battery cells(Modules)
21	BatteryManagement System
22	Power Conversion System for

2.8.2.2 Class II items:

Sl No	**Equipment list for Class II items**	**Sub Vendor name**
1	DC isolator	
2	DC contactor	
3	Numeric Relays	
4	ABT EnergyMeter with software	
5	Surge Protection device for SMU	
6	Cable termination kits	
7	LED lamp fixtures for indoor	
8	Flood light fittings with LED for outdoor	
9	Fire protection system	
10	Fire detection alarm panel	
11	HVAC	

2.8.3 Acceptance Criteria for approval of Sub Contractors for erection works.

For Mechanical, Civil, Electrical and Control & Instrumentation erection works are as follows:
In case the bidder is engaging a sub contractor for Mechanical, Civil, Electrical and Control & Instrumentation erection works, documentary evidence shall be furnished in the form of contract award copy and performance certificate (End user's certificate) to show that similar works were carried out and the job has been completed satisfactorily by the sub contractor as on the original scheduled date of Tender opening and approval shall be obtained from Purchaser, prior to engaging them for Mechanical, Civil, Electrical and Control & Instrumentation erection works.

SECTION 2.9
OPERATION AND MAINTENANCE (O&M)

2.9.1 GENERAL

2.9.1.1
The Bidder shall carry out O&M activities for the entire System including its associated civil structures, roads, Power export Switchyard and control room buildings, Security of the plant Buildings, Garden etc. The O & M activities also includes the entire power evacuation system comprising of UG Cables, transmission lines of grid take off points of the existing 33kV feeders connection point, gantries and allied equipments up to the terminal point of connectivity for a period of 11 years including one year warranty.

2.9.1.2
Operation work includes day-to-day operation of the entire system. The responsibility of ensuring uninterrupted operation of the entire system lies with the contractor or else it will attract penalty/loss of compensation as per relevant clauses of the specification.

2.9.1.3
The contractor shall furnish proposed maintenance (preventive) schedule for theoperation and maintenance of the entire system for NLCIL approval. As the O&M contract period is for 11 years including warranty period, the long term maintenance/replacement schedule indicating the unit replacement of parts/equipments, if any, shall also be furnished considering the life of such parts/equipments. Equipment overhaul schedule indicating the loss of generation during such periods, if any, and the proposed catch up plans for maintaining the scheduled/committed generation shall also be furnished.

2.9.1.4
The maintenance staff for the Entire System shall be available at all times in the plant premises.

2.9.1.5
The Contractor shall maintain attendance register for all their staff deployed for carrying out jobs on regular basis and shall be produced for verification on demand by authorized personnel of NLCIL.

2.9.1.6
The Contractor shall ensure that all safety measures are taken at the site to avoid the accidents to his employees or his sub Contractor employees.

2.9.1.7 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.

2.9.1.8 The O & M charges as per price schedule are inclusive of replacement of parts/equipments, systems, spares, consumables, etc.

2.9.2 SCOPE

2.9.2.1 The Contractor shall provide his operation and maintenance staff for the entire system for day-to-day operation and maintenance. The operation and maintenance personnel shall be qualified, certified by competent authorities and well trained so that they can handle any type of operational hazards quickly and timely. The responsibility of providing suitable Personal Protection Equipments rests solely with the contractor.

2.9.2.2
The security of the entire plant area shall rest with the contractor, till final take over by NLCIL after completion of the contract period. 2.9.2.3 The maintenance personnel shall be in a position to check and test all the equipments regularly, so 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 NLCIL not later than 2 hours for taking appropriate action.

2.9.2.4
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 NLCIL indicating nature of fault & cause of damage etc. within 12 hours from the time of occurrence of the fault.

2.9.2.5
During operation and maintenance, if there is any loss or damage to any component of the power plant and the BESS 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 performance of the components shall not be degraded after repairing, otherwise the defective components shall have to be replaced by new one without any extra cost to NLCIL.

2.9.2.6 The scope of maintenance work shall include the following:

2.9.2.6.1
Regular operation and maintenance of the entire System and submission of daily performance to NLCIL. The Contractor shall maintain log book in this respect to clearly record the date of checking & comments for action taken etc.

2.9.2.6.2
The scope of operation and maintenance includes all equipments/accessories of the entire system and proper records of operation of the entire System shall be kept as per direction of NLCIL.

2.9.2.6.3
Cleaning of the entire areas, buildings, array yard, electrical panels, containers etc. shall be carried out on regular basis.

2.9.2.6.4
Normal and preventive maintenance of the entire system shall be carried out on regular basis.

2.9.2.6.5
Keeping & recording daily log sheet as per approved format shall be maintained after commissioning of the entire system.

2.9.2.6.6
Under no circumstances, the contractor shall run the system in such a way that will damage the grid.
2.9.2.6.7
The contractor shall submit monthly Performance report of entire system indicating net 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 system based on SCADA and EMC details for review. Day to day coordination with A & N Administration Electricity department and submitting reports, details required by them shall also under the scope of the O & M contract.

2.9.2.6.8
The Contractor shall preserve all recorded data in both hard copy and soft copy format and shall submit to NLCIL every month.

2.9.2.6.9
The Contractor shall develop & maintain gardens, which shall be developed by the Contractor himself as per landscaping including daily watering and manuring as and when necessary and on regular basis.

2.9.2.6.10
During operation and maintenance period, the Contractor shall refill the fire extinguishers as per manufacturer's recommendation before expiry.

2.9.3 TOOLS AND TACKLES

2.9.3.1
Tools and tackles is not a supply item. A list of tools and tackles which are required for O & M of the entire system shall be maintained by the contractor for use during the O & M period. The contractor shall maintain all regular/special O&M tools apart from the tools and tackles.

2.9.3.2
Such special tools used by the contractor during operation and maintenance period shall be handed over to NLCIL at the time of completion of 11 years O&M period including warranty period.

2.9.4 TESTING INSTRUMENTS FOR ELECTRICAL & ELECTRONICS

2.9.4.1
The Contractor shall provide all details of onsite testing instruments / equipments. Details of equipment / instrument, make, numbers, range, accuracy, etc shall be furnished to NLCIL

2.9.5 SCOPE OF CIVIL MAINTENANCE

2.9.5.1
Cleaning of surface drain, sewerage line, drainage outfall, down pipes, soil pipes, water pipe lines.

2.9.5.2
Repairs, replacements, cleaning of all joineries etc as and when necessary shall be carried out by the contractor.

2.9.5.3
Repairing or replacement, whatever necessary, of doors, window fixtures, toilet accessories, etc in control room and other buildings as and when necessary.

2.9.5.4
Cleaning & maintaining of power plant area clearing all weeds, leaves and other wood rejects. Vegetation removal inside the power plant and also vegetation removal & cutting of trees/branches en route the transmission lines of the power evacuation system up to Grid Connecting substation on periodical basis as directed by NLCIL.

2.9.5.5
Painting of iron parts of array structures posts once in a year.

2.9.5.6
Painting of the buildings, structures/PCSS, Security room, fencing posts, gates, transmission towers, and extension bays etc once in two years.

2.9.5.7
All minor repair maintenance in case of buildings and all other structures as and when required as per the instructions of Project Manager/NLCIL.

2.9.6 **OTHERS**

2.9.6.1
Any Electrical /Civil maintenance work which are not mentioned or included here but necessary for the entire life of the project shall be carried out by the Contractor.

SCOPE DIVISION

Scope of Work	Executing Agency	Particulars	Terminal Point
2X10MW(AC) Solar PV power plant	BHEL	-BHEL shall be responsible for supply and installation of solar PV power plant -Solar array, Structure, SMU, PCU, Transformer, HT panel, metering equipment, SCADA	Upto 33kV metering yard.
8 MWHr BESS system (Minimum) and EMS	Bidder	-BESS Supply includes- Battery bank, BMS, PCS, HVAC, protection system. All the above shall be containerized. Each shall be 20 feet container. EMS shall be in the main control room integrated with the SCADA	Up to output terminal of PCS containers. Power cable from PCS container to transformer will be BHEL scope. EMS shall achieve design functions as per this specification
Power evacuation from BESS	BHEL Bidder	-BESS transformer with 1 LV winding and 1 HV winding, 33kV panel and metering unit at metering yard. -Bidder shall ensure system suitability to interconnect output from BESS system to LV side of BESS transformer.	Upto 33kV metering yard.
All Civil Work	BHEL Bidder	- BHEL shall carry out all civil works. - Foundation drawings and load details for container installation.	
Supervision and I&C	Bidder BHEL	- Bidder shall be responsible for all supervision of installation and commissioning works required for their scope of supply. - BHEL shall be responsible for Installation of bidder supplies and I&C of BHEL scope of supply.	

LIST OF DOCUMENTS TO BE SUBMITTED ALONG WITH TECHNICAL BID

1 Detailed Schematic diagram of Battery Energy Storage System (BESS) and EMS including following details:
   a) Schematic diagram of battery container
   b) Schematic diagram of PCS container
   c) EMS System configuration

2 Battery details with assumptions / considerations to meet tender requirement of day time power smoothening and energy shift applications (Including but not limited to DOD, Number of cycles, expected life, battery technology).

3 Technical Particulars of Battery with BMS, PCS, EMS and fire protection system.

4 Proposed container layout with tonnage, civil foundation details and area requirement.

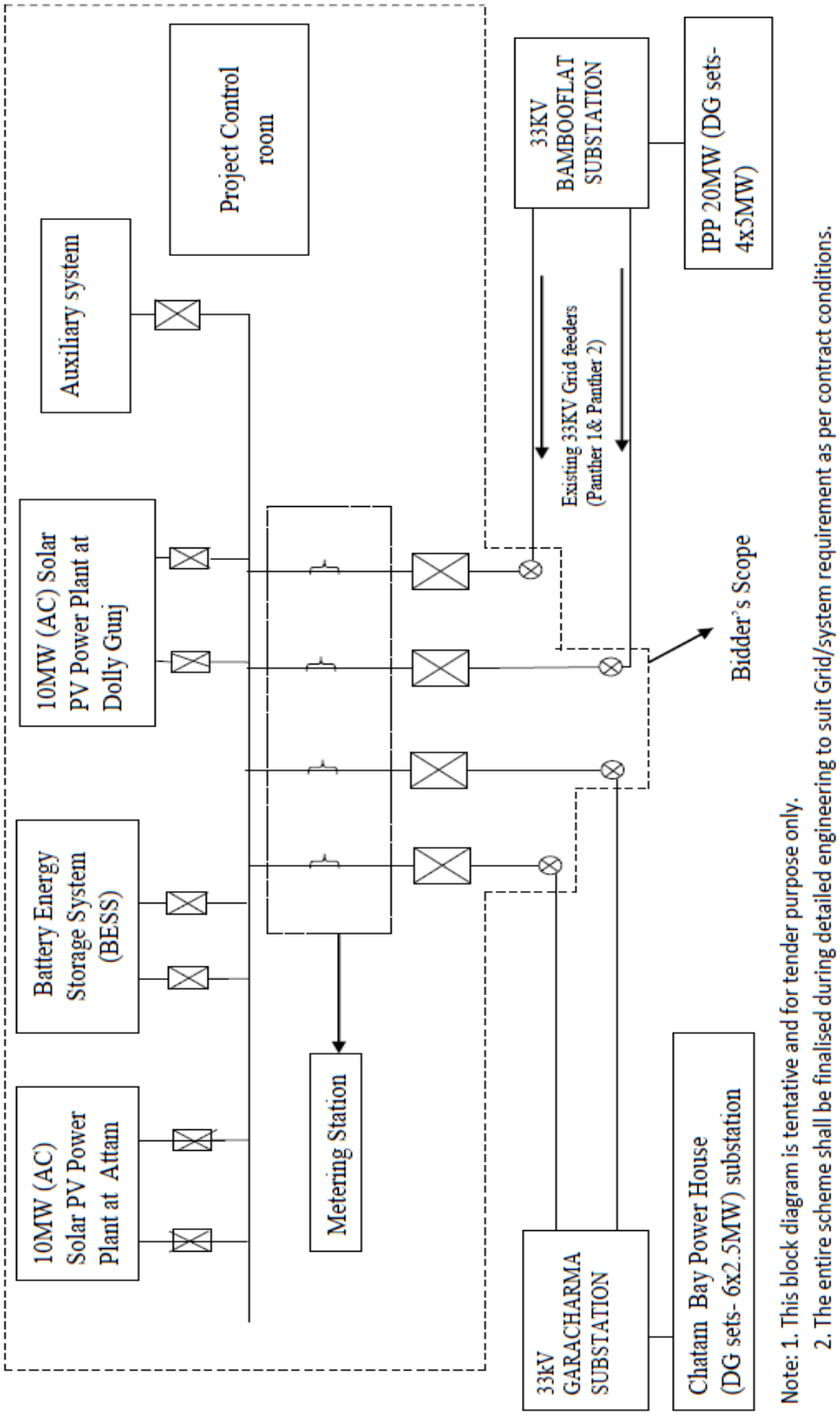
Please refer:

ANNEXURE – 1
Guaranteed Month-wise Net Energy Export at metering station of 33KV switchyard outgoing feeders.
(Page – 318 – 321 0f 328)

ANNEXURE 2
COMPUTATION OF SHORTFALL IN NET ENERGY EXPORT (for PG test period)
(Page – 322 – 323 0f 328)

ANNEXURE 3
COMPUTATION OF NET ENERGY EXPORT DURING O &M PERIOD
(Page – 324 – 325 0f 328)

Fig. 1: Typical scheme of proposed system.



NLC INDIA LIMITED

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OFFICE OF THE CHIEF GENERAL MANAGER / CONTRACTS
CORPORATE OFFICE

CREATING WEALTH FOR WELL BEING

Volume-2 of 2

TECHNICAL SPECIFICATION

FOR

Installation of 2 x 10 MW (AC) Grid interactive Solar PV Power Project integrated with 8 MWhr. Battery Energy Storage System at Andaman includes Operation and Maintenance of the entire system for ten years after one year warranty period

INTERNATIONAL COMPETITIVE BIDDING
Through e-Tender and e-Reverse auction

Tender No. CO CONTS/ 0006G / PV Solar - BESS /ICB/Andaman/e-conts/ 2018, dt.24.02.2018

Pre bid conference : 14.03.2018 at 11.00 Hrs.
Last Date & Time for submission of Bid : 27.03.2018 at 14.30 Hrs.
Date & Time of Opening (Cover-I& II) : 27.03.2018 at 15.00 Hrs. (IST)

Phone No:04142/252210,251620 Fax No.04142-252026/252645/252646
Web site: WWW.nlcindia.com **Email:gmconts_co@nlcindia.com**

Registered Office: First Floor, No.8,Mayor Sathyamurthy Road, FSD, Egmore Complex,Chetpet, Chennai-600 031.

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TECHNICAL SPECIFICATION

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SECTION 1.0
PROJECT INFORMATION

1.1 Project Site:

The project site for the installation of 2x10 MW (AC) Grid Interactive Solar PV power plant integrated with Battery Energy Storage System (BESS) is situated in Attam Pahad and at Dolly Gunj, Port Blair, South Andaman. General information of the project site is as follows:

1. Project site area:

a. Attam Pahad Project site:

Refer Tender Drawing Number: NLCIL/PBD/Andaman/02

Sl No	Area/village	Survey No	Area in Hectares
1	Garacharma (village) Port Blair (Tehsil) South Andaman (District)	1/1/2/2	12.3042
		1/1/6	4.4345
		1/502	4.5693
Total			**21.3080 Hectares**

b. Dolly Gunj Project Site:

Refer Tender Drawing Number: NLCIL/PBD/Andaman/03

Sl No	Area/Village	Survey No	Area in Hectares
1	Dolly Gunj (Village) Port Blair (Tehsil) South Andaman (District)	200/1/P	4.0946
		200/1/P	0.1050
		200/1/P	0.3276
		200/1/P	1.1525
		200/1/P	0.2580
		200/3/P	0.8103
2	Garacharma (Village) Port Blair (Tehsil) South Andaman (District)	393/2/P	1.9762
		393/2/P	3.9400
		393/2/P	0.7000
		393/2/P	0.6775
		393/1/P	0.3327
		393/1/P	5.0330
		393/1/P	0.0446
3	Pahargaon (Village) Port Blair (Tehsil) South Andaman (District)	160/1/P	0.8000
Total			**20.2520 Hectares**

2. Site Elevation: Varies from approximately 3 Meters to 30 Meters
3. Land Topography: Undulated ground and slopped terrain.
4. High tide level: 2 Meters
5. Low tide level: 0 Meters
6. Access road: 250 Meters away from Andaman Trunk Road (ATR- NH 4).
7. Nearest Airport: The distance from Veer Savarkar International Airport, Port Blair to Attam Pahad/Dolly Gunj is 4.1 KMS.
8. Nearest Seaport: Port Blair is the main Harbour to receive all mainland vessels
9. Latitude of Attam Pahad site: 11.62^0N

Longitude of Attam Pahad site: 92.7^0E
Latitude of Dolly Gunj site: 11.627901^0N
Longitude of Dolly Gunj site: 92.711303^0E

10. Climate:
Monthly Average Maximum Temperature-29.89^0C
Monthly Average Minimum Temperature-22.42^0C
Relative Humidity: 90% (Maximum)
Relative Humidity: 70% (Minimum)
Average Annual rainfall: 254.75 cms
Basic Wind speed: 5.3 m/s
Seismic zone: V

1.2 Solar Insolation:

The estimated monthly average solar insolation on horizontal plane is as given below, the bidder has to adopt these solar insolation data for guaranteed net energy export calculations including other calculations.

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
GHI (kWhr/m^2/Day)	5.65	6.47	6.83	6.65	5.08	4.38
Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
GHI (kWhr/m^2/Day)	4.45	4.45	4.64	4.99	4.86	5.19

1.3 Power Evacuation: (Refer Tender Drawing No: NLCIL/PBD/Andaman/01)

1. 33/11 KV Garacharma Substation is the nearest Grid Substation available.
2. 33 KV Tie Panther-I and Panther-II feeders are passing at a distance of 1KM from the location at 33 KV Tower Spans and interconnecting Garacharma Substation and Bambooflat substation.
3. As Per Site conditions 33 KV Transmission line and 33 KV UG cables shall be installed by the contractor for Power Evacuation, by interlinking the Panther I & II feeders with the 33 KV Power Export Switchyard of the project. Refer tender drawing No: NLCIL/PBD/Andaman/01.

1.4 Site Inspection:

For detailed and more accurate information and for authenticated data, the bidder shall collect and confirm data from authorised and authenticated sources.

The bidder is advised to visit and examine the sites of the project and its surroundings and obtain for himself, on his own responsibility, all information that may be necessary for preparing the bid and entering into contract (s). The bidder shall assess and satisfy himself as to the adequacy of the local conditions such as approach roads to the site, adequacy of existing culverts/bridges/roads/ports, harbour for the expected traffic, water and power supply, nature of ground and sub soil condition, water table level, accommodations required during the contract, climatic conditions, local terrain, availability of labour, construction materials, details of taxes and levies as applicable and may other information required. The cost of visiting the site shall be at the bidder's own expenses. Claims and objections due to ignorance of site conditions will not be considered after submission of Bid.

1.5 The site is under possession of the NLCIL and is deemed to be handed over to the Contractor as is where basis from the date of issue of LOA . Widening of the approach roads, strengthening of the sluice gate culvert across the back waters (if required), strengthening of slopes by construction of retaining walls where ever required, removal/shifting of permanent structures (over ground and underground) etc. as required for project installation shall be in the scope of the contractor.

1.6 Mode of Execution:

The entire work shall be executed on Lump sum, turnkey, firm price basis. Any minor item(s) not included in the schedule but required for completion of the work shall have to be carried out/supplied without any extra cost. Such works, not listed in the schedule of works but elaborately described to perform or to facilitate particular operation(s) required for completion of the project shall be deemed to have been included in the scope of this work and the contractor shall supply, install the same without any extra cost to NLCIL.

SECTION 2.1

2.1.1 **DESIGN BASIS**

The contractor shall submit detailed design report for NLCIL approval for the 2X10MW (AC) Grid interactive Solar PV project integrated with installed capacity of 8MWhr with ½ hr backup Battery Energy Storage System. The entire design shall be done taking into consideration of the long term, lump-sum, turnkey, firm price basis EPC contract, uniqueness of the project, solar power generation integrated with large size battery energy storage for power application so that smoothened power can be injected into the 33 KV Grid, connected with the grid which is mostly powered with DG sets / LNG based power generation. The entire design shall be made taken into consideration of project site which is strategically important, environmentally sensitive, remote and island location with challenges of natural disasters, with limited resources etc. The present load demand in the existing 33KV South Andaman Grid is approximately 40 MW-peak load in the evening hours and around 26 MW-average load in other times.

2.1.1.1 The 2x10MW (AC) of Grid interactive solar PV power project integrated with installed capacity of 8 MWhr with ½ hr backup battery energy storage system shall be designed in such a way that for minimum 11 years (including 1st year PG period) the entire system is capable of injecting the smooth power from the solar PV into the grid and guaranteed net energy export to the existing 33 KV South Andaman Grid as per requirements stipulated in the relevant clauses of this specification. The general guiding principles for design basis shall be as follows:

- The month wise average solar Insolation values for the project site (Attampahad, ANI) shall be based on considering the long term published data from NASA, available for the location.
- The established efficiency of solar PV modules at different operating conditions shall be as per international standards and as per the standards of the manufacturer in India for the supply of solar cells / modules proposed for this project.
- The design and selection of solar PV module, panel, array configuration, series and parallel connections, orientation, inverter designs, transformer selection, power export scheme etc., shall be such as to ensure maximum electric power generation and minimum loss to the generated power results.
- The Contractor should carry out Shadow Analysis at the site along with the topographic survey for designing strings & arrays layout for optimal usage of space, material and labour. The Contractor shall submit Shadow Analysis Report along with the array layout drawings to NLCIL for review and approval. The Project site location is surrounded with back water from sea. To protect the

structures from corrosion, apart from painting the structures, cathodic protection shall also be envisaged if required.

- BESS scheme integrated directly with 33 KV system with point of common connection shall be envisaged. The maximum MW that shall be discharged from BESS to the 33 KV Grid during Solar hours shall be limited to 16 MW. However the BESS shall be designed to meet the system requirements and to meet the Annual Guaranteed Net Energy Export.
- Provision for seasonal tilt /fixed tilt/ tracking of solar modules and associated auxiliary power feeding arrangements shall be designed to achieve the guaranteed net energy export for the entire period of the contract.
- The design of entire system including PV array layout, general arrangement of equipments, location of BESS equipments and Power Export switchyard, location of Project Control Room etc. shall be such that the allotted project site area shall not exceed in Attam Pahad site and Dolly Gunj site and as per the contractors design approved by NLCIL. If any area is not utilized, the same shall be handed over back to NLCIL.
- The design of the system shall aim for a fully automated power plant requiring minimum operator intervention, with daily automatic startup and shutdowns, optimized power generation features, grid monitored safety functions, integration of Energy Management System with A & N Grid Energy Management Centre, HMI interfaces, User friendly operation, ,solar forecasting, solar smoothing, data management and remote function capabilities.
- Workmanship and finish shall be in accordance with the best and latest engineering practices. All materials used for the manufacture of equipment by the Contractor or his sub-suppliers or his sub-vendors and the workmanship shall be of good quality and acceptable, as per Indian Standards or other approved standards etc.
- Methods may be adopted for maximizing the quantum of power exported especially during Solar Hours . The distribution losses shall be kept to the bare minimum, by adopting high efficiency design for power transformers with minimum core and copper losses, with liberal use of active materials namely core and copper. The design shall also feature, use of such techniques and other methods to minimize stray losses, reduce harmonics, cater required reactive power loads, withstand all types of fault conditions etc.
- The Contractor shall submit the calculations of the Performance Ratio (PR) of the Solar PV Power Plant for NLCIL approval. It may be noted that the PR value will not be considered for the PG evaluation. With inputs received from various input devices in the field, the PR shall be dynamically calculated and displayed. Suitable software shall be incorporated in the SCADA for this purpose.

2.1.1.2 The DC power generated in the photo voltaic arrays will be fed through Array junction box / combiner box and String monitoring unit and then fed to central inverter in Power Collection Substation (PCSS). In case of string inverters/micro inverters the DC Power generated shall be fed directly to the inverters. **The inverter to module ratio shall be minimum 1: 1.10.** The rating of the inverter is chosen to have minimum line loss on DC side for a typical array layout and optimum power rating.

2.1.1.3 The inverters transform the DC power to 3 phase AC, 50Hz of suitable voltage. AC power from the inverter output side shall be taken to power transformers. The power transformers shall be located near the PCSS. The high voltage side of the transformers shall be connected to the HV switchgear. The selection of the type of PCSS shall be either indoor or outdoor or a combination with container unit, which shall be finalised during detailed engineering to match the system requirements.

2.1.1.4 In the project control room Energy Management System, breaker, distribution board, control and relay panels, metering panel, SCADA, DC and AC auxiliary control power equipment, communication system; fire alarm panel, etc. shall be installed suitably to meet the system requirements.

BESS design basis and specifications shall be as per section 2.5.

2.1.1.5 The following power system parameters for LT system and HT system shall be as per the requirements of Electricity Department, Andaman & Nicobar Administration and to meet the overall system requirements.

- Nominal system voltage
- Highest system voltage
- System frequency
- System Earthing
- Fault level (3 phase symmetrical)
- Short time current rating (For all current carrying parts)
- Power frequency withstand voltage
- Impulse withstand voltage
- Other Power System parameters

2.1.1.6 The Contractor shall design the entire system to meet the requirements of safety and statutory regulations of the Andaman & Nicobar Administration authorities. If any modifications are required to meet the Andaman & Nicobar Administration regulations/requirements, the contractor shall carry out the same without any extra cost to NLCIL.

2.1.1.7 The equipments and systems shall be designed, manufactured, assembled, tested, shipped, installed and commissioned according to the applicable codes, standards and regulations. The design and installation shall be fully in conformity with the standards and codes as applicable but not limited to the following.

ANSI	:	American National Standard Institute
ASME	:	American Standard of Mechanical Engineers
AWS	:	American Welding Society
ASTM	:	American Standards for Testing Material
ISO	:	International Organization for Standardization
ASA	:	American Standard Association
DIN	:	Deutsche Industrie Normen
EN	:	European Standards

BS	:	British Standards
BIS	:	Bureau of Indian Standards
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
ISA	:	Instrument Society of America
SI	:	International System of Units

2.1.1.8 Latest International / National codes and standards shall be followed for the design of the entire system. It is the contractor's responsibility to ensure the coherence of the codes and standards chosen as reference.

SECTION 2.2
SOLAR PV MODULES, ARRAY YARD AND DC SYSTEMS

2.2.1 SOLAR PV CELLS AND MODULES

2.2.1.1 The bidder should adopt only Mono or Poly Silicon Crystalline type flat plate Solar PV Module as detailed in this specification.

2.2.1.2 Solar PV Cells offered for this project shall be tested as per testing standards for its characteristics, surface condition, surface profiling, thickness shape, flatness measurements, etc. The modules using the solar cells described above shall conform to latest IEC 61215 in all respects. The contractor shall furnish latest IEC 61215 Test reports along with constructional data form for the offered PV modules to be supplied during detailed engineering. The IEC 61215 test certificates and test reports consisting of list of the Makes & Description of the each component including Solar PV Cells used in the manufacture of Solar PV modules shall be furnished during detailed engineering. The solar PV modules of same type and rating (above 240 Wp rating) will be maintained at each string level. The exact type and rating of solar PV modules at the respective inverter level will be finalised during detailed engineering. The Contractor shall submitt IEC 61730 certificate and test reports (for safety qualification testing) for the offered PV modules. In addition, the bidder shall also furnish IEC 61701 certificate and test reports (for corrosion testing) for the offered PV modules during detailed engineering. The Project site location is surrounded with back water from sea. Any additional protective care in the manufacture of modules shall be taken to ensure design life of 25 years.

2.2.1.3 All materials used in the Solar PV module shall have a proven history of reliability and stable operation in external applications. It shall perform satisfactorily in high relative humidity with atmospheric temperatures prevailing at the site and should have lowest temperature coefficient and shall withstand gust prevailing at site on the surface of the panel. Each and every SPV module shall be checked for conformity with relevant standard. Modules shall not have negative tolerance and the same shall be incorporated in manufacturing and inscribed in the name plate rating.

2.2.1.4 The bidder shall provide the data sheet of technical specifications for the offered PV modules. The bidder shall furnish electrical characteristics such as current-voltage (I-V) performance curves and temperature coefficients of power, voltage and current during detailed engineering.

2.2.1.5 PV modules after manufacture must be tested for random sample and approved by one of the NABL accredited Test Centres in India/International Laboratory Accreditation Cooperation (ILAC) Member Labs in abroad. Manufacturing Quality Plan for PV modules shall be submitted for approval by NLCIL. Random sample testing by NLCIL during manufacture of PV Modules shall be included in the MQP.

2.2.1.6 Solar PV Peak power rating of the module shall not be less than 240Wp. The module conversion efficiency shall be minimum 15% and above under standard test conditions. The cell should have minimum fill factor of 0.7. It shall be made of high transitivity glass and front surface shall give high encapsulation gain.

2.2.1.7 The front surface of the module shall consist of impact resistant, low iron and high transmission, toughened, plain/patterned glass.

2.2.1.8 The interconnected cells shall be laminated in vacuum to withstand adverse environmental conditions.

2.2.1.9 The module frame shall be made of corrosion resistance materials, preferably having aluminium anodized finish.

2.2.1.10 Minimum clearance between the lower edge of the modules and the developed ground level shall be finalised during detailed engineering.

2.2.1.11 Bidder shall carefully design complete layout and arrangement of equipments in the land available and requisite number of modules shall be installed to achieve the rated power generation and guaranteed net energy export. The inter row distance between solar PV arrays shall be sufficient for easy movement of men / materials for panel cleaning, maintenance works, etc.

2.2.1.12 Solar PV Modules Material Warranty

Material Warranty is defined as: The manufacturer should warrant the Solar PV and Modules to be free from the defects and/or failures specified below:

- Defects and/or failures due to manufacturing
- Defects and/or failures due to materials
- Non-conformity to specifications due to faulty manufacturing and/or inspection processes.

If the solar PV Modules fail to conform to this warranty, the manufacturer will repair or replace the solar modules as per contract terms.

2.2.1.13 PV modules used in Grid Interactive Solar PV power plant integrated with Battery Energy Storage System must be guaranteed for output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.

2.2.1.14 Identification and Traceability

Each PV module used in solar power project must use an RF identification (RFID) tag. The following information must be mentioned in the RFID used on each module.

- Name of the manufacturer of Solar cells
- Name of the manufacturer of PV Module
- Month and year of the manufacture (separately for solar cells and modules)
- Country of origin (separately for solar cells and module)
- I-V curve for the module
- Wattage, Im, Vm and FF for the module
- Unique Serial No. and Model No of the module
- Date and year of obtaining IEC PV module qualification certificate
- Name of the test lab issuing IEC certificate
- Other relevant information on traceability of solar cells and module as per ISO 9000.

The RFID label shall be placed either inside or outside the laminate.

2.2.1.15 Modules shall be provided with a Module junction box of minimum IP 65 rated high quality enclosure with provision for external terminal connection and adequate capacity by-pass diodes. The Module junction box should have weatherproof lid, cable gland entry points and connecting copper cable with MC4 type/equivalent/compatible connector.

2.2.2 ARRAY JUNCTION BOX / COMBINER BOX AND STRING MONITORING UNIT

2.2.2.1 Array junction box and Combiner box shall be provided on the DC power side to combine the electrical power from the strings. String Monitoring Units (SMU) shall be provided for monitoring the DC power generation and other parameters at two string level. In case of String Inverters, the string level monitoring of the inverters shall be of 0.5 % high accuracy monitoring. If string inverters are made acceptable PCSS of container type may be used to accommodate other PCSS equipment.The Array junction box /Combiner box and String Monitoring unit shall be either integrated into a single box enclosure as intelligent array junction /combiner box or with individual box enclosures. However Array junction box /Combiner box and String Monitoring unit shall be standalone units erected nearer to the module mounting structures at an optimized distance to reduce the DC losses and shall be

either integrated box enclosures or individual box enclosures. The box enclosure for Array junction box/ Combiner box and String Monitoring Unit shall be dust, vermin and water proof, impact resistant and made of polycarbonate/ERP/metallic enclosures which should be sunlight/ UV resistive as well as fire retardant. The box must have minimum protection to IP 65 degree of enclosure and Protection Class II.The terminals inside the Array junction box/ Combiner box and String Monitoring Unit shall be connected to copper bus-bar arrangement of proper sizes. The Array junction box/ Combiner box and String Monitoring Unit shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification.

2.2.2.2 Each string shall have a suitable fuse to prevent the reverse current flow with suitable arrangement for its connection. Y harness is allowed for paralleling two strings. The Array Junction Box shall have suitable surge protection device (SPD) and shall consist of Metal Oxide Variasters (MOV) which shall be provided between positive and negative conductor and earth ground. DC photovoltaic fuses for positive side for each string shall be provided and shall have fuse holder with fuse blown indication, easy to isolate the string during fault conditions. It shall be so designed that it should protect the modules from reverse current flow.

2.2.2.3 The Surge Protection Device shall have following minimum specifications.

Repetitive Surges x15(8/20 μS) In : 20kA
Surge Current (8/20 μS) Imax : 40kA

During earth fault and failure of MOV, the SPD shall be capable of safely disconnecting the healthy system. SPD shall have thermal disconnector to interrupt the surge current arising from internal and external faults. In order to avoid the fire hazard due to possible DC arcing in the SPD due to operation of thermal disconnector, the SPD shall be capable of extinguishing the arc by itself.

2.2.2.4 The String Monitoring Units shall be tested using automatic calibration tools so that the accuracy of measured current and voltage reading shall be within +- 0.15%.

2.2.2.5 The Array Junction Box / Combiner box and String Monitoring Unit shall have suitable arrangement for the following:

- Combine a cluster or group of modules into independent charging string that will be wired through the String Monitoring Unit.
- Provides DC Isolator of suitable rating for disconnection at the outgoing.
- Provides a test point for each sub-group for quick fault location.

- Means to measure voltage / current / power of individual and total string as well as means to indicate the status of disconnection, SPD and fuses
- The current carrying rating of Array Junction Box / Combiner Box and String Monitoring Unit shall be suitable with adequate safety factor to inter connect the Solar PV array.
- In each Array Junction box / Combiner box and String Monitoring Unit, 5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided in Fuses and glands.

2.2.2.6 The String Monitoring Units shall be Intelligent, multichannel, industrial grade, reliable, field proven microprocessor based unit. Required operating power shall be made available to the String Monitoring Units from the respective PCSS 110V DC, UPS and 230 V AC Auxiliary power supply system through cable network. DC to DC converter for String Monitoring Unit power supply is also acceptable. Solar power shall be utilized to power the SMU by employing a suitably sized DC-DC converter. The constructional, operational, connectivity and communication features of the SMU are further elaborated in the control and automation section of this specification.

2.2.3 ARRAY YARD AND WATCH TOWER LIGHTING

2.2.3.1 The offer shall include adequate array yard lighting including erection of poles, fixtures and cables as per IS standards, keeping the general security in mind. Watch Tower lightings shall be installed to cover the solar power plant boundary lighting. A minimum illumination level of 10 lux shall be maintained in the internal roads / pathways. It is preferable to adopt low height bollard type road / path way illuminators to avoid shadow on adjoining solar PV modules where ever warranted. The yard lighting and watch tower lighting shall be fed from the station auxiliary power system of the nearest PCSS. The lighting power from each PCSS shall be taken to surrounding road / yard lights and watch tower lights through buried cable network. Automated switching control shall be made available for the yard / road and watch tower lighting system. Array yard lighting schemes and design calculations along with drawings shall be submitted for approval by NLCIL.

2.2.4 DC CABLES

2.2.4.1 DC cables used for inter connecting PV modules and for PV modules to array junction boxes / combiner boxes shall be FRLS, copper conductor cables and shall be electron beam cured with (+) and (-) colour identification, conforming to the requirements of TUV Specification 2Pfg 1169/08.2007.

DC cables used for connecting array junction boxes / combiner boxes to Inverters shall be of suitable voltage DC grade. These cables shall have compacted Aluminium conductor, XLPE insulated, Armoured, FRLS PVC outer sheathed conforming to IS:7098 (Part-1).

2.2.4.2 Sizing of DC cable for PV array shall be selected in such a way that the maximum voltage drop at full power from the first PV module to inverter should be less than +3% (Including voltage drop in module to module interconnecting cable).

2.2.4.3 The Contractor shall design the array yard such that module mismatch loss shall be less than 2% loss in system power.

2.2.4.4 For inter connecting PV modules, no cable joints shall be used. MC4 equivalent/compatible connectors with necessary length of DC cables with positive and negative ends, which are built in component of the PV Modules, shall be used for interconnection of PV modules. DC cables for PV modules to Array junction box/ Combiner box and String Monitoring Unit shall be provided without any cable joints.

2.2.4.5 Cable terminations at Array JB, Combiner Box, SMU shall be made with suitable cable lugs and sockets etc, crimped properly and passed through suitable type cable glands (Double compression) at the entry and exit point of the cubicles. The panel bottoms should be properly sealed to prevent entry of snakes/lizard etc. inside the panel.

2.2.4.6 All cables shall be marked with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

2.2.4.7 Cables shall be fixed to non-moving module mounting structure / column with adequate looping for allowing tilt of the module frame. Bunching of cables and tying to module frame with cable ties shall not be adopted as temperature rise of module frame tend to increase cable power loss and reduce cable life. All cable routed in the array yard shall be laid taking into consideration of undulated, sloppy terrain of the project site. Cable duct bank/hume pipe shall be provided for road crossings. For buried cabling necessary cable markers shall be provided along the route.

2.2.4.8 Cable selection and sizing calculations and detailed explanations along with catalogues shall be submitted for approval by NLCIL.

2.2.5 ARRAY YARD LIGHTNING PROTECTION SYSTEM

2.2.5.1 The Array yard shall be provided with lightning protection system. The lightning protection system must be completed prior to start-up of commissioning activities of the project. The main aim of lightning protection is to protect PV Modules or other sub-system components from any over voltage surge before it reaches the PV

Modules or other sub-system components. The source of over voltage can be lightning or other atmospheric disturbance.

2.2.5.2 The lightning conductors shall be designed as per Indian Standards in order to protect the entire Array Yard from lightning stroke including PCSS structure. Necessary concrete foundation for holding the lightning conductor and spike in position shall be made after giving due consideration to its shadow on adjoining solar PV modules, maximum wind speed and maintenance requirement at site in future.

2.2.5.3 The lightning conductor shall be earthed through flats and connected to the earth mats with earth pits as per applicable Indian Standards. Lightning protection of Early Streamer Emission (ESE) type as per NFC 17-102 is also acceptable. The protection class shall be minimum class II or higher as per NFC 17-102 (2011). Where ever required, Air Terminals shall be provided at the highest point, especially in PCSS as well as in watch towers. Each lightning conductor shall be fitted with individual earth pit as per standards with earth electrode of 3M length including accessories and masonry enclosure with cover plate as per IS 3043. The pit around the electrode shall be treated with carbon based earth enhancement compound or conductive concrete as per provisions of IS 3043. Test links shall be provided in the down conductor as per standards.

2.2.5.4 Design calculations of the lightning system along with drawings shall be submitted for approval by NLCIL.

2.2.6 ARRAY YARD EARTHING SYSTEM

2.2.6.1 The earthing for array yard shall be made with earth electrode of 3 M length including accessories and masonry enclosure with cover plate as per IS 3043. The pit around the electrode shall be treated with carbon based earth enhancement compound or conductive concrete as required as per provisions of IS 3043. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance. Soil resistivity measurement at the project site shall be made by the contractor before commencing the earthing system design.

2.2.6.2 Each Array structure of the Solar PV Yard shall be grounded properly. The array structures are to be connected to earth pits as per IS standards.

2.2.6.3 The complete earthing system shall be mechanically and electrically connected to provide independent return to earth. All equipments shall have two distinct earth connections.

2.2.6.4 For each earth pit, necessary Test Point shall be provided.

2.2.6.5 In compliance to Indian Electricity Rules, (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.

2.2.6.6 The bidder shall ensure adequate earthing system protection to provide an acceptable degree of protection as per IS 3043 for the array yard equipment. If necessary, more numbers of earth pit and conductors may be provided to achieve earthing resistance less than 1 Ohm. Design calculations along with drawings shall be submitted for approval by NLCIL.

2.2.6.7 Earth resistance of the earth pits shall be tested in the presence of the NLCIL officials.

2.2.7 SURFACE PROTECTION AND PAINTING

2.2.7.1 All structures, boxes, panels and all other items except Galvanized and non-metallic items shall be provided with approved scheme of surface paint.

2.2.7.2 Surface preparation - The surface preparation procedure shall be done as per IS: 1477 Part-1C16.2.1.2 for power tool cleaning or equivalent DIN standard st.3 or as per paint manufacturer's recommendation.

2.2.7.3 Paint application

a) Paint shall be applied in accordance with paint manufacturer's recommendation.

b) Paint shall generally be applied by brushing for prime coats and spraying for finish coats.

c) Paint shall not be applied in rain, wind, fog, or at relative humidity of 80% and above or when the surface temperature is below dew point resulting in condensation of moisture.

d) Each coat of paint shall be allowed to dry sufficiently before application of the next coat to avoid damage.

e) After the erection of fabricated steel structures or panels at the plant site, damaged and defective shop coats shall be touched up with the same type paint as used for shop coat after cleaning.

f) If powder coating is followed for the inverter panel and other items, the application shall be in full conformity to paint system of the supplier.

2.2.7.4 Suggested Paint system for Fabricated Steel Structures

No. of coat	DFT/Coat in microns	Paint System	Total DFT in microns
1P	70	Ethyl silicate inorganic zinc primer	220
1I	70	Epoxy MIO	
1F	40	Epoxy paint two pack polyamide cured	
2F	40	Aliphatic Acrylic Polyurethane	

P-primer coat, I-intermediate, F-finish coat, DFT- Dry Film Thickness

The paint shall be applied immediately after surface preparation to the specified quality, preferably within two hours. Prior approval shall be obtained from NLCIL regarding type of paint and manufacturer

2.2.7.5 Colour code -The shade of finish paint coat to be applied shall be as per IS: 5.The colour scheme shall be approved by NLCIL.

2.2.7.6 Cathodic protection may also be incorporated to achieve longevity of structures for surface protection from corrosion.

2.2.8 OTHERS

2.2.8.1 Any array yard work which is not mentioned or included here but necessary for safe operation, maintenance, longevity and improvement in performance of the plant shall be included in scope and carried out.

SECTION 2.3
ELECTRICAL POWER COLLECTION& EXPORT SYSTEMS

2.3.1 POWER COLLECTION SUB STATION (PCSS)

2.3.1.1 The contractor shall provide Power Collection Sub Stations (PCSS) of indoor type which will consist of Transformers, HT circuit breaker and, metering and protection devices.

2.3.1.2 Cables of adequate size shall transfer the DC power for conversion in to AC in the inverters. The location of each PCSS shall be selected in such a way to minimise cable losses.

2.3.1.3 The indoor Power Collection Sub Station (PCSS), shall be RCC building as per section 2.4.

2.3.1.4 The indoor PCSS building shall have PCUs, HT Switch Gear, Auxiliary power (AC&DC) system and other electronics for communication and shall be finalised during detailed engineering in line with system requirement. Cable trench shall be provided between the equipment for connecting external incoming / outgoing cables. The oil cooled transformer which steps up LT power to HT shall be an outdoor installation in a fenced area. HT power from transformer to the HT Switch Gear/ shall also be taken through cabling.

2.3.1.5 POWER CONVERSION UNIT (PCU)

The Power Conversion Unit (PCU) shall be Central inverter / string inverter complying to the statutory norms / CEA regulations /ED/A&N Administration requirements.

2.3.1.5.1 The Power Conversion Units shall consist of an electronic inverter along with associated control, protection and data logging devices. The system shall incorporate a unidirectional inverter and should be designed to supply the AC power to the grid at load end. The power conversion unit shall adjust the voltage and frequency levels to suit the grid. All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency. The PCU shall conform to IEC 62109 or equivalent standards for safety certification. The PCU shall have provision to be isolated from grid through Air Circuit Breakers which shall be inbuilt with the inverter or separate standalone panel.

2.3.1.5.2 PCU shall confirm to IEC 60068-2 standards for Environmental Testing.

2.3.1.5.3 The efficiency of the PCU shall be equal to or more than 98 % at 75% load as per IEC- 61683. The bidder shall submit the conversion efficiency curve on partial output powers for the inverter in his offer. The bidder should specify the overload capacity in the bid.

2.3.1.5.4 The inverter should be warranted for minimum 5 years and the service life of the inverter shall not be less than 25 years under harsh environmental conditions.

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2.3.1.5.5 The PCU inverter shall capable to supply or absorb the reactive power for the grid pf 0.95 lead-lag. The PCU inverter shall also support for grid dynamic power factor of 0.8 lag-lead within its rated KVA capacity. The PCU shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line.

2.3.1.5.6 The PCU inverter shall have the required protection arrangements against earth leakage faults.

2.3.1.5.7. Specifically, the PCU inverter should be three phase power conditioning unit using static solid state components. DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. Isolators used in the DC lines must be rated suitably for DC application..

2.3.1.5.8 The PCU inverter shall be transformer less design with necessary provision for galvanic isolation. Each solid-state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter.

2.3.1.5.9 The PCU inverter shall have special safety features like active anti islanding detection and isolation facility as well as modular system features to harness solar power during lesser irradiation conditions and to maintain equal aging of inverter modular system. The PCUs shall conform to the latest edition of IEEE1547/UL 1741/ equivalent for protection against islanding of grid.

2.3.1.5.10 The PCU inverter must and be able to be successively switched "ON" and "OFF" automatically based on solar radiation variations during the day.

2.3.1.5.11 Inverter system shall tend to balance unequal phase voltage (with 3-phase systems) with reference to the red phase (line-1). Protection shall include negative sequence protection also such that if the balancing of 3 Phase system failed, the protection shall envisage isolation of the inverter from the circuit.

2.3.1.5.12 The PCU inverter front panel shall be provided with a display (LCD or equivalent/ LED + Mobile App Display) of all important parameters such as DC input voltage, DC input current, AC output voltage, AC output current, AC output power, power factor, frequency etc. In addition to the display in PCU panel, the same shall be made available in the monitoring and controlling desk installed in the project control room forming part of the supervisory control and data acquisition system (SCADA) and EMS.

2.3.1.5.13 The PCU enclosure and internals including nuts, bolts etc shall have to be adequately protected, taking into consideration the atmosphere and weather prevailing in the area.

2.3.1.5.14 Dimensions and weight of the PCU shall be indicated by the bidder in the offer.

2.3.1.5.15 The PCU shall include appropriate self protective and self diagnostic feature to protect itself and the PV array from damage in the event of PCU component failure or from parameters beyond the PCU's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices.

It should have local LCD (Liquid crystal display) and keypad for system control, monitoring instantaneous system data, event logs, data logs and changing set points. Control and read-out should be provided on an indicating panel integral to the inverter. Display should be simple and self explanatory to show all the relevant parameter relating to PCU operational data and fault condition in front panel meters / LED's or two line LCD Display.

2.3.1.5.16 PCU shall have arrangement for adjusting DC input current and should trip against sustainable fault downstream and shall not start till the fault is rectified.

2.3.1.5.17 Operation and maintenance manual should be furnished by the Contractor before dispatch of PCUs.

2.3.1.5.18 Bill of materials associated with PCUs should be clearly indicated while delivering the equipment.

2.3.1.5.19 Standby Mode - The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded and that value to be indicated.

2.3.1.5.20 Basic System Operation (Full Auto Mode) - The system shall automatically "wake up" in the morning and begin to export power provided there is sufficient solar irradiance and the grid voltage and frequency is in range.

2.3.1.5.21 Maximum Power Point Tracker (MPPT) – MPPT control algorithm shall adjust the voltage of the SPV array to optimize energy fed into the grid.

2.3.1.5.22 Sleep Mode - Automatic "sleep" mode shall be provided so that unnecessary losses are minimized at night. The power conditioner must also automatically re-enter standby mode when threshold of standby mode is reached.

2.3.1.5.23 Maximum Power Point Tracking (MPPT) - Maximum power point tracker shall be integrated in the power conditioner unit to maximize energy drawn from the Solar PV array at all seasons and in varying solar insolation conditions. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism of MPPT shall be furnished by the Contractor. The MPPT must have provision for constant voltage operation. The MPPT unit shall conform to IEC 62093 for design qualification. Multi MPPT and Master –Slave configuration shall also be considered as applicable. The MPPT shall conform to EN50530.

2.3.1.5.24 The inverter output shall always follow the grid in terms of voltage and frequency. This shall be achieved by sensing the grid voltage & phase and feeding this information to the feedback loop of the inverter. This control variable shall then control the output voltage and frequency of the inverter, so

that inverter is always synchronized with the grid. The inverter shall be self commutated with pulse width modulation technology. The design and operation of inverter shall be such as to limit the individual and total harmonic distortions (THD) within the limits specified in IEEE 519 at HT level and the same shall be demonstrated at site. Additional equipment, if any to meet the above requirement shall be included as part of inverter / HT bus at Power Export Switchyard. Inverter switching scheme shall have in built arrangement to minimize the circulating currents between inverters and the transformer.

Low/High Voltage Ride-Through (LHVRT): The inverter should not get tripped in the event of voltage drop for a pre determined time as per regulatory norms and the inverter need not stay in grid after this pre determined time if the voltage does not develop to a certain percentage of rated value as per regulatory norms.

Low/High Frequency Ride-Through (LHFRT): Immediate disconnections when momentary frequency disturbances should not occur. LHFRT shall allow inverters to stay connected if such frequency excursions are for very short time durations.

Power-frequency droop: Inverters shall not switch off abruptly. Inverters will be required to stay connected when the grid frequency changes after which the inverters are required to shut down.

2.3.1.5.25 Technical Parameters:

Nominal AC Output Power - Output at 0.95 PF :

Minimum 526.32 KVA for 500KW central inverter

Minimum 26.3157 KVA for 25 KW string inverter

VA rating of micro inverter shall be rating of inverter/ 0.95.

Nominal Output voltage	:	To suit.
Minimum Efficiency at 75%load	:	≥ 98%
Output frequency	:	50 Hz +3% to -5% Hz (Inverter to follow grid frequency up to +3% to /- 5% Hz of the nominal output frequency during normal operation)
Power Factor (Adjustable)	:	0.8 Lead to 0.8 Lag
Maximum Input voltage	:	1000 V DC or above
Total Harmonic Distortion (THD)	:	Less than 3 %
Ambient temperature	:	0 to 50deg C
Humidity	:	5% - 95%, non- condensing

2.3.1.5.26 The Inverter shall have following features:

a) No load loss<1% of rated power and maximum loss in sleep mode shall be less than 0.05%

b) Sinusoidal current modulation with excellent dynamic response.

c) VAR control

d) Unit wise and integrated data logging.
e) Dedicated Ethernet for networking
f) Protection against over current, loss of synchronization, over temperature, DC bus over voltage, cooling fan failure
g) Power regulation in the event of thermal overloading
h) Set point pre-selection for VAR control
(i) Provision of Port and protocol for SCADA requirement:
Data Acquisition Systems (DAS) as a combination of a software application programme and electronic hardware for monitoring PV plants and reporting data is required. This can be considered to be a subset of the Supervisory Control and Data Acquisition (SCADA) programme to monitor different datas. This data should be accessible as part of a central database for A&N Electricity department etc. The required protocol for A&N Electricity department is IEC 60870-5-104 protocol and shall be finalised during detailed engineering as per system requirement and A&N Electricity department requirement.
j) Remote control via SCADA and EMS
k) Integrated protection in the DC and three phase system
l) Insulation monitoring of the PV array with sequential fault location.
m) PID monitoring if applicable.
n) Earth Fault Protection – through neutral CT. Alternatively, GFID kit (Ground Fault indication device) is also acceptable.

2.3.1.6 AC BREAKER

2.3.1.6.1 AC converted in the PCUs shall be transmitted through an AC breaker. AC breaker as part of PCU inbuilt is also acceptable. Outgoings of the AC breaker shall be connected to the HT transformer through appropriate size aluminium cables.

2.3.1.6.2 The AC Breaker shall consist of adequately sized ACBs conforming to IS 13947-Part 1&2 and IEC 947-Part 1&2 for circuit breakers of suitable rating for connection and disconnection of PCU from Grid. Suitable capacity breakers shall also be provided for the transformers. The control of the circuit breaker shall be with microprocessor technology and with electro-magnetic compatibility (EMC). The AC Breaker shall be equipped with adequate protection relays, fuses, annunciations and remote operating and controlling facility through SCADA and EMS.

2.3.1.6.3 The Contractor shall submit design calculations and drawings for the AC Breaker for approval by NLCIL.

2.3.1.7 HV POWER TRANSFORMER

2.3.1.7.1 The design, engineering, manufacture and testing of the oil cooled Power Transformer in each PCSS and its related equipment shall be carried out as per the latest Indian /International standards, Indian electricity rules, relevant code of practices and requirement of Central Electricity authority. Salient standards and code of practices are given below:

Power transformers	:	IS 2026, BS 171 and IEC 60076
Guide for loading of oil immersed transformers	:	IS 6600 / IEC 354
Tap changer	:	IEC 60542
Fittings and accessories (if applicable)	:	IS 3639
Insulating oil for transformer	:	IS 335
Bushings for alternating voltages above 1000 volts	:	IS 2099
Dimensions for porcelain Transformer Bushings	:	IS 3347
Recommended practice for hot dip Galvanizing of iron and steel	:	IS 2629
Methods of testing of coating of zinc coated items	:	IS 2633
Colour for ready mixed paints and Enamels	:	IS 5

Except where specified otherwise herein, all material, equipment and construction shall confirm to all the acts, rules and standards indicated.

2.3.1.7.2 Technical Particulars

The transformer offered shall meet the following technical particulars:

Service	:	Outdoor
Rating	:	To suit.
Cooling	:	ONAN
Voltage ratio	:	To suit
Number of phase	:	3
Primary Voltage	:	To suit
Secondary Voltage	:	HV as per requirement
Winding connection, Vector group	:	As per design requirement of the solar PV plant and actual requirements of A&N Electricity Department
Impedance voltage	:	To suit the system requirement.
HT short circuit level	:	As per system requirement.
System earthing at HV	:	As per system requirement.

System earthing at LV	:	As per system requirement.
Highest system voltage	:	As per system requirement
Insulation level HV	:	As per system requirement
Tap changers and Tapping	:	Off circuit type, with +/-2.5 % and +/- 5% taps. (5 Positions)
Temperature rise, degree C		
Top oil, by thermometer	:	45 degree C
Winding, by resistance	:	55 degree C
Terminal arrangement	:	Cable box on HV side for terminating XLPE, armoured, Al cable. Cable box on LV side for terminating XLPE, armoured Al cable.
Neutral	:	As per ED/A&N Administration requirements /system requirements

2.3.1.7.3 The transformer shall be of proven design and robust maintenance free construction featuring liberal use of active materials viz. core iron and copper to keep down losses at low levels and consequently the operating temperature well within the limits of oil cooled transformers.

2.3.1.7.4 Constructional Features

i) The transformer shall be designed to withstand the extremes of all magnetic, electrical, mechanical and thermal stresses and gas pressures which may be encountered during its normal and abnormal operating conditions.

ii) The transformer shall be capable of withstanding the short circuit stresses due to a terminal fault on any one winding with full voltage maintained on the other windings for minimum period for three (3) seconds.

iii) The transformer shall be capable of working at high efficiency in both the directions of power flow.

iv) All materials used shall be new and of tested quality conforming to applicable national or manufacturer's standards and Indian Electricity Acts/rules. Equipment shall be transportable and capable of installation at site with ease and without damage. It shall give continuous reliable operation over long periods under worst specified site conditions. All similar parts shall be interchangeable.

2.3.1.7.5 Tanks

2.3.1.7.5.1 Tanks shall be welded construction and fabricated from tested quality commercial grade carbon sheet steel of adequate thickness. The transformer tank top shall be provided with detachable cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover with core and coil

assembly. Tank covers shall be welded from tested MS flats adequately reinforced externally by structural steel stiffeners. Two side walls of the tank shall be provided with extended finned tubes to act as a radiator. All seams, flanges, lifting lugs, braces and permanent parts attached to tank shall be double welded. Joints which may have to be opened for inspection and/or repairs shall be machined surface and be made oil tight with renewable oil resistant gaskets and seals. Guides shall be welded to the inner side of the tank to facilitate tanking and un-tanking. Tank shall be suitable for full vacuum required during drying out for oil filling and shall withstand the required pressure.

2.3.1.7.5.2 All removable covers shall be provided with weather proof, hot oil resistant, resilient gaskets. The openings for all removable covers shall be made on suitably elevated bosses/contour frames. The design shall be such as to prevent any leakage of water into or oil from the tank.

2.3.1.7.5.3 Adequate space shall be provided at the bottom of tank for collection of sediments.

2.3.1.7.5.4 After fabrication and welding of cooling fins, tank and its fittings with respective valves shall be pressure tested with transformer oil to withstand specified pressure. No valve shall drip and no weld or joint shall sweat.

2.3.1.7.5.5 All gasket joints shall be perfectly oil tight under all conditions of operations. Gaskets shall be of neoprene or approved oil resistant material and so placed that they will not be exposed to weather. Damaged gaskets shall not find way into the tank.

2.3.1.7.6 Core

2.3.1.7.6.1 The core shall be constructed from high grade, cold rolled, non- aging, grain oriented, silicon steel laminations to BS: 601. Core, its supporting steel and insulation shall be of such design, material and construction that harmful changes in electrical or physical properties shall not occur during the life of transformer. Limbs and yoke shall have similar section to minimise effects of transverse flux. Butt joints between yoke and limbs shall not be made. Generous cooling ducts shall be provided for core heat dissipation.

2.3.1.7.6.2 Core and winding shall be strongly braced to prevent displacement or distortion during transportation or abnormal electrical conditions in service. The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short circuit stresses.

2.3.1.7.6.3 Each core bolt and parts of core clamping framework shall be insulated from the core laminations and tested after assembly of core to withstand 2 kV RMS for one (1) minute. Preference shall be given to such construction of core, which does not involve use of core bolts. The core design shall be such as to limit the flux density to 1.6 Tesla.

2.3.1.7.7 Windings

2.3.1.7.7.1 Each coil shall be wound of paper insulated, continuous smooth, high grade, electrolytic copper conductor, without sharp corners or bends and shall be adequately transposed to minimize eddy current losses and equalize current and temperature distribution. Successive coils may be smoothly brazed or welded in an accessible location. Abrasive damage and high dielectric stresses in insulation shall not occur. Similar coils shall be interchangeable. Liberal ducts shall be provided for oil circulation and prevention of 'hot spots' that may

affect insulation life. Insulation of windings and other live parts should be adequate to sustain 110% of rated operating voltage continuously.

2.3.1.7.7.2 An earthed screen shall be installed between the primary and secondary windings to capacitatively decouple primary and secondary windings and eliminate the effects of high frequency transients on the other winding

2.3.1.7.7.3 The coils shall be manufactured from electrolytic copper conductor. The materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically in-active in the hot transformer oil and shall not soften or otherwise be affected under the worst operating conditions. Insulating material shall be of proven design, Coils shall be so insulated that impulse and power frequency voltage stresses are minimum

2.3.1.7.7.4 Coil supports shall be by permanently secured, highly compressed and dried, regularly spaced insulating spacers. Coil clamping rings, if made of steel shall each be earthed by connection to core clamping structure and shall otherwise be of insulating material built up from flat laminations.

2.3.1.7.7.5 Coil assembly shall be suitably supported between adjacent sections by insulating spacers and barriers. Bracings and other insulation used in assembly of winding shall be arranged to ensure free circulation of oil and to reduce the hot-spot of winding.

2.3.1.7.8 Fasteners

2.3.1.7.8.1 Clamping bolts for current carrying parts inside oil shall be of oil acidity resistant material. Terminal screws, studs, nuts and bolts shall be of non-ferrous material, threaded to IS. All fasteners exposed to weather shall either be nonferrous or hot dip galvanized or electroplated conforming to relevant IS.

2.3.1.7.9 Cooling

2.3.1.7.9.1 The transformer shall be provided with finned tube radiator panels on two sides to cool the oil.

2.3.1.7.9.2 The finned tubes shall be of heavy gauge, corrosion resistant steel construction. All internal surfaces of the tubes shall be pickled, free of all rust and scale and passivated. External surfaces shall be sand blasted and required number of coats of weather proof paint applied so as to prevent rusting.

2.3.1.7.10 Bushings

2.3.1.7.10.1 Oil communicating type porcelain bushing and its terminal fittings shall carry full rated current continuously without exceeding temperature of any component beyond 70^{o}C. These shall operate satisfactorily in heavy sand storms, rain with lightning and other site atmospheric conditions. Freedom from corona and radio interference shall be ensured. Bushing shall be wet process porcelain with uniformly brown external shell. All bushings shall be designed or equipped to withstand arcing or flashover without damage to seals or any vital part. Terminal bushing shall be oriented for the minimum clear distances in air as per CBIP stipulation. Minimum distance between terminals of two windings of different voltage shall equal the phase-to-phase distance of the HV winding.

2.3.1.7.10.2 Bushings shall be provided with terminal connectors of approved type and size. Bushing location shall provide adequate phase and ground clearances. Bushings shall be suitable for surrounding atmosphere and shall have creepage distance.

2.3.1.7.11 Cable box and disconnecting chamber

2.3.1.7.11.1 On the HV side cable box, disconnecting chamber shall be provided for disconnecting and moving away the transformer without unsealing the cables or draining oil from the main tank leaving the cable box and part disconnecting chamber behind on external supports supplied by the vendor.

2.3.1.7.11.2 The HV cable box shall be complete with other accessories including armour and earthing clamps. The box shall be suitable for heat shrinkable type/push on type/tapex type termination kits of proven design against short circuit levels of as per standards for one second with a peak value as per standard.

2.3.1.7.11.3 The disconnecting chamber shall be air insulated, removable links and removable covers shall be provided for the disconnecting chamber. Plates through which high current carrying conductors pass, shall be of non- magnetic materials.

2.3.1.7.11.4 Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or cable to be subjected to HV tests. Clearances shall be subject to approval by NLCIL.

2.3.1.7.11.5 LV cable boxes shall be of steel plate construction, self-supporting weather proof type complete with all accessories including brass cable glands & tubular copper lugs to receive number of 1.1kv grade Aluminium XLPE cables to suit.

2.3.1.7.12 Marshaling box

2.3.1.7.12.1 The marshaling box shall be corrosion resistant sheet steel, weather proof, dust and vermin proof construction conforming to degree of protection IP55 with 16 SWG thick sheet steel water tight hinged and padlocked doors, fully wired, for terminating all wiring for control, protection and alarm circuits of the transformer. All wiring shall be of 1100V grade, oil and fire resistant, multi core copper cables. All devices and terminal blocks within the marshaling box shall be identified by symbols corresponding to those used in applicable schematic or wiring diagram.

2.3.1.7.13 Insulating Oil

2.3.1.7.13.1 Transformer shall be filled with mineral insulating oil conforming to IS: 335. Material in contact with the oil shall be such as not to contribute to the formation of acid in oil.

2.3.1.7.14 OFF Circuit Tap Changers

2.3.1.7.14.1 OFF circuit tap changers suitable for variation of secondary (constant flux voltage variation) shall be provided on the primary Windings. The range of taps shall be as specified. The transformer shall be capable of operation at its rated KVA on any tap provided the voltage does not vary by more than ±10% of the rated voltage corresponding to the tap. The winding including the tapping arrangement shall be designed to maintain electromagnetic balance between two primary and one secondary windings at all voltage ratios. The tap switches shall be of robust construction, of adequate rating, capable of repeated operation and of withstanding short-circuit forces. All contacts shall have ample area and shall be held in position under strong contact pressure to avoid contact pitting.

2.3.1.7.15 Grounding

2.3.1.7.15.1 Two grounding pads, located on the opposite sides of the transformer tank, shall be provided for connection to station ground mat. The core coil assembly shall be directly connected to this ground bus by removable bolted link for effective grounding. Ground terminals shall be provided on marshaling box, cable end box etc. to ensure its effective earthing. For continuity of earth connection, all gasket joints shall be provided with minimum two numbers braided copper conductor jumpers of adequate size.

2.3.1.7.16 Fittings and Accessories

2.3.1.7.16.1 The transformer shall be complete with oil for first filling and all standard fittings and accessories as per IS 2026 including the following:

1. First fill of oil as per IS2026 with 10% extra oil

2. Oil conservator with filling hole, cap, and air cell separator for the main and OLTC oil compartments
3. Drain plug for conservator
4. Magnetic oil level gauge with alarm contacts
5. Prismatic oil level indicator
6. Silica gel breather for conservator
7. Double float Buchholz relay with alarm and trip contact
8. Shut off valve for Buchholz relay on both sides
9. Dial type oil temperature indicator with alarm, trip contacts and maximum temperature indicator
10. Dial type CT operated winding temperature indicator with alarm, trip contacts and maximum temperature indicator
11. Thermometer pockets
12. Pressure relief valve with trip and alarm contacts
13. Air release vent, drain plug for radiators.
14. Flanged filter valve at top and bottom
15. Lifting lug and jacking pads
16. Rating and terminal marking plate
17. Bi-directional flanged wheels
18. Detachable radiators complete with top and bottom valves

2.3.1.7.17 Paint and Finish

2.3.1.7.17.1 All surfaces to be painted including interior and exteriors of tanks, mechanisms and enclosures and other metal parts. These shall be shot or sand blasted or chemically treated to remove all rust, scale, grease and other adhering foreign matters. All steel surfaces in contact with hot insulating oil, shall be painted with not less than two (2) coats of heat resistant and oil insoluble paint. Steel surfaces, exposed to weather shall be given two (2) coats of zinc chromate and two (2) coats of finishing paint light grey No. 631 of IS:5 with glossy finish except for panels which shall have matt finish. The final finished thickness of paint film on steel shall not be less than 100 microns and shall not be more than 150 microns

2.3.1.7.18 Tests and Inspection

2.3.1.7.18.1 The transformer shall be designed and manufactured to national and international standards. After manufacture, it shall be subjected to inspection and testing in the manufacturers' works which should be accredited by the National testing laboratory and tests as per MQP sampling shall be carried out in the presence of the NLCIL Engineer. The various tests to be carried out shall be as follows:

1. Assembly inspection
2. Measurement of winding resistance
3. Measurement of voltage ratio
4. Check of vector group

5. Measurement of impedance voltage, short circuit impedance and load loss
6. Measurement of no load loss and no load current
7. Temperature rise test
8. Separate source voltage withstand test
9. Inducted over voltage withstand test
10. Verification of type test reports for short circuit, impulse voltage and partial discharge tests

The contractor shall furnish type test reports of the transformer for NLCIL approval. The contractor shall also arrange to conduct site tests including ratio test, etc. after installation.

2.3.1.7.19 Performance Guarantee

2.3.1.7.19.1 The transformers shall be guaranteed for workmanship, materials and satisfactory performance in respect of voltage ratio, load / no load losses, heating etc. for a minimum period of twelve (12) months from date of Provisional take over. The guarantee for performance shall be inclusive of individual component parts and the equipment as a whole for their ratings/output as well as for the operation of the transformer. If it fails to meet the performance requirements due to defective material and workmanship, the same shall be replaced free by the contractor.

2.3.1.8 **HT Breaker**

2.3.1.8.1 Standards and Construction Features

The HT switchgear distribution board shall conform to IS 3427, IS 12729 and IS 13118 for all essential features of design, construction and testing. The board shall be factory assembled and wired, totally enclosed, dead front, draw out type, fully interlocked and compartmental design.

2.3.1.8.1.1 The switchgear must provide a maximum degree of personal safety and operational security for the operators and others in the vicinity of the switchgear under all operating and fault conditions. To fulfil the high safety requirement for personnel, the switchgear insulation must be designed to provide the best possible protection in the event of an arc fault. To ensure this condition, all compartments of the switchgear shall satisfy the requirements of IEC 298.

2.3.1.8.1.2 The products of the arc shall not transport from one compartment to another. There must be no danger to any person standing at the front or to the side of the switchgear, caused by the venting of hot gases or the scattering of other products of the arc. The circuit breaker compartment shall also meet the above test requirement while the circuit breaker is being raked in or out of service.

2.3.1.8.1.3 The bus bars shall be of electrolytic grade copper, air insulated and housed in a separate metal clad chamber at the top. The bus bars shall be provided with insulation sleeving rated for full system voltage. Adequate electrical clearances between live parts and between live part and earth shall be provided. The cross

section of bus bars shall be adequate to limit the temperature rise to 45degC over ambient of 50 deg C while carrying rated current.

2.3.1.8.1.4 The cable compartment shall be located at the bottom and shall be accessible through bolted cover plates at the rear. The current transformers shall also be located in the cable compartment.

2.3.1.8.1.5 The HT switchboard shall be provided with earthing truck or earthing switch with safety interlock features for bus earthing and outgoing cable earthing. The earthing switch / truck shall be interlocked with the circuit breaker so that it can be closed only when the circuit breaker is racked out to isolated position. The interlock shall also ensure that the cable side or bus side is dead before earth switch is closed through voltage metering facility, audio visual alarm and holding solenoid.

2.3.1.8.1.6 A copper earth bus shall be provided at the bottom of the switchboard throughout its length. The switchboard, devices and terminal blocks shall be provided with legibly engraved inscription plates for identification. The switchboard shall be provided with caution notice boards conforming to IS 2551 in the front and rear.

2.3.1.8.1.7 The circuit breaker compartment of the switchboard shall have a fixed and a moving portion, fixed portion being part of the switchboard. The moving portion shall contain the circuit breaker of horizontal draw out design mounted on a truck. The circuit breaker compartment shall have a front hinged door after opening of which the circuit breaker shall be accessible.

2.3.1.8.1.8 The design of the board shall permit the moving portions to be withdrawn and provide for isolation of the main contacts by means of plug and socket connections. Automatic safety shutters shall be provided over the isolating contacts in the stationary portion and shall be so designed as to close firmly over the contacts when the circuit breaker is in drawn out position. The draw out mechanism of the circuit breaker shall have Service, Isolated and Test positions

2.3.1.8.1.9 In the design of the switchgear, the following positive inter-locking shall be provided:

2.3.1.8.1.10 Interlock to prevent movement of truck to “Service” position without engaging secondary plug socket connections.

2.3.1.8.1.11 Interlock to prevent disconnection of secondary plug socket connection in “Service” position.

2.3.1.8.1.12 Interlock to prevent withdrawal of truck past “Isolated” position without disconnecting secondary plug socket connection.

2.3.1.8.1.13 Interlock to prevent switching ON of breaker unless truck is properly engaged in “Service” or “Isolated” positions.

2.3.1.8.1.14 Interlock to prevent movement of truck to “Test” position

2.3.1.8.1.15 Interlock to ensure that the breaker truck is in “Isolated” position before closing the integral earth switch if provided.

2.3.1.8.1.16 Interlock to prevent insertion of truck to “Service” position with earth switch “ON”.

2.3.1.8.1.17 Interlock to prevent opening of cubicle door with the breaker “ON” while in “Service” position.

It shall be possible to achieve “Service” and “Isolated” positions of breaker truck with compartment door closed.

Front door shall be interlocked with the breaker such that the door cannot be opened with the circuit breaker in service position or can the circuit breaker inserted into the service position with door open. It shall be possible to defeat the interlock with use of tools if this becomes necessary.

2.3.1.8.2 Technical particulars of HT Circuit Breaker

2.3.1.8.2.1 The circuit breaker shall be HT, required continuous 120% of load current and short circuit rating required for 1 second rated, fully interlocked horizontal draw out design. The circuit breaker shall be of vacuum design. The circuit breaker shall have motorized spring charged closing mechanism of trip free design with provision for manual closing, manual tripping and mechanical ON/OFF indicators. The circuit breaker shall be of tested and proven design and the bidder shall furnish type test certificates for short circuit making and breaking capacities, electrical and mechanical endurance tests and power frequency and impulse voltage withstand tests for the circuit breaker panel. The circuit breakers and accessories shall conform to IEC- 62271-100 or equivalent Indian Standard.

2.3.1.8.2.2 The duty requirement of the Circuit breaker shall be C2/M1class under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on HT effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily. The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to HV transformers. It shall also be capable of breaking line charging currents as per IEC- 62271-100 with a voltage factor of 1.4. The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC: 62271-100.

2.3.1.8.2.3 The Contractor shall indicate the noise level of breaker at a distance of 50 to 150 m from base of the breaker.

2.3.1.8.2.4 The contractor may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage etc. While furnishing the proof of the total break time of complete circuit breaker, the contractor may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time. While furnishing particulars regarding the D.C. component of the circuit breaker, the Contractor shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation. The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated. All the duty requirements specified above shall be provided with the support of adequate test reports.

2.3.1.8.2.5 Operating Mechanism - Circuit Breaker of vacuum type shall be with electrically spring charged mechanism. The operating mechanism shall be electrically and mechanically operated with anti-pumping and trip free (as per IEC definition) under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the failure in vacuum. The circuit breaker shall be able to perform the duty cycle without any interruption. Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. “Local / remote” selector switch and close & trip push buttons shall be provided in the breaker control cabinet. Operating mechanism and all accessories shall be in control cabinet.

2.3.1.8.3 The technical particulars of the switch board shall be as follows:

Nominal system voltage	:	HT
Highest system voltage	:	As per standards
Phase	:	3
System frequency	:	50Hz
System earthing	:	As per standards
Type of circuit breaker	:	Vacuum
Continuous rating of CB in enclosure:		As per standards
Continuous current rating of bus bar	:	As per standards
Short circuit interrupting capacity of CB	:	As per standards
Power frequency withstand voltage	:	As per standards
Impulse withstand voltage	:	As per standards
Degree of protection of enclosure	:	IP 4X
Terminal arrangement	:	HT Cable on the outgoing side, XLPE insulated , Al conductor armoured, PVC sheathed HT grade cable.

2.3.1.8.4 Accessories

Current transformer : Require sets of current transformers on the incoming and outgoing feeders as per IS-2705/IEC-185, each having two secondary cores of ratios as per system requirement.

The primary and secondary current limits and other technical parameters of the CTs shall be compatible with the protection relays.

One (1) additional CT core of 0.2 S class shall be provided in the outgoing breaker as redundancy for metering.

Potential transformer : One set of PT as per IS-3156/IEC-186, having two secondary cores of ratios and class of accuracy as per standards. The PT shall be mounted on the outgoing side and shall have fuse protection. PT shall be accommodated in a separate compartment in the breaker enclosure.

Instruments and meters : Electronic multi function energy meter to read current, voltage, kW, kVA, kVAr, kWh, power factor etc., in the incoming feeder and ammeter with selector switch in case of outgoing feeders.

Protective relays : Microprocessor based numeric protection relays for multi characteristic inverse minimum time/current type over current and earth fault protection with numerical display of setting values, measured values, memorized fault values and software self supervision with auto diagnosis. The relays shall have communication port for hooking up to PSS (pooling substation) SCADA. The protection relays shall have the data transfer interface conforming to the IEC 61850 communication protocol. One set of trip circuit supervision relay and one set of high speed trip relay shall also be provided. The protection relays shall be provided with non-volatile memory for preserving important data during auxiliary supply breaks.

Other devices : Requisite number of LED type indication lamps, breaker control switches, HRC fuses and other devices.
Control and trip power supply for the HT switchgear shall be derived from 110 Volts DC and from the station auxiliary supply switch board at 230V single phase AC to ensure availability of trip supply at all times including when there is a terminal short circuit.

2.3.1.8.5 Inspection and Tests

After manufacture, the switchgear panel shall be subjected to inspection and testing in the manufacturers' works in the presence of NLCIL Engineer. The various tests to be carried out shall be as follows.

1. Operation test
2. Power frequency voltage test
3. Measurement of resistance of main circuit
4. Functional test on control circuit.
5. Insulation Resistance (IR) value test.
6. Verification of type test reports for the following tests:
    - Short circuit making and breaking currents
    - Peak withstand current and short time current
    - Small inductive breaking current
    - Impulse voltage withstand
    - Electrical endurance
    - Internal arc test

2.3.1.8.6 Instruments and Meters

2.3.1.8.6.1 All instruments and meters shall be of robust design, vibration proof and suitable for flush mounting on vertical panels.

2.3.1.9 PROTECTIVE RELAYS

The protective relays shall be as per CEA norms and it shall be designed to meet system requirements and Grid requirements. It shall be finalized during detailed Engineering.

2.3.1.10 110 V DC SYSTEM - PCSS

2.3.1.10.1 Each PCSS shall be provided with suitable capacity 110 V DC system for meeting the power requirement of switchgears, control panels, Inverter Monitoring Units (IMU), etc in each PCSS and respective String Monitoring Units (SMU) in the yard. 110V (AC) UPS system instead of 110V DC system shall also be acceptable to meet the system requirements.The battery together with the charger and DCDB shall be suitable to meet the DC load. The basic design data for battery and battery charger shall be as given below:

2.3.1.10.2 Battery

Type of cell : Valve regulated lead acid type (VRLA) only and the battery shall be located in the ventilated room for RMU.

Nominal DC voltage : 110V DC

Load : To meet the requirements of breakers, ventilation fans, system panels, IMU and SMU.

Battery capacity : Ah to suit based on 10 hour rate of discharge

Duty : Sub Station duty

End cell voltage : 1.85 Volts (C10 or higher battery

Shall be selected to achieve the same).

Ampere hour efficiency : Better than 90%

Watt hour efficiency : Better than 80%

Self discharge : Not to exceed 1% per week.

Accessories : Battery rack made of acid resistant paint coated steel sheet

Set of lead coated heavy-duty copper strips with bolts and nuts as inter cell and inter row connectors

Cell testing voltmeter

Thermometer with temperature correction chart

Back up: The 10 hours backup time for the 110V DC system in PCSS.

2.3.1.10.3 Battery Charger

2.3.1.10.3.1 The battery charger shall be designed for charging the battery in float as well as boost modes and simultaneously supplying the continuous load current indicated in the duty cycle. The charger shall be designed to operate with input voltage from auxiliary power of 415V $\pm$10%, 3 phase, 50 Hz +5%/-3% with an output voltage shall be 110VDC $\pm$1%.

2.3.1.10.3.2 The charger shall consist of input switchgears, two winding transformer, SCRs and diodes, regulator, filter circuit, output switchgear, metering and protective devices for under voltage, over voltage and earth fault, alarm indicator circuit and integral DC distribution board. All necessary indications and meters like AC voltmeter, DC voltmeter, DC ammeter etc. shall be provided. Indication for DC battery connected to load shall also be provided.

2.3.1.10.3.4 Both float and boost chargers shall have control device to vary the voltage to achieve the desired output.

2.3.1.10.3.5 The output voltage of bridge for float charger shall be 120V DC max. The output voltage of the bridge for boost charger shall be 145V DC max.

2.3.1.10.3.6 The charger shall be provided with auto-changeover circuitry from float to boost and vice versa in addition to manual changeover switch. The float circuit shall be designed for supplying the continuous load current as well as charge the battery. The boost circuit shall be suitable for delivering charging current suitable for 110V, battery. RMS ripple factor in input voltage of the charger shall not be more than 3%.

2.3.1.10.3.7 The charger shall be provided necessary communication port for interfacing with plant SCADA for remote monitoring and control through Station Facility Controller.

2.3.1.10.3.8 DC Distribution Board (DCDB)

a) The DCDB shall form an integral part of main battery charger. It shall be compartmentalized; dust & vermin proof and shall be equipped with main incoming switch fuse unit and required number of double pole MCBs and switch fuse units.

b) The utilization category of the DC switching devices shall be based on the individual loads as recommended in IS 13947.

2.3.1.10.3.9 DC Battery, charger, DC power distribution system and remote control / monitoring design, calculations and drawings shall be submitted for approval by NLCIL.

2.3.1.11 Auxiliary AC Power Supply

2.3.1.11.1 For 110 V DC system battery chargers, lighting, UPS , operation of ventilation fans, and other system loads, auxiliary power at 415 V 3 Phase 50 HZ power will be obtained from a PDB in all PCSS with necessary metering.

To meet auxiliary power requirement of the plant such as lighting, water pumps, battery charger, UPS, switchgear panels, AC & Ventilation etc., the contractor has to provide auxiliary power supply to each PCSS. Auxiliary supply arrangements shall be finalized during detailed Engineering in line with approved design and system requirements.

2.3.1.11.2 The Control and trip power supply for the AC switchgear feeding the winding transformer as well as the HT circuit breakers in each PCSS shall be derived from DC supply. If the control and trip power supply is AC then the same shall be derived from auxiliary power ACDB of the Inverter Room. To ensure availability of trip supply at all times including when there is a terminal short circuit, a storage capacitor power pack shall be provided. The sizing of capacitor shall be such as to ensure adequate charge for at least 3 consecutive shots of tripping without recharging.

2.3.1.12 Ventilation System

2.3.1.12.1 The Power Conversion Unit of PCSS shall be equipped with appropriate fan powered ducted ventilation system for effective heat dissipation. The system shall be designed to draw air from the compartment through filter and pass through thyristor cubicle and exhaust to outside atmosphere through suitable ducting arrangement such that the heat generated by the inverter is directly evacuated without heating other equipment and panels in the compartment. The battery bank shall also be enclosed and a separate ducted exhaust system shall be provided to prevent acidic fumes to enter the compartment. Provision shall be made to allow fresh air from outside to enter the compartment through suitable filter capable of preventing entry of sand during severe sand storms. The ventilation system fans shall be mounted on side walls with suitable sand filter / louver having easy access for cleaning and maintenance. The Battery bank shall have suitable exhaust system.

2.3.1.12.2 Power for the Ventilation system shall be fed from the auxiliary power supply system and will be automated to run during power generation period only. The operation, control and status monitoring of ventilation system shall be feasible from SCADA & EMS through HT kV / 415 V SS RTU. Ventilation system design, scheme, calculations and drawings shall be submitted for approval by NLCIL.

2.3.1.13 PCSS Lighting

2.3.1.13.1 LED lamp fixtures shall be indoor type and pre-wired comprising of Lamp(s) with lamp holder(s), Electronic powering unit(s) and metal reflector(s). The lamp fitting shall be covered by Glass or Perspex material.. The number of lighting fixtures should be such that it should give sufficient luminance level for comfortable operation as per BEE standards. All the switches shall be of modular type

2.3.1.13.2 Lighting Power System in each PCSS for powering the lights inside PCSS, yard lights and watch tower lights near each PCSS shall be derived from Auxiliary power system PDB with necessary controls and cabling. All outdoor lighting circuits will be controlled through industrial timers provided at LDBs.

2.3.1.13.3 PCSS Lighting and Lighting Power System design, calculations and drawings shall be submitted for approval by NLCIL.

2.3.1.14 Cables and Wires

2.3.1.14.1 HT Cables

2.3.1.14.1.1 The HT cable used in the work shall be XLPE insulated aluminium conductor flat steel armoured PVC insulated type rated for HT grade manufactured and tested to IS: 7098 part 1 and 2- 1985.

2.3.1.14.1.2 The insulation for the conductor shall be of high quality XLPE compound. The insulation shall be applied through an extrusion process and chemically cross linked in continuous vulcanizing process. The cable shall be shielded with metallic tape over the extruded semi-conducting shield. The cores shall be identified either by colour tape along the insulated core or running a number tape along the conductor. The cable shall be provided with inner sheath either with suitable fillers in the interstices and covered with a common tape or an extruded sheath of required thickness. Armouring over the inner sheath shall be provided with flat steel strips or steel wire. Outer sheath for the cable shall be provided with heat resistant PVC compound to IS: 5831. The outer sheath shall also be extruded over the steel armouring. The colour of the outer sheath shall be black or orange.

2.3.1.14.1.3 The cable shall undergo the following type tests and copy of type test certificate shall be submitted to NLCIL for approval and it shall be subjected to inspection and testing in the manufacturer works in the presence of NLCIL engineers.

- Tensile test
- Conductor resistance test
- Physical test for insulation
- Physical Tests For PVC sheath
- Wrapping test
- Test for armour wire/ flat steel strip
- Test for insulation resistance test
- Dielectric power factor test
- High voltage test.
- Routine and acceptance test.

2.3.1.14.1.4 Manufacturer's identification mark, NLCIL mark along with ISI certification mark shall be printed on the outer sheath of the cable as stipulated in IS 7098 part1 and part 2 of 1985 as applicable.

2.3.1.14.2 LV Power Cables

2.3.1.14.2.1 All LV power cables used in the work shall be armoured cables unless otherwise stated and of 1100 V Grade. All cables shall be of XLPE insulated and flat steel or steel wire armoured cables manufactured to IS: 7098 1988 part I and PVC insulated and PVC sheathed Armoured cable in conformity with IS: 1554 of 1988 part I. The cables shall be identified as XLPE/SWA or SFA/PVC for XLPE cables and PVC/SWA/PVC for PVC insulated cables. The insulation used in manufacturing the LV Power Cables shall be of flame retardant and low smoke generating material.

2.3.1.14.2.2 The cable used in the work shall be as far as possible of one manufacturer only. The cables used in the yard shall be delivered to the site as complete coiled drums/coils with wrapping seals intact. The contractor shall provide manufacturer's test certificate and date of manufacture at the time of delivering the cables to the site. All multi-core cable drums shall be from manufacturer and unwound cables delivered to site shall not be approved for installation

2.3.1.14.2.2 The cable conductor shall be of electrolytic pure grade Aluminium conforming to IS 8130 of 1984.

2.3.1.14.2.3 All cables shall be fitted with suitable compression or packing ring to protect the same from ingress of water and moisture. All glands shall be provided with locking nut, earth tag and PVC cable shoe/shroud. PVC insulated earth continuity conductors of appropriate size in conformity with Indian Electricity Rules shall connect all earth tags 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.

2.3.1.14.2.4 The compression type cable lugs shall be used for terminations. The Crimping termination of the cables shall be carried out with the help of correct compression type crimping tool with proper size dies. The compression tools and terminations materials shall be from a single manufacturer and care shall be taken to adhere to manufacturer's recommendations. PVC shoe/ shroud shall be fitted to cable terminations to prevent dust and moisture entry into terminations.

2.3.1.14.2.5 Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted.

2.3.1.14.2.6 All LV cables shall be tested for insulation resistance and continuity test at two stages.

2.3.1.14.2.6.1 Insulation and continuity test before after laying but before backfilling.

2.3.1.14.2.6.2 Insulation and continuity test after backfilling.

In addition, Insulation resistance test shall be conducted to measure the insulation resistance between phase conductors and between each phase conductors and earth. The resistance shall be measured with the help of megger by applying 1000 volts for duration as specified by relevant standards. Earth continuity tests to confirm that the cable armouring has been properly bonded to earth shall be carried out. Phase rotation test shall be conducted to prove that the cables have been properly connected.

h) Cable shall be laid in the cable trench in PCSS building, routed in cable trays on the module frames and Combiner box / Array JB support frames and shall be buried in the yard with suitable protection. The type and specification of the cable tray used and cable burying scheme shall be submitted for approval by NLCIL before commencement of work.

2.3.1.14.3 LV Wiring Cables

2.3.1.14.3.1 The low voltage wiring cables shall be PVC insulated single core, colour coded, stranded Copper conductor rated for 1100 V and conforming to IS 694 and IEC 227.Conductor strand diameter and resistance of the conductor shall be in conformity with IS: 8130 of 1984. The insulation used in manufacturing the cable/wires shall be of flame retardant and low smoke generating material.

2.3.1.14.3.2 The stranded conductor shall be made of thin strands of electrolytic copper not less than 0.25mm. The number of strands shall be suitable for the size of the cable. However the minimum number of strands shall be as follows:

Size of the wire	Thickness of the conductor	No. of Strands.
1.5 Sq. mm	0.25 or 0.3 mm	32 or 22
2.5 Sq. mm	0.25 or 0.3 mm	50 or 36
4.0 Sq. mm	0.3 mm	56
6.0 Sq. mm	0.3 mm	84

2.3.1.14.3.3 All wiring for connecting various fittings shall be through steel conduits of approved make. All Tees, Bends etc shall be of standard make. Approval for materials should be obtained from NLCIL.

2.3.1.14.4 Control, Data, FAS and Communication cabling shall be selected to suit the system configuration adopted by the contractor and as discussed further in automation and control system of this specification. The cabling and accessories for the same shall confirm to relevant IEC/ IS codes and practices.

2.3.1.14.5 Cable terminations shall be made with suitable cable lugs & sockets etc, crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles. The panel bottoms should be properly sealed to prevent entry of snakes/lizard etc. inside the panel.

2.3.1.14.6 All cable/wires shall be marked with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

2.3.1.14.7 Cable sizing shall be based on voltage drop not exceeding 1% on DC side and not exceeding 3% on AC side between source and load. Power and Control cabling and wiring design and calculations with drawings shall be submitted for approval by NLCIL.

2.3.1.15 Fire Protection and Control System

2.3.1.15.1 Each Power Collection Sub Station shall be provided with adequate number of smoke / fire detectors forming part of Plant Fire Detection and Alarm System. Zonal repeater panel shall be provided in PCSS with alarm and visual indication facilities.

2.3.1.15.2 Suitable capacity portable DCP type fire extinguishers shall be provided in each compartment of PCSS for fighting electrical fires.

2.3.1.16 Lightning Protection

2.3.1.16.1 The Power Collection Sub Station shall be provided with Lightning protection. The lightning protection system must be completed prior to start-up of commissioning activities of the project.

2.3.1.16.2 The Lightning protection system for PCSS shall comprise of lightning conductors on the roof with spike rods at the highest point above roof. The system shall be designed as per Indian Standards / IEEE in order to protect the entire Power Collection Sub Station from Lightning stroke.

2.3.1.16.3 The lightning conductor shall be earthed through flats and connected to the Earth mats as per applicable Indian Standards with earth pits. Each Lightning Conductor shall be connected to an individual earth pit as per required Standards including accessories. Lightning protection of Early streamer Emission (ESE) type as per NFC 17-102 (2011) with minimum protection class II or higher is also acceptable.

2.3.1.16.4 The contractor shall ensure adequate lightning protection to provide an acceptable degree of protection (minimum protection class 3) as per IS for the substation including transformer. If necessary more numbers of Lightning conductors may be provided. Theoretical lightning design calculations and drawings shall be submitted for approval by NLCIL.

2.3.1.17 Earthing System

2.3.1.17.1 The earthing for LT power system of PCSS shall be made with an earth mat connected with number of earth pit around PCSS. Each earth pit shall be provided with an earth electrode of required diameter and minimum 3 M length including accessories and masonry enclosure with cast iron cover plate as per IS 3043. The pit around the electrode shall be treated with carbon based earth enhancement compound or conductive concrete as required as per provisions of IS 3043.

2.3.1.17.2 The earthing for the power collection substation equipment shall be made as per provisions of IS. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

2.3.1.17.3 The complete earthing system shall be mechanically & electrically connected to provide independent return to earth. All equipments shall have two distinct earth connections.

2.3.1.17.4 For each earth pit, necessary Test Point shall have to be provided.

2.3.1.17.5 In compliance to 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.

2.3.1.17.6 The contractor shall ensure adequate Earthing system protection to provide an acceptable degree of protection as per IS for each PCSS. If necessary more numbers of Earth pit & conductors may be provided. Theoretical earthing design calculations with necessary drawings shall be submitted for approval by NLCIL.

2.3.1.17.7 Earth resistance of the earth pits shall be tested in the presence of the representative of NLCIL.

2.3.2 33 KV POWER EXPORT SWITCHYARD

2.3.2.1 33KV Power Export Switchyard Equipments:

The 33 KV Power Export Switchyard shall be installed as Outdoor switchyard and the details of 33KV Power Export Switchyard equipments shall be as follows.

1. Required number of 33KV feeder bays which shall be connected through UG cables / Transmission lines and Gantries from Solar PV Power Plants, BESS, Auxiliary system and from Grid take off points (existing Panther 1 & 2 feeders)
2. 33KV Outdoor switchyard shall be single bus arrangement with suitable capacity sectionalizing isolator shall be provided within single bus arrangement
3. One no. 33KV / 415V Auxiliary Power Transformer of required capacity to feed the Auxiliary system.

The specification for UG cables / Transmission lines, termination, gantries etc from Grid take off points (existing Panther 1 and 2 feeders) shall be as per the existing practise and requirements of A & N Electricity Department and shall be finalized during detailed engineering and approved by NLCIL.

2.3.2.1 POWER SYSTEM PARAMETER

The power system parameters shall be as follows:

System Parameters	LT System	33KV System
Nominal system voltage	415	33 KV
Voltage variation	+ or – 10%	
Number of phases	3	3
System frequency	50Hz +3% / - 5%	50Hz +3% / - 5%
System Earthing	Solid Grounding	To suit the Solar power station 33KV Power output.
Fault level (3 phase symmetrical)	31.5kA	25 kA
Short time current rating (For all current carrying parts)	31.5kA for 1sec	25kA for 3 sec
Power frequency withstand voltage	2.5KV RMS	80KV RMS
Impulse withstand voltage	-	170 peak

2.3.2.3 DRAWINGS AND LAYOUT

The following drawings shall be submitted for approval by NLCIL / A & N Electricity Dept

a) SLD of 33 KV Power Export Switchyard
b) Equipment Layout
c) Section Drawings

The Contractor shall finalize the location of the 33 KV Power Export Switchyard at suitable site within the project boundary.

The plant equipment and systems shall be designed, manufactured, assembled, tested, shipped, installed and commissioned according to the applicable codes, standards and regulations. The design and installation shall be fully in conformity with the following standards and codes as applicable.

ANSI	:	American National Standard Institute
ISO	:	International Organization for Standardization
ASA	:	American Standard Association
DIN	:	Deutsche Industrie Normen
EN	:	European Standards
BIS	:	Bureau of Indian Standards
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
SI	:	International System of Units

Nationally or internationally recognized codes and standards which meet or exceed the qualities specified in the lists above may be used. It is contractor's responsibility to ensure the coherence of the codes and standards chosen as reference.

2.3.2.4 The 33kv feeders shall be routed as per the overall layout. In the Project Control Room protection relays, metering and control panels, SCADA and EMS and control desk, Station DC control power system, Auxiliary AC power distribution system, UPS, lighting power distribution system, Data and voice communication facilities, Fire detection and alarm panel, interconnecting cabling, earthing and lightning protection shall be installed.

2.3.2.5 The 33KV Outdoor Switchyard Equipments include Circuit breaker, Current Transformers, Potential Transformers, Isolators, Surge arresters, Aluminium bus, ACSR conductors, Clamps and connectors, Columns, beams, poles, Support Insulators, String insulators, Bus post /Pole Insulators, earth wire, HV/LV power, control cables, communication cables etc., as per the requirement of CEA rules and norms and as per A & N Electricity Department requirements.

2.3.2.6 CONDUCTOR

This specification covers design, manufacture, testing before dispatch, supply and delivery of Aluminum Conductors Steel Reinforced (ACSR) Conductors. Bus bar conductor shall be '**Zebra**' ACSR Conductor. Conductor sizing calculation for 33KV bus bar shall be submitted to the purchaser for establishing

the selected sizing of the conductor and any upward revision of conductor sizing shall be done based on calculation.

APPLICABLE STANDARD FOR CONDUCTORS

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

i. IS : 398- Aluminium Conductors for Overhead Transmission Purposes (Part-I):Aluminium Stranded Conductors
ii. IS :398- Aluminium Conductors for Overhead Transmission Purposes (Part-II): Aluminium Conductors Galvanised steel reinforced

2.3.2.7 SWITCH YARD STRUCTURAL STEEL STRUCTURES

2.3.2.7.1 The structural work shall include design, fabrication and supply of all switchyard structures, galvanized steel structural work for equipment supports, towers and lightning masts. All structural steel shall be of mild steel confirming to the latest edition of the standard as stated hereunder.

2.3.2.7.2 I.S. 2062 / 226 Specification for structural steel and quality steel.

2.3.2.7.3 I.S. 802. Use of structural steel in over head transmission line.

2.3.2.7.4 I.S 806 Code of practice for use of steel tubes.

2.3.2.7.5 I.S. 808 Specification of rolled steel, channel, beam and angle sections

2.3.2.8 DESIGN REQUIREMENTS:

2.3.2.8 Following general guide lines shall be followed for verification of design:-

2.3.2.8.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS 875 Part IV.

2.3.2.8.2 For materials & permissible stresses, IS 802 Part I Section 2 shall be followed in general.

2.3.2.8.3 Maximum slenderness ratios of leg members, other stressed members and redundant members for compressive force shall be as per IS 802.

2.3.2.8.4 In order to facilitate inspection & maintenance the structures shall be provided with step bolts spaced not more than 450 mm apart, staggered on faces on one leg extending from about 0.5 metre above ground level to top of the tower. The step bolts shall conform to IS: 10238.

2.3.2.8.5 All Structures shall be designed for worst condition of dead loads, live loads wind loads etc. as per IS 875 Seismic forces as per IS: 1893, loads due to deviation of conductor, loads due to un-balanced

vertical and horizontal forces, erection loads, short circuit forces.

2.3.2.8.6 Substation gantry structures shall be designed for 2 conditions i.e. Normal condition & Short Circuit Conditions. Factor of safety of 2.0 under Normal conditions & 1.5 under Short Circuit condition shall be taken.

2.3.2.8.7 Vertical levels of half the span of conductors/ string & the Earth wire on either side of beam shall be taken for design.

2.3.2.8.9 The contractor shall furnish design, drawing, Bill of Material (BoM) of structures on award of contract. The design drawing should clearly indicate sections numbers and sizes of the bolts & details of typical joints, member wise weights & total weight of the structure.

2.3.2.8.10 There should be provision of connectivity of beam in the last feeder gantries for future beam.

2.3.2.8.11 As designing is in the scope of contractor, supply/approval of design & drawing shall not relieve the contractor from his responsibility for :–

2.3.2.8.11.1 Observing all the required clearances (phase to phase, phase to earth, sectional clearances & ground clearances) as per tender specifications.

2.3.2.8.11.2 Calculation of force at all the joints/sections and their load carrying capacity shall be as per details of design requirements given above.

2.3.2.8.12 Minimum thickness of members other than bracings shall be 5 mm and that for bracings shall be 4 mm.

2.3.2.8.13 Switchyard structures shall be designed in accordance with IS 802-1977.

2.3.2.8.14 All fastening bolts and nuts shall conform to IS 1363/ IS 1367, all washers shall conform to IS 2016/ IS 6610 and spring washers shall conform to IS 3063.

2.3.2.8.15 Minimum size of bolts for all bolted connections shall be 16 mm dia and minimum two bolts shall be provided for each member connection in important structures like towers and gantries. The center to center distance between bolts shall be a minimum of 2.5 times the nominal diameter of the bolt.

2.3.2.8.16 All foundation bolts shall conform to IS 5624.

2.3.2.8.17 All embedded members shall be installed during concreting in accordance with construction drawings.

2.3.2.8.18 The steel structure shall not be erected on the foundations until at east 7 days after placing of the concrete in the foundations. All base plates shall be set level, in exact position and shall be given full and even bearing grouted into place. All anchor bolts and base plates shall be set accurately to the grade and alignment designated on drawing or as directed.

2.3.2.8.19 All galvanized steel shall be handled with care to avoid bending or damage to the galvanizing. Pieces bent in handling may be used only after they are straightened to

the satisfaction of the engineer. Material on which galvanizing has been damaged shall be repaired as specified.

2.3.2.8.20 All connectors of the steel structures shall be bolted. Welded or riveted joints shall not be permitted

2.3.2.8.21 The structures may be erected by assembling in sections on the ground and hoisting successive sections into place, or they may be built up in place by individual members at the option of the contractor. If erected by assembling in sections, not less than 50 percent of all bolting in place shall be done on each section before starting another section.

2.3.2.8.22 All bolts shall be drawn up tight but not to such a degree as to endanger the strength of the bolt. Wrenches approved by the engineer shall only be used on the work and the use of any wrench, which may deform the nut or cut or flake galvanizing shall not be permitted.

2.3.2.8.23 Reasonable amount of drift shall be allowed in assembling but reaming for correction of mismatched holes shall not be permitted.

2.3.2.8.24 During structural erection inspection shall be carried out at every stage o identify all loose bolts or other errors in erection are rectified in time.

2.3.2.8.25 All exposed structural steel shall be hot dip galvanized as per IS 4759. The thickness of zinc coating shall not be less than 610 g/m².

2.3.2.8.26 All bolts, nuts and washers shall be hot dip galvanized as per IS 1367.

2.3.2.8.27 All spring washers shall be electro galvanized as per IS 1573.

2.3.2.8.28 All foundation bolts shall be galvanized as per IS 5624 up to a depth of 300 mm (minimum) below top of pedestal.

2.3.2.9 CLAMPS AND CONNECTORS

2.3.2.9.1 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.

2.3.2.9.2 The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire. Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel. Clamps & Connectors technical requirements are furnished in 2.3.2.19.

2.3.2.10 CIRCUIT BREAKERS

The circuit breakers shall conform in all respects to the highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the purchaser shall have the power to reject any work or materials, which, in his judgment, is not in full accordance therewith. Circuit Breakers shall be outdoor type, comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to IEC- 62271-100 or equivalent Indian Standard.

2.3.2.10.1 DUTY REQUIREMENTS

2.3.2.10.1.1 Circuit breaker shall be totally re-strike free under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 33 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.3.2.10.1.2 The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 33 kV transformers. It shall also be capable of breaking line charging currents as per IEC- 62271-100 with a voltage factor of 1.4.

2.3.2.10.1.3 The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC:62271-100.

2.3.2.10.1.4 The circuit breaker shall be reasonably quiet in operation. Noise level in excess of 140 dB measured at base of the breaker would be unacceptable. Contractor shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.

2.3.2.10.1.5 The Contractor may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the Contractor may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.

2.3.2.10.1.6 While furnishing particulars regarding the D.C. component of the circuit breaker, the Contractor shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation.

2.3.2.10.1.7 The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated.

2.3.2.10.2 Operating Mechanism – Circuit Breaker of vacuum type shall be with electrically spring charged mechanism. The operating mechanism shall be electrically and mechanically operated with anti-pumping and trip free (as per IEC definition) under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the failure in vacuum. The circuit breaker shall be able to perform the duty cycle without any interruption. Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. "Local / remote" selector switch and close & trip push buttons shall be provided in the breaker control cabinet. Operating mechanism and all accessories shall be in control cabinet.

2.3.2.10.3 General Parameters for 33KV Circuit breaker:

Type of circuit breaker	Vacuum
Highest system Voltage	36 kV
Rated frequency	50 Hz
Number of poles	Three (3)
Type	Outdoor
Continuous Max. current rating	To suit system requirements
Rated /Minimum Power Frequency withstand voltage	70KV
Rated lightning impulse withstand voltage	170KV
Minimum creepage distance	25mm/KV of highest system voltage
Rated operating duty cycle	O-0.3 sec. –CO-3 min.-CO
Rated line charging/breaking current (Voltage factor 1.4)	As per IEC
Control Circuit Voltage	110V DC
Reclosing	Three phase high speed auto reclosing
Maximum fault level	25kA (rms) for 3 sec.
Total closing time	Not more than 150msec.
Auxiliary contact	As required plus 4NO and 4NC contacts per pole as spare
Noise level	Maximum 140db at 50M distance from base of circuit breaker.
The VCB shall be suitable for one reclosing followed by one delayed reclosing and lock out	
Minimum clearances:-	
(a)Between phases	360 mm

(b)Between live parts & ground	3700 mm
(C) Creepage distance	900 mm or more
IR value live part to earth	50 Ohm

2.3.2.11 ISOLATORS

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

2.3.2.11.2 Earth switches shall be provided on isolators wherever called for.

2.3.2.11.3 General Parameters

Operating mechanism of Isolator and earth Switch	Manually operated Double break, upright mounting with the movement of the blade in a horizontal plane suitable for outdoor installation
Nominal system voltage	33KV
Highest system voltage	36KV
Type	Outdoor
Rated Normal Current	To suit system requirements
Rated short time current of isolator and earth switch	25kA (rms) for 3 sec
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 & 80kV (rms) across isolating distance
Temperature rise	As per Table-IV of IS: 9921
Rated mechanical terminal load	As per 62271-102
Safe duration of over load	
150 % of rated current	5 minutes
120% of rated current	30 minutes
Creepage distance (Total)	900 mm
Temperature rise	Max.Temp deg.C
a. Copper contacts in air	
Silver faced Copper	105
Bare copper	75
b. Terminal of isolator to be connected to	
Silver faced copper	105
Bare copper	90

2.3.2.11.4 Isolator shall be gang operated for main blades and earth switches. The operation of the three poles shall be well synchronized and interlocked.

2.3.2.11.5 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.

2.3.2.11.6 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.

2.3.2.11.7 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.

2.3.2.12 INSTRUMENT TRANSFORMERS

2.3.2.12.1 General Requirement

2.3.2.12 .1.1 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.

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

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

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

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

2.3.2.12.1.6 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.

2.3.2.12.2 CURRENT TRANSFORMERS (CTs)

2.3.2.12.2.1 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.

2.3.2.12.2.2 The secondaries shall be totally encased in metallic shielding providing a uniform equi- potential surface for even electric field distribution.

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

2.3.2.12.2.4The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

2.3.2.12.2.5 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. 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.

2.3.2.12.2.6 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.

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

2.3.2.12.3 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
Number of cores	As per requirement
Number of terminals in marshaling box	All terminals of control circuits wired up to marshaling box plus minimum 20 terminals spare

2.3.2.12.4 VOLTAGE TRANSFORMERS (VTs)

General Requirement of Voltage Transformer

2.3.2.12.4.1 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.

2.3.2.12.4.2 The secondaries 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.

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

2.3.2.12.5 PARAMETERS FOR VOLTAGE TRANSFORMERS

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)	70kV
Rated lightning impulse withstand voltage (peak value)	170kV
Standard reference range of Frequencies for which the accuracy are valid Rated voltage factor	96% to 102% for protection and99% to 101% for measurement 1.2 continuous & 1.5 for 30 sec
Class of Accuracy	0.2
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 50^0C	As per IEC 60044
Number of terminals in control spare.	All terminals of control circuits wired Cabinet up to marshaling box
Partial discharge level	10 pico Coulombs max.

2.3.2.13 SURGE ARRESTOR

General Requirement

2.3.2.13.1 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. Contractor shall furnish the technical particulars of Surge arrester.

2.3.2.13.2 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.

2.3.2.13.3 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

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

2.3.2.13.5 Technical Requirement for Surge Arrestor

Rated System Voltage	36Kv
Rated 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 arrestor 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
High current short duration test Value (4/10 micro-sec-wave)	100 kAp
Current for pressure relief test	25kA rms
One minute power frequency withstand voltage of arrestor housing (dry and wet)	70 kV (rms)
Impulse withstand voltage of arrestor housing with 1.2/50 micro sec. Wave	170 kV (Peak)
Radio interference voltage at156kV	Not more than 1000 micro volt
Partial discharge at 1.05 MCOV(continuous operating voltage)	Not more than 50 p.c

2.3.2.14 TYPE TEST REQUIREMENTS FOR ALL 33KV SWITCHYARD EQUIPMENTS

2.3.2.14.1 Type certificates and reports as per relevant standards shall be submitted for NLCIL approval for Current Transformers, Voltage Transformers Breakers, Isolators and Surge arrestors. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract.

2.3.2.14.2 All acceptance and routine tests as per relevant standards shall be carried out.

2.3.2.15 LIGHTNING PROTECTION SYSTEM – 33 KV POWER EXPORT SWITCHYARD

2.3.2.15.1 The outdoor switchyard shall be provided with lightning protection to protect the outdoor switchgear equipment and transformer against lightning. The lightning protection system shall be designed based on IS 2319 code of practice for protection of buildings and allied structures against lightning.

2.3.2.15.2 The lightning protection for switch yard shall comprise of vertical air terminations mounted on steel tower. The system shall be designed as per Indian Standards / IEEE in order to protect the entire switch yard and 33 KV POWER EXPORT SWITCHYARD from lightning stroke. The towers shall be interconnected using shield wire. The tower shall also be used for fixing light fittings for illumination of switchyard.

2.3.2.15.3 The lightning conductor shall be earthed through flats and connected to the Earth mats as per applicable Indian Standards with earth pits. Each Lightning Conductor shall be connected to an individual earth pit as per required Standards including accessories.

2.3.2.15.4 Theoretical lightning design calculations and drawings shall be submitted for approval by NLCIL. The detailed requirement for lightning protection is furnished under lightning and earthing section of this technical specification

2.3.2.16 33 KV POWER EXPORT SWITCHYARD EARTHING

2.3.2.16.1 The 33 KV POWER EXPORT SWITCHYARD earthing system shall be designed to cover the system neutral earthing and earthing of non-current carrying metallic parts of equipment, cable trays etc. The design shall ensure that the touch potential and ground potential rise are within limits in accordance with the requirements stipulated in IEEE 80-Guide for Safety in AC Substation Grounding. The earthing system shall also conform to IS 3043.

2.3.2.16.2 The earthing for LT power system of 33 KV POWER EXPORT SWITCHYARD shall be laid with an earth mat connected with number of earth pit around 33 KV POWER EXPORT SWITCHYARD. Each earth pit shall be provided with an earth electrode of low carbon steel rod with molecularly bonded copper on the outer surface of required diameter and minimum 3 M length including accessories and masonry enclosure with cover plate having. The pit around the electrode shall be treated with carbon based earth enhancement compound or conductive concrete as required as per provisions of IS 3043.

2.3.2.16.3 The earthing for the power export substation equipment shall be made as per provisions of IS. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

2.3.2.16.4 The complete earthing system shall be mechanically & electrically connected to provide independent return to earth. All equipment shall have two distinct earth connections.

2.3.2.16.5 For each earth pit, necessary Test Point shall have to be provided.

2.3.2.16.6 In compliance to 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.

2.3.2.16.7 The switch yard earthing shall consist of a mat buried in ground to cover the entire substation yard area with spacing between conductors as per design based on IEEE 80. The contractor shall ensure adequate Earthing system protection to provide an acceptable degree of protection as per IS / IEEE 80 for the switch yard. Individual earth pits shall be used for transformer neutral earthing and earthing of lightning arrestors. All the earth pits shall also be connected to the earth mat. If necessary more numbers of Earth pit & conductors may be provided. Theoretical earthing design calculations with necessary drawings shall be submitted for approval by NLCIL.

2.3.2.16.8 Earth resistance of the earth pits shall be tested in the presence of the representative of NLCIL.

2.3.2.16.9 The earth mat shall be designed considering the earth fault current and soil resistivity value at site. For the purpose of estimating requirement of earth conductor, the earth fault current on 33 KV side shall be taken as 31.5 kA for 1 second. The soil resistivity values shall be measured by the contractor at site during detailing and the system shall be designed accordingly.

2.3.2.16.10 The earth mat shall consist of GI flats of adequate size for the fault current magnitude. The conductor sizing shall also consider adequate allowance for corrosion for a period of 25 years. To estimate the touch and step potentials, shock duration of 0.5 seconds shall be considered. The risers and equipment connections shall be using a minimum conductor size of 50x6& 75x12 mm galvanized steel strip.

2.3.2.16.11 Each equipment in switch yard shall have a minimum of two earth connections to the earth mat. The earth mat shall be buried at a depth of 600 mm from the finished ground level. All structures in the switchyard shall also be bonded to the earth mat. The installation of the earth mat shall be coordinated with the equipment foundations and cable trench construction so as to avoid interference. All cable

trays are to be earthed by 50x 6 mm GI flats at regular interval of 25 meters to the earthing grid or nearest earthing pit.

2.3.2.16.12 The switchyard earthing shall also include earthing of the substation fence at regular intervals. In addition the gate shall be earthed using flexible copper tape.

2.3.2.16.13 The detailed requirement for earthing scheme is mentioned under the section 'Earthing and Lightning protection of Power evacuation scheme'.

2.3.2.17 SWITCH YARD STRUCTURAL STEEL WORKS

2.3.2.17.1 The structural work shall include design, fabrication and supply of all switchyard structures, galvanized steel structural work for equipment supports, towers and lightning masts. All structural steel shall be of mild steel confirming to IS 2062.

2.3.2.17.2 Minimum thickness of members other than bracings shall be 5 mm and that for bracings shall be 4 mm.

2.3.2.17.3 Switchyard structures shall be designed in accordance with IS 802-1977.

2.3.2.17.4 All fastening bolts and nuts shall conform to IS 1363/ IS 1367, all washers shall conform to IS 2016/ IS 6610 and spring washers shall conform to IS 3063.

2.3.2.17.5 Minimum size of bolts for all bolted connections shall be 16 mm dia and minimum two bolts shall be provided for each member connection in important structures like towers and gantries. The center to center distance between bolts shall be a minimum of 2.5 times the nominal diameter of the bolt.

2.3.2.17.6 All foundation bolts shall conform to IS 5624.

2.3.2.17.7 All embedded members shall be installed during concreting in accordance with construction drawings.

2.3.2.17.8 The steel structure shall not be erected on the foundations until at least 7 days after placing of the concrete in the foundations. All base plates shall be set level, in exact position and shall be given full and even bearing grouted into place. All anchor bolts and base plates shall be set accurately to the grade and alignment designated on drawing or as directed.

2.3.2.17.9 All galvanized steel shall be handled with care to avoid bending or damage to the galvanizing. Pieces bent in handling may be used only after they are straightened to the satisfaction of the engineer. Material on which galvanizing has been damaged shall be repaired as specified.

2.3.2.17.10 All connectors of the steel structures shall be bolted. Welded or riveted joints shall not be permitted.

2.3.2.17.11 The structures may be erected by assembling in sections on the ground and hoisting successive sections into place, or they may be built up in place by individual members at the option of the contractor. If erected by assembling in sections, not less than 50 percent of all bolting in place shall be done on each section before starting another section.

All bolts shall be drawn up tight but not to such a degree as to endanger the strength of the bolt. Wrenches approved by the engineer shall only be used on the work and the use of any wrench, which may deform the nut or cut or flake galvanizing shall not be permitted.

2.3.2.17.12 Reasonable amount of drift shall be allowed in assembling but reaming for correction of mismatched holes shall not be permitted.

2.3.2.17.13 During structural erection inspection shall be carried out at every stage to identify all loose bolts or other errors in erection are rectified in time.

2.3.2.17.14 All exposed structural steel shall be hot dip galvanized as per IS 4759. The thickness of zinc coating shall not be less than 610 g/m².

2.3.2.17.15 All bolts, nuts and washers shall be hot dip galvanized as per IS 1367.

2.3.2.17.16 All spring washers shall be electro galvanized as per IS 1573.

2.3.2.17.17 All foundation bolts shall be galvanized as per IS 5624 up to a depth of 300 mm (minimum) below top of pedestal.

2.3.2.18 INSULATORS AND FITTINGS

INSULATORS AND FITTINGS This specification covers post insulators and insulators and fittings for 33 KV POWER EXPORT SWITCHYARD

2.3.2.18.1 CODES AND STANDARDS

2.3.2.18.1.1 The design, material selection, constructional features and testing of insulators and fittings shall comply with all currently applicable statutes, regulations and safety codes in the locality where these are proposed to be used.

2.3.2.18.1.2 Insulators and fittings shall conform to the latest editions of standards specified in enclosed Data Sheet - A. In case of withdrawal/revision of any of the stipulated standards by issuing authorities prior to commencement of fabrication, mutual agreement with Purchaser shall be reached for compliance with applicable standard.

2.3.2.18.2 GENERAL REQUIREMENTS

2.3.2.18.2.1 Supporting insulators of circuit breakers, disconnecting switches and lightning arrestors, bushing insulators for instrument transformers as well as all post type insulators and string insulator assemblies for supporting bus-work shall be made of best quality porcelain and shall be brown glazed.

2.3.2.18.2.2 All insulators shall be suitable for heavily polluted atmosphere and shall be able to withstand the duty requirements of the associated equipment.

2.3.2.18.2.3 When operating under normal rated voltage, there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action.

2.3.2.18.2.4 No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

2.3.2.18.2.5 All iron parts shall be hot dip galvanised and all joints shall be airtight. All current carrying contact surfaces shall be silver plated.

2.3.2.18.2.6 The strain insulators shall be of ball and socket type. The socket shall be malleable cast iron and the pin shall be of steel. After machining is completed, the ball and sockets shall be hot dip galavanised.

2.3.2.18.2.7 Individual units of each strings shall be identical and interchangeable and shall be suitable for forming either suspension or strain strings and shall be so designed as to prevent formation of any defect due to expansion or contraction in porcelain or metal fittings.

2.3.2.18.3 TESTING

All routine tests and acceptance tests shall be carried out as per the latest applicable standards.

Type Tests : If type test report of equipment of same design is not available the test shall also be carried out on equipment as per relevant standards.

2.3.2.18.4 MARKING AND PACKING

Marking on insulators and fittings and packing of fittings shall be as per guidelines covered in applicable standards

2.3.2.19 Clamps and Connectors

2.3.2.19.1 Clamps and Connectors

This specification covers requirements of Bus bars, clamps and connectors for bus bars, transmission lines, Tubular Bus conductors, cable box terminals, equipment terminals and support insulators.

2.3.2.19.2 CODES AND STANDARDS

The design, materials, construction, manufacture, inspection and testing of the clamps and connectors shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment shall be installed. The equipment shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. The equipment shall conform to latest relevant standards.

2.3.2.19.3 CASTINGS

All castings shall be free from blow holes, surface blisters, cracks and cavities.

2.3.2.19.4 CONSTRUCTIONAL DETAILS

All sharp edges and corners shall be blurred and rounded-off. No part of a clamp or connector shall be less than 10 mm thick.

Bolts and nuts shall have hexagonal heads and threads as per applicable standards.

For bimetallic clamps or connectors, loose bimetallic strips or washers shall be provided.

Flexible connectors, braids or laminated straps shall be made from tinned copper sheets or aluminium laminates depending on the clamp.

Size of the terminal/conductor for which the clamp/connector is suitable, shall be embossed/punched (i.e. indelibly marked) on each component of the clamp/connector, except on the hardware.

Clamp shall be designed to carry the same current as the conductor as specified in Data Sheet-A and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/conductor is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

Connector design shall permit easy checking to ensure that the connector is installed correctly.

For parallel connector, power tied wedge pressure connectors (latest state of the art technology) shall be used instead of conventional parallel groove clamp.

Bolts shall have M10 or M12 thread. Tightening torque shall be 45 Nm and 80 Nm for M10 and M12 respectively.

Clamps shall be designed such that the support insulators are not subjected to extra stresses by butt torsional action from the tubular conductor during vibration, wind, ice load and short circuits.

2.3.2.19.5 Contact Paste

Contact paste shall be used on all contact surfaces during installation of non-tensile, rigid and flexible connectors, both clamped and crimped types. Contact paste shall effectively prevent corrosion occurring on the contact surfaces between aluminium and copper throughout the service period.

Contact paste shall be easy to apply to the contact surfaces within temperature range – 300o to +50oC, shall have good adherence and be chemically in relation to both aluminium and copper conductors and other materials included in the connector.

Contact paste shall not be poisonous or inflammable. Contact paste shall not decay, evaporate, run away, harden or crack under the service conditions described in the specification.
The clamps shall be light in weight and easy to handle. Suspension clamp shall have ease of oscillation around horizontal axis and moment of inertia enabling it to follow freely the movement of the conductor. The clamps shall have low effective power loss.

The natural frequency of mechanical vibration of clamps shall be different from that of the conductor, to avoid any effect of resonance. The clamp shall be designed, manufactured and finished to give it a suitable shape without sharp angles at the ends and radii of curvature so as to avoid any possibility of hammering between the clamp and conductor due to vibrations.

Strain clamps for GI shield wires shall be made from hot dip galvanised malleable cast iron, free from blow holes, cracks, etc.

Connectors used for copper to ACSR conductor connections shall be aluminium alloy clamps with necessary bimetallic strips.

Clamps shall be corona free.

Where suspension clamps / strain clamps / dead-end-assemblies / bus post clamps are procured separately, the VENDOR shall co-operate with the supplier of clamps / dead-end assemblies to ensure that the same fits properly with the hardware fitting supplied by him.

2.3.2.19.6 Spacers

No magnetic material should be used in the fabrication of the spacers except for the GI bolts and nuts.

Correct separation of conductors, as required shall be maintained by the spacer without wear even if no lubrication or maintenance is carried out.

Spacer design shall take care of ease of fixing and removing during installation and maintenance. Spacer shall have ultimate compression strength.

2.3.2.19.7 Grading / Corona Rings

Grading / corona rings shall be of such design that when added to suspension or strain strings, the flashover values of complete insulator string shall not be reduced below the following percentages of corresponding flashover values of these assemblies without grading / corona rings.

i) Dry power frequency : 94%
ii) Wet power frequency : 100%
iii) 1.2 / .50 sec. impulse : 96% positive and negative

The grading / corona rings shall be of GI pipe / aluminium tube having outside diameter as required for corona control and minimum wall thickness of 2.5 mm. The brackets for supporting the rings shall be galvanised mild steel.

2.3.2.19.8 DESIGN

Bolted type of connector shall be designed to withstand normal assembly stresses without suffering permanent deformation.

Connectors shall be designed to withstand stresses in service due to wind, ice, vibrations, fluctuations in temperature and short-circuits, without suffering permanent deformation or breakages. In addition, connectors for bundled stranded conductors shall withstand short-circuit inertia forces.

Connector design shall be such that tensile bending and wrenching stresses transmitted to the equipment terminals are minimum possible. Connectors shall permit axial movement of the tubular conductor.

Parts of current carrying connectors which are in direct contact with the conductor shall be designed so that dangerous galvanic corrosion in the contact surface does not occur.

Flexible connectors shall be designed so that electric current during both normal load and short circuiting is not transferred through mechanical support.

Current carrying connectors shall be designed so that hysteresis and eddy current losses are small.

The shape of current carrying connectors shall be such that water collection is eliminated. If this is not possible, the connector shall be supplied with drainage holes of at least 6 mm.

Tubes in flexible connector shall not rattle.

Tubes in flexible connectors shall be prevented from falling out of connector.

The bus post clamps shall be so dimensioned that clashing between the copper tube and clamp does not occur during short circuit.
The bus post clamps shall be so dimensioned that it is not notably heated by hysteresis and eddy current losses.

The bus support clamp shall with respect to partial discharge be designed with a reliable electric contact between the copper tube, all parts in the clamp and insulator fixing.

Bus support clamp intended for flexible current carrying conductors shall for each copper tube allow a total axial movement of at least 60 mm.

Flexible conducting connectors between copper tubes shall be designed and constructed in such a way that the copper tube movements resulting from temperature changes and vibrations do not result in fatigue fracture.

2.3.2.20 BUS BARS

The bus bar for the 33KV bus shall be ACSR '**Zebra**' conductor. Conductor sizing calculation shall be submitted for the adequacy of conductor sizing to NLCIL for approval.
Aluminium strands of ACSR conductor shall be hard drawn from 99.5% pure electrolyte aluminium rods with 60% IACS conductivity. The VENDOR shall specify the guaranteed minimum and average values of conductivity.
Chemical composition of the material shall comply with the requirements of relevant Standards.

The surface of conductor shall be clean and dry and free from any excess grease that may be used in its fabrication. The surface strands shall be smooth and free from burrs and other projections which may be cause for increasing corona losses when the conductor is used on extra high voltage lines.

The steel wire strands of ACSR conductor and steel conductor shall be hot dip galvanised. Zinc coating shall be evenly and uniformly coated complying with relevant standards
The steel core and the inner layer of aluminium wires, (where more than one aluminium layer exists), shall be protected with a special grease in order to provide additional protection against corrosion due to saline pollution. The

grease shall fill the whole space between wires within circumscribed cylinder at inner aluminium layer or at steel core, if the conductor has only one aluminium layer.

The grease shall be chemically neutral with respect to aluminium, zinc and steel. It shall withstand weather conditions given under (Project Data) and permanent temperature of 85 deg C without alteration of its properties

2.3.2.20.1 TUBULAR BUS CONDUCTOR

Tubular Bus conductor wherever required may be provided and the same shall be finalized during detailed engineering.

2.3.2.20.2 Material

Tube material shall be aluminium and shall comply with properties as specified in Data Sheet A.

2.3.2.20.3 Constructional Features

For the inside diameter of the tube there shall be no plus tolerance and for the outside diameter and thickness there shall be no minus tolerance.

Corona bells shall be provided wherever the bus extends beyond the clamps on free ends for sealing the ends of the tubular conductor against rain and moisture and to reduce the electrostatic discharge loss at the end points. There shall be a small drain hole at the end of each tube.

2.3.2.20.4 Sleeves for straight through joints

Length of the jointing sleeves shall be six times the nominal size (diameter) of the tube and the outer diameter of sleeve shall be suitable to fit snugly in the main tube.

2.3.2.20.5 TESTS

All routine tests shall be carried out as per the latest applicable standards.

If Type tests reports of the components of same material are not available the test shall be carried out as per relevant standards.

2.3.2.21 Protection Relays

2.3.2.21.1 Protective relays shall be microprocessor based numeric type conforming to IEC 60255, IEC 60259, IEC 60068, IEC 60801, IEC 60521 and IEC-CISPR22 standards. The protective relays scheme shall be designed to provide maximum discrimination between faulty and healthy circuits and shall remain stable during transient and switching disturbances in the system.

2.3.2.21.2 The relay preferably shall be of withdrawable type to facilitate easy replacement and testing. The withdraw-able module shall have facility for shorting CT terminals when the relay is withdrawn. In case of non-withdrawable type, means of isolating the relay circuitry shall be provided for testing purposes.

2.3.2.21.3 Alphanumeric display LCD screen shall be utilized as man machine interface (MI) built onto the relays. The MMI shall be provided to visualize or display parameter settings and to manually interrogate the relay in the case of relay operation or tripping shall be made available on the screen.

2.3.2.21.4 Modbus protocol Communication ports shall be provided for remote connection for control and indication. Relay and Control Panel shall interface with plant SCADA and Energy Management system through RTU

2.3.2.21.5 The relays shall have indicators, such as LED indications, that show clearly and unambiguously that the relay had operated for various functions. A minimum of 3 indicators shall be provided for protection functions. The indications shall be maintained until reset by the operator. Facilities to test the indicators shall be available to indicate a healthy auxiliary power supply. Suitable labeling shall be provided for each indicator.

2.3.2.21.6 The relay auxiliary supply shall be supplied from 110V DC system. The functionality of the relay shall not be affected by the variation of DC supply. The power supply module shall tolerate a variation of plus/ minus 30 % of the station DC supply and shall also withstand higher DC voltage during rapid charging of station batteries. The power supply card or module shall also be able to remain stable when transient dips in the DC voltage occur.

2.3.2.21.6.1 The numerical relay shall be able to retain in a non-volatile memory all its latest logics, algorithm, settings, registered values, events, oscillography and operation indications in the event of DC power failure. The relay shall also be able to continuously keep track of its internal clock (time and date) in the event of DC power failure.

2.3.2.21.6.2 On-line changing of relay shall not affect the operational value until confirmed. The relay shall have a minimum of two protection function group settings and be able to be interchanged between the group settings. Any changes of relay settings shall be authentically verified. To maintain the level of security for relay operational setting, configurations, access to these functions shall only be permitted through a system of passwords.

2.3.2.21.6.3 The relay shall be provided with necessary interrogation and fault analysis software. The software shall be considered part of the relay and deemed to be provided as part of the contract. Any hardware and accessories that

is required to enable interfacing between relay and laptop shall also be provided.

2.3.2.21.6.4 An internal watchdog or self-supervision functions shall be provided. In the event of an internal relay failure, the relay shall trigger an alarm or indication and identity any internal relay errors and failures. Self-supervision separate alarm/trip contact shall be provided. The self-supervision functions shall not affect the performance of any protection functions.

2.3.2.21.7 Trip Relays and Auxiliary Relays

2.3.2.21.7.1 Auxiliary relays and High speed Trip relays shall be suitable for operation on DC system in the range of 80% to 120% of the nominal 110 volts DC for PSS. The relays shall be stable and not be affected by a slow decay, surges, dips, ripples, spikes and chattering of the DC supply. High speed trip relays shall utilize trip supply of the associated circuit breaker from dedicated protection supply circuit. This DC supply shall be monitored continuously and an alarm provided in event of failure.

2.3.2.21.7.2 Trip & Auxiliary relays shall be housed in dust and moisture proof cases and shall be arranged so that adjustments, testing and replacement can be effected with the minimum of time and labour.

2.3.2.21.7.3 Trip & Auxiliary relays shall be provided with LCD/ LED or flag indicators, phase labeled/coloured, where applicable. Where two or more phase elements or functions are included in one case, separate indicators shall be provided for each element or functions.

2.3.2.21.7.4 Resetting facilities shall be made available, either electrically or manually, without opening the front cover of the relay. All indicators shall be clearly visible without opening of relay front cover or relay panel door. Relays, with provision for manual operation from outside the case, other than for resetting, shall not be accepted.

2.3.2.21.7.5 Relay contacts shall be suitably rated for tripping, control and indication purposes. The contacts shall be suitable for making and breaking the maximum currents, which they may be required to control in normal service. Separate and sufficient number of contacts shall be provided for tripping, control and alarm functions. Separate contacts shall be provided for alarm tripping functions. Relay contacts shall make firmly without bounce and the whole of the relay mechanisms shall be as far as possible unaffected by vibration or external magnetic fields.

2.3.2.21.8 Instruments and Meters

2.3.2.21.8.1 All instruments and meters shall be of robust design, vibration proof and suitable for flush mounting on Control & Mimic panel /Relay panel.

2.3.2.21.8.2 Multifunction meters for all 33KV feeders: All Electrical parameters shall be shown in the Multifunction digital meters for all 33kv feeders. All phase current, voltage, Export /Import KW, KVAR, KWhr, Frequency, P.F, etc., shall be available in the Multi-function meters The multifunction meters of all 33kV feeders shall be suitably communicated to SCADA scheme for monitoring scheme. The multifunction meter shall have accuracy class of 0.2.

2.3.2.21.8.3 **Metering Station**: HT outgoing feeders shall be provided in the Power Evacuation Switchyard with metering stations with ABT billing energy meters at take off points inside the plant boundary of each location. The 2 nos. ABT energy meters (Main and check) as per ANI Electricity Authorities requirement at take off point at along with Metering CTs and PTs in Power Evacuation Switchyard with software shall be provided by the Contractor. The ABT energy meters shall be microprocessor based multi function type and ABT meters shall be suitable for billing purposes and shall have necessary sealing arrangement as per the requirements of ANI ELECTRICITY AUTHORITIES Separate CTs, PTs, ABT meters (Main and Check). The meters shall be capable of measuring voltage, current, frequency, power factor, active and reactive power, real and reactive energy, maximum demand etc. The meters shall have facility to monitor power interruptions, run hour with power on time and off time with date. The meters shall have crisp high visibility display and scrolling facility to display the desired parameter. The meters shall further have communication port for interface with plant automation system. The energy meters shall have class **0.2s** accuracy, meeting CERC/JERC norms and ANI ELECTRICITY AUTHORITIES norms and requirements. The contractor shall obtain approval from ANI ELECTRICITY AUTHORITIES for the Metering station. The responsibility of arranging for the meters, its inspection/calibration/testing charges etc. from Statutory authorities rests with the Contractor and all charges incurred on Meter testing, shall be borne by the Contractor. The energy meters shall be suitable for interfacing for synchronizing the built in clock of the meter by GPS time synchronization equipment to be provided in SCADA & EMS system. Meters must be provided with the necessary data cables.

2.3.2.22 Station DC control power system be installed in line with specification clause 2.3.1.10. Required capacity UPS shall be installed and UPS sizing and design calculation shall be submitted for NLCIL approval. Auxiliary AC power distribution system, Lighting power distribution system shall be installed to meet the system requirements and drawings shall be submitted for NLCIL approval.

2.3.3 SCADA AND ENERGY MANAGEMENT SYSTEM (EMS)

2.3.3.1 The Solar PV power plant integrated with battery Energy Storage System and Power Export system shall be provided with a comprehensive control automation system consisting of SCADA and EMS and it shall acquire all data, store, analyze and control the operation of various equipment and systems to achieve the objectives specified in Design Basis. The Control Automation system shall comprise of String Monitoring Units (SMU) connected to all Solar PV panels, Array Junction Boxes, DC Bus panel etc., in a looping ring as the first sub system at the field level.

2.3.3.2 All SMUs get connected to respective inverters of Power Conversion Unit located in PCSS through Inverter Monitoring Unit (IMU) as second level sub system. The third level sub system shall comprise of PCSS Control and Monitoring units connected to Central Processer for interface with Supervisory Control And Data Acquisition (SCADA) system and EMS. Other sub systems integrated into the main control automation scheme are Switchyard RTUs, Weather Monitoring Unit, RTUs of BESS, PCS, BMS etc. All three levels of subsystems shall be connected through OFC either UG or OPGW in a redundant ring network.

2.3.3.3 STRING MONITORING UNIT (SMU)

2.3.3.3.1 The String Monitoring Units shall be installed in each Combiner Box, Array JB and DC Bus Panel and shall be connected to respective PCSS through the Optical Fibre Cable (OFC) in a redundant ring network in order to have better reliability with lesser field control cables.

2.3.3.3.2 The SMU shall be of Industrial Grade, reliable and field proven microprocessor based unit having the following minimum specifications:

1. Set of field PV panels shall be interconnected in string to form a cluster and multiple strings shall be interconnected to form an Array and multiple arrays will be connected to the PCSS sub-system with DC Bus panel. Each parallel string shall be monitored by the SMU and each string data shall be transmitted through OFC network to PCSS and to SCADA and EMS located in Project Control Room. Each string data shall be used for attaining smooth power during Solar hours by issuing commands for charging/discharging of BESS.

2. The system shall be designed to have a field bus connection from the PV Junction box / combiner box and the measurements are made at the initiation point and transmitted to the PCSS sub system as a digitalized data signal. For Zoning of faults, measurements are also taken at higher level Array JBs and DC Bus Panel and transmitted to PCSS sub system.

3. The SMU shall have multiple channels to interface the various strings of the PCSS through a field bus type of connectivity conforming to IEC 60870 bus standards and protocols and remote I/Os shall be used to achieve the same.

4. Necessary DC or AC power distribution system from respective PCSS shall be provided in the yard for meeting the operating power requirements of SMUs.

2.3.3.3.3 The SMU shall be capable of monitoring the parameters like Voltage, Current, and power as well as rate of rise /drop of parameters for each string and each array along with diagnostic digital status signals from each combiner box to provide adequate information with respect to the performance fluctuation and efficiency of the PV arrays connected to it. It shall be possible to monitor and identify the non-performing or underperforming PV panel strings from the PCSS sub system so that the same can be attended or isolated easily.

2.3.3.3.4 The SMU unit shall be of RTU type to acquire data on continuous basis and store the data in the SCADA. The SMU shall have logical capabilities to perform any interlocking and protection logics as per the process requirement. The SMU shall have other standard features like RTC, self-diagnostic routines, event logging, alarms, fluctuation feedback etc. For electrical parameters like voltage, current, etc., direct I/O modules without the usage of transducers shall be preferred.

2.3.3.3.5 The components and interconnections of SMU shall be suitable for higher service temperature within Array Junction box and Combiner box prevailing in the project site.

2.3.3.4 INVERTER MONITORING UNIT (IMU)

2.3.3.4.1 Inverter Monitoring Units shall be installed in each PCCS for each Power Control Unit (PCU) or Inverters. This inverter-monitoring unit shall be industrial grade microprocessor based unit with direct digital interface to the PCUs. The IMU can be built in to PCU / inverter itself or it can be a separate unit for each PCU / inverter or common for both PCUs / inverters.

2.3.3.4.2 The IMU shall collect all the operating conditions of the inverter including fluctuation parameters in AC side from the PCU / inverters and transfer the data to the PCSS Control and Monitoring Units through the bus connectivity as shown in the configuration diagram.

2.3.3.4.3 These monitoring units shall be connected through a redundant bus network to the control and monitoring unit (PCSS-CMU) as part of the PCSS Sub – system. Provision shall be made in PCSS to attach a portable HMI such as Lap Top when required.

2.3.3.4.4 The IMU shall be capable of accessing real time downstream and upstream performance values, analyzing dynamic PR, automatic changing of control parameters based on trending and comprehensive monitoring the status of all equipment connected to it along with its parameters. Commands from SCADA and EMS shall be issued through IMU to inverters for controlling and smoothing of the AC side output.

2.3.3.4.5 The IMU unit shall be of RTU type to acquire data on continuous basis and store the data in the SCADA. The IMU shall have logical capabilities to perform

any interlocking and protection logics as per the process requirement. The IMU shall provide required information to SCADA for self-diagnostic routines, event logging, alarms etc.

2.3.3.5 HT / 415 V SS RTU

2.3.3.5.1 The HT / 415 V SS RTU shall be industrial grade microprocessor based unit with direct digital interface to the bus. This RTU is connected to different substation systems such as HT Three winding Transformer, Tap Changer, HT and 415 V Switchgears, voltage / current / Temperature measurement devices, Position Sensors, Control and Automation Relays, 110 V DC system battery status and charger functions, PCU Ventilation fan operating status, etc.

2.3.3.5.2 The HT / 415 V SS RTU shall be capable of controlling the operations of circuit breaker with intelligent interlocks and safety configurations from remote server such as SCADA and EMS. All relay functions shall be programmable through SCADA and EMS. Status abnormality of all equipment in Power Collection Sub Station shall be monitored by the HT / 415 V SS RTU for providing necessary alarm / alerts.

2.3.3.5.3 RTU shall be with built – in memory and extended removable type flash memory cards to acquire data on continuous basis and store the data in the memory modules .The RTU shall have logical capabilities to perform any interlocking and protection logics as per the process requirement . The RTU shall have other standard features like RTC, self-diagnostic routines, event logging, alarms etc.

2.3.3.6 PCSS CONTROL MONITORING UNIT (PCSS CMU)

2.3.3.6.1 The PCSS CMU shall be an industrial grade microprocessor based unit which shall act as bridge between each PCSS data network and main Optic Fibre Ring Network. It shall be capable of handling all data and control functions of PCUs as well as Substation RTUs. The constructional features of PCSS CMU shall be similar to SS RTUs.

2.3.3.6.2 The other systems which shall be hooked up to the main OFR network at PCSS are, phone communication, Fire alarm repeater panel and Station Facility Controller. The Station Facility Controller shall handle all substation facilities such as yard and building lighting, UPS / 110V DC system battery, battery charger and access control.

2.3.3.7 OPTIC FIBER RING NETWORK

2.3.3.7.1 An optic fibre cable network in ring architecture is envisaged to connect the entire plant for data transfers in a most economical manner. Single mode 6 or 12 core corrugated steel tape armoured Optical Fibre cable conforming to IEC 60794 shall be routed as buried at a depth of 600 mm below ground connecting the entire plant.

2.3.3.7.2 The optical fibre link shall be redundant and the ring network shall consist of necessary splitter boxes, closure terminals, couplers, drop / patch cables, attenuators, etc., of reputed make.

2.3.3.7.3 Where ever required the optical fibre link between site and SCADA/EMS shall be connected through Optical Fibre Ground Wire (OFGW) installed on Transmission line towers to avoid crossing of public roads and private areas.

2.3.3.8 CENTRAL PROCESSOR UNIT AND SUB NET

2.3.3.8.1 Central Processor unit connected to Optical Fibre ring network collects data and interact with SCADA and EMS through sub net. The Central Processing unit shall be a rugged industrial type microprocessor based unit with built in redundancy.

2.3.3.8.2 The sub net in control room shall be a redundant data highway bus connecting SCADA and EMS servers and weather monitor unit, HT RTU etc.

2.3.3.9 WEATHER MONITORING UNIT (WMU)

2.3.3.9.1 The WMU shall be an industrial microprocessor based unit capable of collecting weather data from field instruments listed in Clause 2.3.3.13 below. Functions of WMU are elaborated in Clause 2.3.13.15. Pyranometer data from WMS shall be taken by SCADA and EMS for control operations of BESS charging and discharging.

2.3.3.10 33 KV POWER EXPORT SWITCHYARD

2.3.3.10.1 The constructional and operational features of HT SS RTU shall be similar to HT / 415V SS RTU of PCSS.

2.3.3.11 SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA) AND EMS

2.3.3.11.1 The computer aided SCADA and EMS shall be designed for simultaneous monitoring and recording of various parameters of different sub-systems in the solar power plant integrated with Battery Energy Storage System, power generation on the DC and AC sides, capable of computing performance ratios and efficiency of different sub system operations and implement corrective action for achieving smoothend power output to grid and achieving maximum plant output. SCADA and EMS shall be suitably connected with necessary hardwares and softwares and proper linkages.

2.3.3.11.2 The SCADA and EMS shall be designed on reliable operating platform and time tested software featuring, Energy Management, String level control if required and inverter control, Battery management system control, DC & AC switch gears, lighting automation system, security, alerts, analytical reporting, auditing and data archiving functions etc.

2.3.3.11.3 SCADA and EMS shall be capable of providing different on screen dashboards for overall / zone of the plant, combiner box monitoring, weather station parameters, DC / AC SLD, Trend Charts, Alarm / Alert listing, Audit Reports,

Equipment parameters, communication link monitoring, GIS based plant view with dynamic change key performance indices and operating parameters, Battery Management system parameters, Power Conversion Substation parameters etc.,

2.3.3.11.4 Minimum of three operating stations with servers is envisaged for the SCADA and EMS. Personal computer (PC) with monitor and key board shall serve as servers. One server shall be Operating Station with data storage, second server shall serve as back up data storage as well as Operating Station cum Engineering Station and the third server shall be web connected to act as Web Station with web data storage. The Data Acquisition System should be housed in a desk made of sheet steel, powder coated.

2.3.3.11.5 The SCADA and EMS configuration, equipment details, software features, on screen dashboards and other operational highlights shall be submitted for NLCIL approval. Necessary design documents and drawings of SCADA and EMS including Plant Monitoring Desk shall be submitted for approval by NLCIL before commencement of supply.

2.3.3.11.6 Each PC shall be rugged & robust in nature to operate in a hostile environment. The PC shall have minimum Intel Core i5 processor having 2 X 500 GB HDD with minimum 4 GB RAM. The PC shall also have 21" or higher TFT Colour monitor, DVD Drive with Writer, USB ports, Scroll Mouse and UPS for four (4) hours power back up.

2.3.3.11.7 The printer shall be A4 and A3 colour laser type rugged & robust in nature and of reputed make. The printer shall be equipped for printing, scanning, copying and faxing and shall be hooked up to network.

2.3.3.11.8 The Data Acquisition System shall perform all measurements and continuous recording of all data required for system operation.

2.3.3.11.9 SCADA and EMS shall provide fifteen (15) Minutes daily, monthly and annual average of all parameters.

2.3.3.11.10 All data shall be recorded chronologically date wise. The data file should be MS Excel compatible. The data logger shall have internal reliable battery backup and data storage capacity to record all sorts of data simultaneously round the clock. All data shall be stored in a common work sheet chronologically. Representation of monitored data shall be available in graphic mode or in tabulation form. All instantaneous data can be shown in the Computer Screen.

2.3.3.11.11 SCADA and EMS shall have feature to be integrated with the local system as well remotely via the web using either a standard modem or a GSM/WIFI modem. The bidder shall provide compatible software and hardware so that data can be transmitted via. standard modem. Plant generation data shall be made available for NLCIL web site for display in NLCIL intranet.

2.3.3.11.12 The SCADA and EMS shall enable automatic operation of entire solar PV power plant in all modes, during power generation as well as in non-power generation periods. Final out going breaker will be controlled by SCADA and

EMS in coordination with Energy Management Centre of A & N Electricity Department. SCADA and EMS shall be in addition to proprietary data logging and control system provided by the Contractor and it shall be the responsibility of the Contractor to ensure all system interfacings are properly matched to have an integrated operation from SCADA and EMS.

2.3.3.11.13 The Solar PV Power Plant integrated with Battery Energy Storage System will be requiring interface with the A & N Electricity Department for power export. It is the responsibility of contractor to make provisions in SCADA and EMS to have required networking with A & N Electricity Department. The Contractor shall provide necessary hardware to meet these requirements and their standards.

2.3.3.12 VOICE AND DATA COMMUNICATION SYSTEM

2.3.3.12.1 A Voice /Data Communication Network interconnecting all Power Collection sub stations, BESS, Power Export switchyard and voice communication for Security Building and watch-towers etc shall be provided for the Solar PV Power Plant integrated with Battery Energy Storage System with necessary hardware, software and optic fibre cable interface.

2.3.3.12.2 Suitable capacity electronic IP PBX shall be provided at Project Control Room with cable network for IP phones inside the project site building.

2.3.3.12.3 Proposed Voice Communication System Scheme, exchange and phone data sheet, number and location of hand sets, etc., shall be submitted for approval by NLCIL.

2.3.3.13 **FURNITURE**

Adequate and appropriate ergonomically designed furniture of approved make for the Office and SCADA rooms, AC and non AC stores shall be included in the offer. The furniture should be chosen in such a way that it matches with the décor of the rooms. Furniture shall be modular design. The furniture to be included in the scope shall not be limited to the list given below. The type of the furniture proposed to be supplied shall be submitted for approval by NLCIL. After award of contract, Contractor shall arrange to get the modular furniture arrangement as well as furniture types approved by NLCIL before proceeding with the procurement.

Sl.No.	Description of Furniture and Fittings	Quantity
1	Executive steel table with glass top and 3 sliding drawers for office	4 Nos.
2	Height adjustable cushioned chair with arm rest for office	7 Nos.
3	Steel table with 3 sliding drawers for stores	3 Nos.
4	SCADA workstation table (Modular design)	1 Set

5	Computer station chair with hand rest, back and height adjustment	3 Nos.
6	Standard filing Cabinet	3 Nos.
7	Standard steel cupboard	3 Nos.
8	Slotted angle racks for stores	9 Nos.
9	Slotted angle racks for tools and tackles	5 nos.
10	Workers locker (6 compartment design)	3 Nos.

2.3.3.14 INSTRUMENTS AND WEATHER MONITORING UNIT (WMU)

2.3.3.14.1 Contractor shall provide all measuring instruments listed below for each site location and with all necessary software & hardware to make it compatible with SCADA and EMS.

1. Pyranometer -2 nos.

2 RTD/Thermister type ambient temperature measuring instrument -2 nos.

3. Wind speed sensor- 1 no.

4. Wind direction sensor -1no.

5. Rain gauge – 1no.

6. Surface temperature sensor- 1 no in each PCSS zone.

7. Data logger – 1no.

2.3.3.14.2 **Pyranometer:** Typical specification for Pyranometers, for measuring incident global solar radiation shall be as follows:

Spectral Response : 0.31 to 2.8 microns

Sensitivity : 7-14microvolt/ w/Sq. m

Time response (95%) : Max 15 s

Non linearity : ±0.5%

Tilt error : ±0.5%.

Zero offset thermal radiation : ±7 w/m^2

Zero offset temperature change : ±2 w/m^2

Operating temperature range	:	- 40 deg to +80 deg.
Non stability	:	Max ±0.8%
Resolution	:	Min + / - 1 W/m^2
Input Power for Instrument & Peripherals	:	230 VAC (If required)
Output Signal	:	Analogue form which is compatible with the data

2.3.3.14.3 If any higher version is required to meet system requirements with the approval of NLCIL the same shall be installed without any extra cost to NLCIL. Each instrument shall be supplied with necessary cables. Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the supply of the instrument.

2.3.3.14.4 The signal cable length shall not exceed 20m. Contractor shall provide Instrument manual in hard and soft form.

2.3.3.14.5 Bidder shall install two RTD type ambient temperature measuring instruments at suitable places in PV array. Instruments shall have a range of - 4^0 C to 70°C.

2.3.3.14.6 **Weather Monitoring Unit:** The WMU shall be an industrial microprocessor based unit capable of collecting weather data from field instruments listed above. Instruments with built in I/O modules and instruments connected through analog – digital converters shall be connected to WMU through suitable data network and shall be programmed to provide weather parameters continuously. WMU shall be programmed to monitor the weather parameters obtained from field instruments constantly to deduct abnormality, especially of Pyronometer and give immediate warning for recalibration of instrument.

SECTION 2.4

CIVIL WORKS AND STRUCTURAL STEEL WORKS

2.4.1 GENERAL

2.4.1.1 The scope of civil works detailed below is only indicative. Any other civil & structural steel work which is not mentioned or not included here but necessary for the establishment and operation & maintenance of Solar Power Plant shall be included in the scope and borne by the Contractor.

2.4.1.2 This specifications document is not exhaustive and the contractor shall be responsible not only for the requirements specified herein but for the correct choice

of materials, for proper fabrication and for the conformity to codes, regulations and legal requirements and for supplying all the documentation of these materials.

2.4.1.3 In General, all civil works shall be carried out as per relevant latest BIS, unless otherwise specified.

2.4.1.4 Minimum grade of RCC work shall be M30 as per IS code.

2.4.2 PRELIMINARY WORKS

2.4.2.1 LAND DEVELOPMENT AND SITE PREPARATION

Land Development activities shall include marking of boundaries with boundary pillars in co-ordination with Andaman & Nicobar Administration Authorities. Removal of trees including roots within the site boundary, vegetation removal and stacking the usable materials within the boundaries for disposal are in the scope of the contractor.

2.4.2.2 TOPOGRAPHICAL SURVEY

Topographical survey for the entire proposed site at a grid interval of 5m in both directions shall be carried out by the contractor. All surveying Northing & Easting co-ordinates shall be based on UTM (Universal Transverse Mercator of respective Zone). After completion of field survey, the contractor shall submit contour layout (contour interval 0.5m) along with spot levels for the total project. The Contractor shall submit all data @ 5m Grid interval in both directions pertaining to the survey to NLCIL in a CD/DVD including all levels & co-ordinates in X-Y-Z format for the entire area.

On completion of field survey work, the contractor shall submit soft copy of Draft Survey report to NLCIL for review. The draft report shall contain all relevant documents and General layout drawing with clear demarcation showing boundary pillars, finished ground levels (FGL) of Array Yard, Power Collection Sub Stations, Power Export Sub Station, building sewage / drainage systems, fencing, approach roads, peripheral roads, internal roads, storm water drains connecting to the nearest Nallah or to the existing storm water drain, culverts, if any, watch towers etc.,

After attending NLCIL's comments if any in the draft report, Six (6) sets of hard copy and one (1) set of soft copy (in DVD/CD in editable AutoCAD format) of the Final Survey report with all relevant drawings shall be submitted to NLCIL for approval. The FGL should be got approved by NLCIL before commencement of work at site.

Levelling and terracing works for the entire power plant area shall have to be done at different levels & slopes based on the natural terrain and requirements. Hence cutting, filling, levelling and other allied works are in the scope of the contractor. The finished ground levels of array yard, sub stations, control room etc., shall be

finalised taking into consideration all formation levels on completion of the above survey work. Based on the contours, drainage system shall have to be designed.

2.4.2.3 **SOIL INVESIGATION:**

2.4.2.3.1 The Contractor shall carry out sub soil investigation at all locations through a qualified soil consultant to ascertain the soil parameters of the proposed solar power Plant. At the proposed sites, for design purpose, recommended value of Net safe bearing capacity of the soil at a depth of 1.2 m may be taken as 8.00 T/m2. This Net Safe Bearing capacity value is indicative only. After award of LOA, the contractor shall have to carry out all necessary soil tests to ascertain actual soil parameters including Net Safe Bearing capacity.

2.4.2.3.2 The scope of sub-soil investigation includes, execution of complete soil exploration including boring according to the site requirement, drilling, collection of undisturbed soil sample where ever possible, otherwise disturbed soil samples, SPT, Electrical Resistivity test, etc., conducting laboratory test of samples to find out the various parameters mainly related to load bearing capacity and settlement, ground water table level, sub soil conditions such as chemical characteristics of soil. The soil test also includes analysis of ground water sample.

2.4.2.3.3 On completion of field and lab test, the contractor has to submit soft copy of Draft Soil investigation report to NLCIL for review. The draft report shall contain data for each borehole, layout drawing showing all test locations (with UTM coordinates), along with recommendation regarding suitable type of foundation for all the structures as well as recommendation for soil improvement, wherever necessary. The report shall include Safe bearing capacity of soil for different types of foundations (Shallow/Pile) based on soil parameters and settlement characteristics defining clearly, how these capacities were arrived at, based on the relevant latest BIS standards.

2.4.2.3.4 After attending NLCIL's comments if any in this regard, the contractor shall submit one (1) soft copy (in the form of DVD/CD) and six (6) hard copies of Final Soil Investigation Report to NLCIL and get them approved, before commencement of foundation designs.

2.4.2.4 PLANNING AND DESIGN COORDINATION

The Contractor has to plan and design array yard infrastructure in a proper manner based on the technological as well as functional requirements. Contractor shall develop general layout drawing of array yard, internal roads, peripheral roads & path ways, drainage system, etc ensuring no water logging takes place in the array yard area or near boundaries. The work also includes leveling the entire Plant area and grading to suit the topography of the area. All design & drawings have to be developed based on technical specifications of the tender documents, approved soil investigation report and relevant latest BIS unless otherwise specified. All details for

water supply for module cleaning and the resultant drainage system shall be clearly shown in the detailed drawings.

2.4.3 MODULE MOUNTING STRUCTURE

2.4.3.1 Foundation for Modules Mounting Structures (MMS) can be shallow foundation or driven cast-in-situ Pile/Under reamed pile depending on the soil conditions. While designing the foundations, due consideration shall be given for the self weight of module assembly and maximum wind speed as per latest IS 875-Part-3. The size of the foundation shall be based on design parameters & to prevent liftoff of structure due to wind forces. Minimum pile diameter shall be 300mm. The Grade of concrete for foundation shall be M30. Top of concrete/height of collar for MMS foundation shall be minimum 150mm above FGL. In case of pile foundation, necessary INITIAL TEST (Pullout & Lateral load) for piles – minimum 2 tests at each site shall be done as per latest IS2911(Part-4) and accordingly the depth of pile shall be firmed up. Foundation work of Module Mounting Structure shall commence only, after the proper leveling / grading of the site

2.4.3.2 Seismic parameters Zone & Importance Factor for the project sites shall be based on latest BIS: 1893(Part-1).

2.4.3.3 Members shall be fabricated by cold forming process and shall have minimum yield strength of 345 MPa and shall conform to the physical specifications of ASTM A653 or latest IS 811 or any other relevant international standards. Light gauge structural steel or structural aluminium members can also be proposed subject to approval of NLCIL. Mild steel members with weather protection coating as per ASTM A792M or IS:15961 (latest revision) standard Al-Zn alloy hot dip process with minimum 150 GSM on both sides are acceptable for purlins (structural member connected to modules) with minimum 0.9 mm base metal thickness and yield strength not less than 550 MPa. Inside coating of purlins should be ensured.

1. Fabrication and erection shall be carried out in accordance with latest IS 800 and IS 801.
2. Dimensions of plates, flat bars shall conform to latest IS 1730. The minimum thickness of 2.5mm for MMS column post and minimum 2mm for other members shall be ensured.
3. Bolts, nuts, screws, washers etc… shall be of stainless steel SS 304 of class A2-70 and sizes as per latest relevant BIS provisions. All fasteners shall be provided according to connection design requirement. All bolts shall be tightened with designed torque mechanically.
4. All structural members shall be hot dip galvanized as per IS 4759 or relevant Indian standards and the average coating thickness shall be 80 micron and local coating thickness shall be minimum 70 micron. In case of aluminium, anodized coating as per IS 1868 (AC25) shall be provided.
5. Structural design of MMS structure shall be as per provisions of latest IS 801.

2.4.3.4 Design Parameters and Design Loads:

The structure shall be designed for loads and load combination as per Indian Standards (latest revisions)

i. Dead load: Dead loads shall be self weight of all the modules, members and fasteners.

ii. Wind Load: The wind load parameters shall be considered as per latest IS 875 (Part-3).

iii. Earthquake Load: The MMS structure shall be designed for Seismic forces. Seismic parameters Zone & Importance Factor shall be based on latest BIS: 1893(Part-1).

iv. Vertical Deflection & Horizontal Sway Limits: The limiting permissible vertical and horizontal deflection for structural steel members shall be as per latest IS 800: 2007.

For fixed/seasonal tilt MMS structure, bidder shall submit STAAD file & design document for approval of MMS drawings. For tracking system, bidder can propose wind tunnel test report/STAAD file & design document for approval of drawings. If bidder is going for wind tunnel test for the design and analysis of solar tracking system following has to be ensured.

i. It must be done from an institute of reputed (IITs in India).

ii. If test is done by any reputed international facility the test results must be vetted by any of the IITs in India.

iii. Bidders must ensure that offered tracker has proven design with wind tunnel test simulating actual site conditions.

iv. Test results and design must comply Indian codes.

v. The design shall be shown in STAAD pro for further checking of NLC India Ltd. if asked to do so.

2.4.3.5 The contractor shall prepare array layout to suit their design and plan the total power plant within the available land area without involving any major site modifications.

2.4.3.6 The structure shall be designed for simple mechanical and electrical installation. It shall support Solar PV modules absorb and transfer the mechanical loads to the ground properly. There shall be no requirement of welding or complex machinery at site for installation of module mounting structure to the foundation.

2.4.3.7 The structure shall be designed to allow for easy replacement of any module as well as easy access to the bottom of module by O&M staff.

2.4.3.8 General arrangement of Module mounting structures, array layout, and fabrication drawing shall be submitted to NLCIL along with necessary supporting design documents for approval, before commencement of fabrication/erection.

2.4.3.9 Installation details of the Solar PV modules and the support structures with appropriate diagrams and drawings shall be submitted for approval by NLCIL.

2.4.3.10 All building and other foundation drawings & designs shall be based on Final Soil Investigation Report and to be submitted to NLCIL for approval, before starting the work.

2.4.4 ROADS & PATH WAYS

2.4.4.1 The roads shall be designed and constructed based on the General layout of the Solar Power Plant. The main approach road from the existing nearest road to the Solar Plant shall be a single lane road, designed to carry the equipments as per relevant specification of IRC along with connecting RCC culverts (M25) wherever required. The approach road, peripheral road & all internal roads are to be designed to suit the Solar Plant layout and shall be of single lane of 3.6 M width. These roads shall be laid with

a) WBM – using 40 mm BG metal - two layers – each of 135 mm pre-consolidated thick – rolled to 100 mm thick - consolidated thickness totaling to 200 mm which includes dry and wet rolling of each layers, spreading gravel for blindage and consolidation with water, spreading sand/M.sand/quarry dust to a thickness of 3 mm and top rolling and
b) Top coat – Top finishing coat shall be of Bituminous Toping using 12 mm downgraded metal with consolidated thickness of 20mm and seal coat.

2.4.4.2 All roads shall be provided with 0.60 M wide berm on both sides with 150mm thick well compacted BG boulders/ locally available natural rock boulders and trapezoidal earthen drains as per the approved drainage layout. The area between the solar arrays shall be leveled for carrying panels and materials, modules washing, easy movement during O & M, etc. The layout and details drawing of all roads and culverts (if any) shall be submitted to NLCIL and got approved, before commencement of work.

2.4.5 FENCING & SIGN BOARD

2.4.5.1 The entire Solar Power Plant array yard shall be provided with 2.1 M high Fencing arrangement using Goose Neck RCC (M30 Grade) Fence Posts of 2.7m length (IS 4996) at a maximum spacing of 2.30 M with strut posts at every 15 M Spacing (maximum) and at corners. The bottom portion of fencing shall be with 1.8 M height PVC coated Chain link Fencing and the top 0.30 M with barbed wire fencing (2 rows & one cross diagonal) which act as anti-climbing device for safety. PVC coated Chain link Fencing & GI Barbed wire shall be of reputed make and shall be got approved before use on works. Fencing details and layout drawings shall be submitted to NLCIL for approval, before commencement of work.

2.4.5.2 Aesthetically designed sign board 2.4 M x 1.5 M shall be provided at the entrance of approach road to Solar Power Plant at each plant site. The sign board shall contain

brief description of the Power Plant. The Signboard shall be made of stainless steel tubular frame with SS steel plate of not less than 3 mm. Necessary SS steel tubular support column with concrete foundation shall be provided. Letters on board shall be designed with proper colour scheme and fluorescent paint system / arrangement. The design & size of the signboard shall have to be befitting the landscaping planned for the main entrance to power Plant. The sign board design and drawing shall be submitted to NLCIL for approval, before the commencement of manufacturing.

2.4.6 SECURITY BUILDING AND GATES

2.4.6.1 The Security Building shall be provided near the main entrance of each plant /project site. The security building shall be of single storeyed RCC (M 30) framed structure 3m x 3.6 m (inner dimension) with an internal toilet provision for 1.5m x 1.2 m size & front verandah for a minimum width 1.20 m. This building shall generally be constructed as per the relevant specifications laid down for the Project Control Room building. Security building shall be provided with necessary electrical fittings and sanitary items along with adequate sewage disposal system. The design and drawings of security building shall be submitted to NLCIL for approval, before commencement of work.

2.4.6.2 The main entry to each plant/project area shall be provided with a main gate of size 5.00 x 2.40 M and a wicket gate of size 1.20 x 2.40 M (both using MS Structural). RCC (M 30) gate pillars of required size shall be provided at the main entrance. Apart from this main gate, additional gates of size 1.20 x 2.40 M shall be provided at appropriate locations within each project site, wherever necessary. These gates shall be designed aesthetically and the design and drawings of Gates & RCC Pillars shall be submitted to NLCIL for approval, before commencement of manufacturing / construction.

2.4.7 WATCH TOWERS

Adequate number of Watch towers (using MS Structural) to have coverage of the entire plant/project site shall be provided around the periphery. Watch tower shall be of height 3.50M up to the bottom of the cabin of size 2.00 x 2.00 x 2.40 M. The cabin floor shall be provided with a platform of size 3.20 x 3.20 M, using 6mm thick chequered plate over MS structural framework and the roof shall cover the entire platform area. Cabin roof and sides shall be provided with double skin metal cladding with 60mm thick Poly Urethane Foam (PUF) insulated sandwiched panel. The cabin shall be provided with a steel door of size 0.80 x 1.80M on one side and powder coated aluminium glazed sliding windows of size 1.20 x 1.20 M on all other 3 sides. Minimum 800 mm wide steel staircase with MS handrails on both sides as per requirement shall be provided. Hand rail and toe guards shall be provided for platform around cabin. These watch towers shall be designed and constructed considering the safety and security requirements of the Solar Power Plant. Entire structure of the watch tower shall be provided with proper surface treatment and painting system. Watch towers shall be provided with necessary electrical

arrangements. The location and design drawings of the Watch Towers shall be submitted to NLCIL for approval, before commencement of fabrication.

2.4.8 WATER SUPPLY ARRANGEMENT FOR MODULE WASHING AND DRAINS

2.4.8.1 Contractor shall provide necessary arrangement for module washing in the Solar Power Plant. This shall include construction of a water storage sump, pump & motor and routing buried ring main system using heavy duty rigid PVC pipe network covering all areas of Solar arrays. 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. To the extent feasible, the run-off from washing shall be designed to get absorbed in the soil below the solar arrays. Excess water during rains shall be drained through storm water drains built in the Plant area and finally let into the main storm water drain leading to the Nallah. Construction of underground storage sump for module washing system with M30 grade concrete sump or field assembled buried FRP tank are acceptable.

2.4.8.2 The plant storm water drainage system shall be designed taken into account the topography of the plant area, area drainage patterns and intensity of rainfall as per Indian Meteorological data etc. For design of drains, the maximum recorded rainfall intensity shall be considered. All internal drains shall be earthen drain, trapezoidal in section and shall be of sufficient width at the base. Internal road cross over, intersections and the drains near PCSS etc. shall be provided with removable RCC slab covers of adequate thickness and reinforcement.

2.4.8.3 The Contractor shall submit to NLCIL the schematics of the wash water system with location of pump, pipe work and tap off points as well as drains, module washing accessories, etc., for review and approval.

2.4.8.4 The Contractor shall carry out chemical analysis of water independently to ascertain the quality of supplied water and to size any equipment or system required for treatment of raw water for successful operation of Plant for 11 years. Based on chemical analysis of water, if any equipment/system is required for treatment of raw water before it is used for module cleaning and the same shall be submitted to NLCIL for approval.

2.4.9 POWER EXPORT SWITCHYARD AND TOWER LINES.

2.4.9.1 **GENERAL REQUIREMENTS:**

Civil and structural works for the Power Export Switchyard & Tower lines shall be installed as per the technical requirements of Electricity Department, Andaman & Nicobar Administration and CEA norms.

2.4.9.2 The scope of civil works for the PSS includes design, supply of materials and construction of all equipment / tower / mast foundations, cable trenches, earth

pits, and drains. Contractor will co-ordinate and supervises complete civil construction and structural fabrication and erection for correctness as per the requirements indicated in the design inputs.

2.4.9.3 All pedestals for towers/equipment will extend to a minimum of 300mm above FGL.

2.4.9.4 Supplying and spreading with crushed BG metal comprising of average 40mm (30mm to 50mm) normal size over the entire Switchyard area to 100 mm. thickness (min.).

2.4.9.5 The safe touch & step voltage will be achieved considering crushed stone/gravel resistivity for Substation. Beside this if any extension of earth mat outside Sub-Station area is required to achieve safe earth mat design; the same will be within the scope of the Contractor.

2.4.9.6 Contractor will submit the design of switchyard foundation and structures with details of load combinations, factor of safety, sag tension basis, etc. to NLCIL for review and approval.

2.4.9.7 The scope of civil works detailed above for the switchyard is only indicative. Any other civil & structural steel work which is not mentioned or not included here but necessary for the establishment and operation of 33KV Switchyard for Power evacuation purpose will be included in the scope and borne by the Contractor.

2.4.9.8 Cable Trench in Switchyard shall be constructed as per standards including necessary provisions for road crossings.

2.4.10 PROJECT CONTROL ROOM BUILDING:

2.4.10.1 **GENERAL REQUIREMENTS:**

The project Control Room building shall be designed based on topographical survey report & soil testing report, relevant BIS code and National Building Code of India.

The building shall have to house Control room equipments, SCADA & Energy Management system (EMS) panels, LT panels, UPS, DC system-Battery, Battery charger (DC loads required for switchgear), Lighting & Power Distribution Panel etc.,

This building shall also have 20 sq.m. Office Room, AC and Non AC stores, and other building facilities including pantry, separate toilets (Ladies& Gents), necessary water supply & drainage system.

Office, AC stores and Control room equipments, SCADA & Energy Management system (EMS) panels shall be air-conditioned and shall be provided with false ceiling arrangement.

Design details of all the facilities described above shall be submitted to NLCIL for approval before execution.

2.4.10.2 **DESIGN:**

The Power Export Sub Station building shall be designed as RCC framed structure with external staircase as per NBC. A portico with RCC slab for a minimum dimension of 4.5mx3.6m shall also have to be provided at the main entrance. All passages/corridors shall be provided with a minimum width of 2.0 m.

2.4.10.3 **RCC WORK**:

All RCC works shall be of M30 grade.

Cement:

Cement of the following Grades shall be used for all works. It shall conform to the following standards.

- 43 Grade OPC IS 8112
- 53 Grade OPC IS 12269
- Portland - Pozzolana Cement IS 1489(Parts 1 & 2)

Steel Reinforcement:

All reinforcement steel used shall confirm IS 1786 and shall grade Fe 415/ Fe500.

The corrosion resistant steel bars alone shall be used in the concrete. The corrosion resistant steel bars manufactured by SAIL/RINL/TISCO, JINDAL/VSPSAIL /SRMB/ SHYAM/ UDYOG/ TATASTEEL/ PULKIT/ TULSYAN/SURYADEV shall be used.

Mix Design & Strength of Concrete:

Before commencement of the concreting works, the Contractor shall get the approval for Mix design. The strength of concrete shall be tested as per latest BIS.

2.4.10.4 **MASONRY WORK:**

Bricks/ solid/hollow blocks used in the works shall conform to relevant IS.

2.4.10.5 **PLASTERING:**

All internal and external surfaces of wall shall have 15 mm thick plastering in CM 1:4. Ceiling plastering shall be 12mm thick in CM 1:3

2.4.10.6 **FLOORING**:

Flooring for stores and HT Switchgear room shall be of cement concrete flooring as per IS 2571. Flooring for office, pantry and SCADA room shall be approved quality vitrified ceramic tile of approved colour and shade, minimum size 600 x600 mm over PCC. Acid resistant tile flooring of 10mm thick confirming to IS4457 shall be provided for Battery room. For pantry room platform, Polished Granite slab of thickness 12 to 16mm shall be used.

2.4.10.7 **ROOFING** - Roof of the Control Room Building shall be sloped Cast-in-situ RCC slab (Grade M 30) treated with waterproofing system.
Concrete/ red clay tiles of approved quality, brand shall also have to be provide over the RCC slab.

2.4.10.8 **DOORS & WINDOWS** - Doors, windows and ventilators shall be provided with electro colour dyed (15 micron thickness) aluminium framework with glazing.
Minimum size of door shall be 1.2 m x 2.1 m. However for toilets minimum width shall be 0.75 m. All doors of toilet areas shall be FRP frame and FRP shutter. All windows and ventilators of all buildings shall be provided with suitable MS Grill. Doors and windows on external walls of the buildings shall be provided with RCC sunshade over the openings with 300 mm Projection on either side of the openings. Projection of sunshade from the wall shall be minimum 600 mm over window openings, 750 mm over door openings & 1000 mm for rolling shutters (other than at main entrance). The Rolling Shutter shall confirm to IS6248 and the size based on functional requirement.

GLAZING: All windows and ventilators shall be provided with 4mm thick tinted glass. For aluminum doors, tinted glass of 6 mm thickness shall be used. All glazing work shall conform to relevant BIS.

2.4.10.9 **FALSE CEILING:**
All A/C rooms (including office rooms) shall be provided with false ceiling of suitable type using approved materials. The false ceiling shall be designed aesthetically and shall be from reputed supplier. The false ceiling design & drawings with light fittings shall be submitted by Contractor to NLCIL for approval, before commencement of work.

2.4.10.10 **PAINTING:**
The emulsion paint for both internal & external walls shall be anti-fungal quality of reputed brand suitable for masonry surfaces for the corresponding rainfall zone of Project site. The ceiling & walls of the Battery room shall be painted with epoxy based paint. All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller. All paints shall be of approved make and quality. Minimum 2 finishing coats of paint shall be applied over a coat of primer. For painting on concrete, masonry and plastered surface IS: 2395 shall be followed. For painting on steel work and ferrous metals, relevant BIS shall be followed.

2.4.10.11 **PLINTH PROTECTION:**
Plinth protection to a minimum width of 0.75m with 75mm thick of cement concrete 1:2:4 over 75mm bed of dry brick ballast 40mm nominal size well rammed and

consolidated and grouted with fine sand/M Sand including finishing the top with suitable slope & edge drain.

2.4.10.12 **TOILET & WATER SUPPLY:**

Heavy Duty Rigid PVC pipes of reputed manufacturer and high quality conforming to IS: 4985 shall be used for all water supply and plumbing works in the building. SINTEX make HDPE storage water tank conforming to IS: 12701 shall be provided over the roof for a capacity of minimum 1000 litres with all required pipeline & fittings.

Each toilet shall have the following minimum fittings.

- WC (Western type) of approved colour with seat cover, low level flushing tank, paper holder, health faucet etc.
- Urinal for Gents Toilet
- Wash basin of approved colour with all fittings.
- Mirror with PVC beading
- Stainless steel towel rail with brackets
- Stainless steel soap holder and liquid soap dispenser.
- Stainless steel sink with drain board in the pantry.

The floor finish for washroom, pantry and toilet shall be vitrified anti-slip tiles and Dado glazed ceramic tiles up to 2.1m shall be used.

2.4.10.13 **SEWAGE SYSTEM**

Adequate sewage disposal arrangements shall be provided. The septic tank shall be designed as per NBC guidelines. The outfall of septic tank shall be led to soak-pit of suitable dimensions for dispersion. The drainage system design and construction drawings of sewage piping / septic tank shall be submitted to NLCIL for approval, before commencement of work.

2.4.11 POWER COLLECTION SUB STATION (PCSS)

2.4.11.1 **GENERAL REQUIREMENTS:**

The PCSS building shall be designed based on topographical survey report & soil testing report, relevant BIS code and National Building Code of India.

The building shall have to house PCUs, HT Switch Gear, Auxiliary power (AC&DC) system and other electronics for communication.

Design details of all the facilities described above shall be submitted to NLCIL for approval before execution.

2.4.11.2 **DESIGN:**

The Power Collection Sub Station building shall be designed as single storey RCC framed structure.

2.4.11.3 **RCC WORK**:

All RCC works shall be of M30 grade.

Cement:

Cement of the following Grades shall be used for all works. It shall conform to the following standards.

- 43 Grade OPC IS 8112
- 53 Grade OPC IS 12269
- Portland - Pozzolana Cement IS 1489(Parts 1 & 2)

Steel Reinforcement:

All reinforcement steel used shall confirm IS 1786 and shall grade Fe 415/ Fe500.

The corrosion resistant steel bars alone shall be used in the concrete. The corrosion resistant steel bars manufactured by SAIL/RINL/TISCO, JINDAL/VSPSAIL /SRMB/ SHYAM/ UDYOG/ TATASTEEL/ PULKIT/ TULSYAN/SURYADEV shall be used.

Mix Design & Strength of Concrete:

Before commencement of the concreting works, the Contractor shall get the approval for Mix design. The strength of concrete shall be tested as per latest BIS.

2.4.11.4 **MASONRY WORK:**

Bricks/ solid/hollow blocks used in the works shall conform to relevant IS.

2.4.11.5 **PLASTERING:**

All internal and external surfaces of wall shall have 15 mm thick plastering in CM 1:4. Ceiling plastering shall be 12mm thick in CM 1:3

2.4.11.6 **FLOORING**:

Flooring, including preparation of surface, cleaning etc. shall be of cement concrete flooring as per IS: 2571 with ironite hardener.

2.4.11.7 **ROOFING** - Roof of the Control Room Building shall be sloped Cast-in-situ RCC slab (Grade M 30) treated with waterproofing system. Concrete/ red clay tiles of approved quality, brand shall also have to be provide over the RCC slab.

2.4.11.8 **ROLLING SHUTTER:**

Rolling shutter of push pull type (Hand operated) shall be standard make and shall confirm to IS: 6248 and the size based on functional requirement.

2.4.11.9 **DOORS & WINDOWS** - Doors, windows and ventilators shall be provided with electro colour dyed (15 micron thickness) aluminum framework with glazing. Minimum size of door shall be 1.2 m x 2.1 m.

Doors, rolling shutter and windows on external walls of the buildings shall be provided with RCC sunshade over the openings with 300 mm Projection on either side of the openings. Projection of sunshade from the wall shall be minimum 600 mm over window openings, 750 mm over door openings & 1000 mm for rolling shutters (other than at main entrance)..

GLAZING: All windows and ventilators shall be provided with 4mm thick tinted glass. All glazing work shall conform to relevant BIS.

2.4.10.10 **PAINTING:**

The emulsion paint for both internal & external walls shall be anti-fungal quality of reputed brand suitable for masonry surfaces for the corresponding rainfall zone of Project site. All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller. All paints shall be of approved make and quality. Minimum 2 finishing coats of paint shall be applied over a coat of primer. For painting on concrete, masonry and plastered surface IS: 2395 shall be followed. For painting on steel work and ferrous metals, relevant BIS shall be followed.

2.4.10.11 **PLINTH PROTECTION:**

Plinth protection to a minimum width of 075m with 75mm thick of cement concrete 1:2:4 over 75mm bed of dry brick ballast 40mm nominal size well rammed and consolidated and grouted with fine sand/M Sand including finishing the top with suitable slope & edge drain.

2.4.12 TWO/ FOUR WHEELER SHED:

The contractor shall provide Two / Four wheeler parking sheds at each project site to house minimum two 4wheelers and ten 2wheelers using MS structural framework with colour coated metal /Galvalume sheet roofing.

SECTION 2.5
BATTERY ENERGY STORAGE SYSTEM (BESS)

The provision for a Battery Energy Storage System (BESS) with the Solar PV Project has been incorporated in the Scheme with the objective of improving the quality of power injected into the grid by Solar PV plants that rely on an intermittent energy resource like Solar radiation and thus, contribute to stable and secure operation of transmission grid. Specifically, the proposed Energy Storage System is intended to be used for PV Power Smoothing application. The utility of BESS for ancillary services including features such as Active Power Regulation services (primary control or Frequency response) etc., shall also be included which is only for demonstrative purpose.

The BESS shall remain connected to the grid as per Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments and its components shall be designed accordingly. BMS shall ensure safe operation and mitigate fire risk. The BESS shall be configured to perform multiple charge discharge cycles.

2.5.1 PEAK SMOOTHING:-

The Prime application of BESS shall be smoothing of power output from the Solar PV plant due to fluctuation in solar radiations. Peak smoothing shall be demonstrated within the deployed battery capacity in MW, for above 75% of the instances within the specified assessment window i.e., when a need for response is detected. BESS should respond in a manner that the combined Solar PV and BESS output at the Point of Common Coupling (PCC) targets the 15 minutes moving average value of the Solar PV array output. BESS shall charge and discharge power at appropriate ramp rate such that the smooth power output from the combined BESS and Solar plant is injected into grid.

For the purpose of smoothing assessment, this BESS application shall be carried out for during solar hours every day. The upper and lower SOC for BESS operation shall be set as per the system requirements. The Battery manufacturer's specification and operating instructions shall be selected in such a way to suit the above requirements. Temporal resolution of the data provided shall be minimum 1 second.

2.5.2 The PV smoothing Index Calculation shall be as follows:

Criteria Code	Description	Criteria
M1	Measure/Count of Instances when the BESS is expected to respond for the smoothing application	Count those records in the 10 hour assessment period (Minimum temporal resolution of one second), where BESS is expected to respond
M2	Count of those instances out of M1 when the BESS successfully responded as required	Count of the instances when power output at PCC (Solar PV output + BESS output) lies within +/- 2% of the 15 minutes moving average of Solar PV Power Output
M3	M2/M1	M3=Ratio between M2 and M1
M4	PV Smoothing index, PVS: The metric for Smoothing Assessment	M3 value of above 0.75 shall be acceptable. At least 90% of the days in a Contract year shall have M3 above 0.75

The PV smoothing Index shall be dynamically calculated in the EMS and if it is less than 0.75, then alarm shall be initiated. As per grid operator requirement or under special emergency grid condition requirement the smoothing of solar PV plant output power intermittency. For this, the detailed control logic shall be submitted for NLCIL approval and finalized during detail engineering.

The BESS shall provide energy up to 30 min by providing immediate injection of a large amount of energy for a short duration during the recovery period after any sudden loss of generation within the power rating of BESS for example due to a passing cloud cover.

2.5.3 FREQUENCY REGULATION:-

Frequency regulation provision shall be incorporated in BESS and the contractor shall not consider any additional battery sizing for this application requirement. The BESS shall be able to support grid during very low or high grid frequency by supplying or absorbing power to/from grid. The power support shall be based on power vs frequency droop characteristic for system frequency outside of the pre-defined frequency dead band (say 49.5 to 50.5 Hz). The operation in this mode shall be initiated by detection of low or high grid frequency while the BESS is in any other mode. After normalization of grid frequency to normal operating range, the BESS shall return to the mode in which it was operating at the start of frequency regulation mode. Within the dead band frequency range the BESS do not have to participate for frequency regulation operation. During detail engineering the actual value of dead band frequency range shall be finalized based on CEA grid regulation.

2.5.4 ANTI-ISLANDING MODE:-

The BESS shall have anti-islanding protection as per IEC 62116 or equivalent international standard

2.5.5 The digital inputs from Inverters, SMUs, Power Conversion System (PCS) of BESS, Outgoing feeders, grid parameters and using other required inputs, the EMS shall ensure that none of the solar fluctuation and intermittency shall affect the grid parameters. Based on the history of data of various grid parameters available in Port Blair including existing 5 MWp Solar Power Project , the forecast shall be finalised during detailed engineering to achieve the above functions in a coordinated way.

2.5.6 Components required to support reactive power shall also be taken into consideration for design of EMS and BESS

2.5.7 The critical parameters such as Response time, Discharge duration, Depth of discharge, Frequency of Discharge, Cycle life, round trip cycle efficiency, performance degradation, self discharge characteristics, short time discharge ratings, transient response characteristics, auxiliary systems requirements etc. shall be finalized during detailed engineering to meet system requirements.

2.5.8 Simulation studies shall be done for various conditions of Solar Generation, Grid condition and fault conditions during detailed engineering. Necessary documents required for obtaining the grid parameters available with Electricity Department. ANI shall be provided by NLCIL. However it is the contractor's responsibility to carry out simulation studies based on available grid parameters and appropriate assumptions. The simulation results shall be the basis for the design of the system and it shall be submitted for approval by NLCIL and Electricity Department, ANI.

2.5.9 The contractor shall submit complete design documents and expected performance of the BESS calculations, drawings, reports and data and other submittals for NLCIL approval during detailed engineering

2.510 Prior to the dispatch of BESS, a unit part of the system which shall represent the final BESS system to be installed at site, shall be taken into Factory Acceptance Test (FAT). It shall be arranged by the contractor in any test place of convenience in the presence of NLCIL and Electricity Department, ANI authorities. This test is envisaged with an aim to minimize malfunctions during installation at site. The tests that cannot be built during FAT shall be simulated and tested as close as possible in a manner corresponding to the final functioning.

2.5.11 Fire protection system (FPS) shall be designed for the BESS in line with NFPA or international norms regulations and CBIP guidelines as applicable and system requirements taking into consideration of the project site at island.

2.512 Power Conversion System (PCS) for BESS shall have efficient cooling and a more compact housing concept. The housing concept must be a closed-concept with an air-conditioning system or a ventilation system and shall be supplied either in a separate compartment or integrated system. The BESS shall be able to supply power at power factor of 0.95 lead-lag during normal operation and should be able to allow grid power factor until 0.8 lead-lag. During the period of back down/surrender, grid outage conditions, the BESS shall be capable of getting charged from Solar PV Power plant on stand alone basis. .

2.5.13 The response of PCS shall be in such a way that it meets the requirements of Energy Management System (EMS) which is in the scope of the contractor as well as Energy Management Centre which is in the scope of Electricity Department, A & N Administration. The Energy Management System (EMS) shall function as the main command centre for the entire plant and receive inputs via SCADA, from Solar PV strings, inverters, HT transformers, Feeders, Battery Management system, Power conversion system, weather monitoring unit, grid parameters etc. the charging and discharging commands shall be issued accordingly.

2.5.14 Test certificates and test reports as per IEC 62133, IEC 61959 and IEC 61960 or other international equivalent standards applicable for the battery technology selected shall be submitted by the contractor for NLCIL approval during detailed engineering. All other test certificates and test reports as per international standards and norms for large scale Battery Energy Storage System shall be submitted for NLCIL approval during detail engineering.

2.5.15 BESS replacements, repairs, substitutions, maintaining spares and consumables etc., shall be programmed and carried out by the contractor so that the annual guaranteed net energy export is achieved. The tie up arrangements including after sales service support for the entire cycle life of the Battery shall be made by the contractor with Battery supplier and the same shall be submitted to NLCIL.

2.516 Load banks devices with dummy loads of capacity suitable for a unit part of BESS specially designed for battery discharge testing shall also be a part of BESS maintenance and testing system at project site..

2.5.17 The contractor shall install and integrate minimum 8MWhr with half hour backup. BESS with 2 x 10 MW (AC) Solar Power Plant. The contractor shall install and integrate more capacity to achieve the annual guaranteed net energy export if required without any extra cost to NLCIL.

2.5.18 The BESS shall consists of components but not limited to the following:

- Battery cells /Modules/stacks
- Power Conversion System, Battery Management System, Control panels and HMI interfaces
- Lightning Arrestor, CT, PT, Protective relays, Control and Metering Panel, Surge Protection devices, Filters etc.
- Panels, Switch gears, cables and distribution boards
- Transformers
- Data communication units
- Auxiliary systems and ventilation systems
- Fire Protection system and suppression system, safety equipments
- Container unit
- Mounting structures and Dike structures
- Civil foundation works and platforms as per Battery Manufacturer's requirement

2.5.19 The contractor shall submit detailed technical particulars, drawings and documents of the above components for NLCIL approval.

2.5.20 BESS PARAMETER:

The following shall be the minimum BESS parameters. Bidder shall submit all technical parameters to assess all BESS functionalities.

S.No	**Parameter**	**Value**
1	Installed capacity of BESS	8 MWhr
2	Rated AC power at PCC	16 MW (45 deg C ambient temperature) at 0.95 PF
3	BESS Round trip AC/AC Efficiency at PCC	To be specified by EPC contractor as per their BESS system
4	Depth of Discharge (DOD)	To be specified by EPC contractor as per their BESS System
5	Battery Efficiency (DC-DC round trip)	To be specified by EPC contractor as per their

		BESS System
6	Guaranteed Minimum service life	minimum 11 years (including 1 year PG period and 10 years O&M)
7	Charging rate	To be specified by EPC contractor as per their BESS system
8	Power factor (Measure at PCC)	Four quadrant capability is required. Operating power factor shall be 0.95 lead or lag
9	Response time: It is the time interval between need for response (a command or grid event or Solar Plant power generation event, etc) is detected by the BESS and the time when power as measured at the grid has attained that level. This shall include all intermediate response time of system components	BESS shall have suitable response time to support smooth injection of solar PV plant output power into grid to achieve PVS above 0.75 at least 90% of the days in a Contract year.
10	Positive and Negative Ramp Rate	BESS shall have suitable positive and negative ramp rate to support smooth injection of solar PV plant output power into grid
11	BESS design temperature	0 – 45 degC ambient

Section 2.6
TESTING, COMMISSIONING, PROVISIONAL TAKEOVER AND PG TEST

2.6.1 On completion of erection, Contractor shall carry out testing, commissioning, operational checks, instrument and device calibrations, control loop checks, interlock and trip checks, etc, based on a systematically planned procedure. All manufacturers' specific recommendations for testing shall be included. All test results shall be provided to NLCIL for verification and acceptance during commissioning of the entire system.

2.6.2 The Contractor shall do clean up of all equipment and area within project site prior to preparing the equipment for trial run and start-up. The start up and commissioning of the entire system shall be executed by the Contractor in a planned coordinated sequence.

2.6.3 Power and control cabling shall be done as per approved scheme and in sections, taking adequate precautions against electrical shocks as the solar PV cells are capable of producing power on exposure to light. Necessary covers shall be supplied for covering the solar PV modules during cabling termination works. Safety precautions and manufacturers recommendations shall be strictly followed for BESS testing and commissioning activities.

2.6.4 Calibration and commissioning of all instruments and control equipment supplied under this contract shall be executed by the contractor. Hardware required for erection of all instruments and control equipment covered under this contract shall be supplied by the contractor.

2.6.5 Pre-commissioning checks, individual loop checks, power initialization, back charging, verification of system functioning, trouble shooting, final solutions to application and / or instrument problems etc., are contractor responsibility. All the required software and hardware changes shall be incorporated as required for successful commissioning to NLCIL's satisfaction. O&M activities from part commissioning up to provisional take over shall be carried out by the contractor at no extra cost to NLCIL. Part commissioning shall be planned in such a way that sub-blocks of Solar PV Plant integrated with sub – blocks of BESS shall be commissioned, interconnected and tuned with grid parameters. On any condition grid power shall not be used for charging BESS, however grid power shall be used for auxiliary system, during unavailability of solar power and BESS discharge power to feed the auxiliaries. The drawl of grid power shall be deducted from the export and the Net Energy Export can be calculated accordingly Energy required for initial charging shall be drawn from Solar PV Power plant.

2.6.6 Supply and erect metallic tags on the equipment / instruments and accessories supplied by the Contractor. The tags and connecting wires shall be of stainless steel and the size of the tags shall be adequate to accommodate tag number.

2.6.7 Follow up of all the required activities to obtain A&N Administration / Central Electrical Inspectors approval for the installation and carrying out any changes called for by the Inspector at no extra cost to NLCIL.

2.6.8 Provisional Take over: On successful completion of commissioning, the Solar PV Power Plant integrated with BESS along with Power Evacuation System shall be Provisionally Taken over with a list of major and minor defects and non conformities prepared jointly by the Purchaser and the Contractor. Differentiation of defects as major and minor shall be jointly discussed and agreed by the Purchaser and Contractor. Upon the completion of commissioning, as soon as practicable, or at such time as may be otherwise agreed to by the parties concerned, the Contractor shall notify in writing to the Purchaser that the entire system is ready for Performance Guarantee Test only after liquidating all the major defects

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2.6.9 The Provisional Acceptance Certificate (PAC) will be issued after necessary checks of works by NLCIL and the contractor fulfilling all contractual obligations. The plant will be operated and maintained by the contractor for one year from the date of issue of Provisional Acceptance Certificate i.e., Provisional Take Over under full warranty conditions for which no payment will be made for the contractor. Performance Guarantee test period of one year will be concurrent with the warranty period of one year. O&M period for balance 10 years shall commence from the date of Final take over i.e., after successful completion of PG test period for the entire plant and other related conditions and the O&M payment will be made as per corresponding price schedules. No O&M payment will be made for the PG test period/warranty period.

2.6.10 **PERFORMANCE GUARANTEE TEST (PG TEST)**

Performance Guarantee Test shall be carried out for the entire system for one year after provisional take over. Guaranteed Net Energy Export in Kwhr from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points shall be as per the following table:

Year	Annual Guaranteed Net Energy Export in Kwhr from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points
PG Period(one year)	268,64,000
1st year O&M	2,65,95,360
2nd year O&M	2,63,26,720
3rd year O&M	2,60,58,080
4th year O&M	2,57,89,440
5th year O&M	2,55,20,800
6th year O&M	2,52,52,160
7th year O&M	2,49,83,520
8th year O&M	2,47,14,880
9th year O&M	2,44,46,240
10th year O&M	2,41,77,600

The procedure for PG test shall be as follows:

a) Minimum two nos. (2) calibrated Pyranometers shall be installed by the contractor at project location mutually agreed by the Contractor and NLCIL. The test report for the calibration shall be submitted by the Contractor for approval by NLCIL. The output of these Pyranometers for the PG test period shall be made available at data logger / SCADA and EMS.

b) "Net Energy Export" shall be recorded in the metering station and shall be taken into account for all contract durations. For this purpose, metering station shall be erected by the contractor as per the requirements of A&N Administration Electricity Department to measure the net energy export. Approval from the Andaman & Nicobar Electricity Administration Authorities in this regard is in the scope of the contractor.

c) "Base Net Energy Export" for a month is computed by correcting the month wise guaranteed net energy export finalised during detailed engineering in the Annexure-1 with a factor taking into account the actual average global solar insolation measured by the calibrated Pyranometer for the PG period as per sl.no. (a) above. The procedure for computation of "Base Energy Export" is detailed in Annexure-2.

d) The measured value of net energy export as per sl.no. (b) above shall be compared with the "Base Net Energy Export" for

arriving at the difference in net energy export for the PG period for one year, which shall be reported as + ve (or) -ve.

If the sum of difference in net energy export for the PG period is (-) ve, there is shortfall in net energy export, based on which the LD for performance will be calculated at the rate and levied as detailed in Annexure -2. No incentive will be paid if there is excess net energy export.

e) The month wise target of net energy export for 11 years with respect to the corresponding Global Horizontal Insolation of the project site shall be submitted along with the calculations for NLCIL approval as per **Annexure 1** format during detailed engineering and this shall be considered for the entire contract period for computing the "Base Net Energy Export".

2.6.11 Following factors shall be considered while computing the "Base Net Energy Export"

i) Actual insolation level at the project site shall be considered while computing the base net energy export. However, effect due to variation of metrological parameters viz., ambient temperature, wind speed, humidity etc., shall not be considered.

ii) During the period of grid outage, back down/surrender, the measured global solar insolation (for the period of Grid outage) shall be excluded to calculate average global solar radiation for the PG period.

iii) During the O&M period due to Battery replacements / substitutions if any shall fall occurs in Annual Net Energy Export in that year/years then the short fall in Annual Net Energy Export shall be limited to maximum three years

iv) Along with Battery replacements/substitutions to meet the Annual Net Energy Export re-powering of Solar PV modules. If required shall also be included in the scope of work without any extra cost to NLCIL

2.6.12 The contractor shall furnish the following during detailed engineering in relation to **Annexure 1** for NLCIL approval.

a. The basis, reference standards and calculations used for arriving at the guaranteed month-wise net energy export data.

b. PV System Design Report with simulation parameters / variants, shading diagrams, production charts, loss diagrams, etc correlating with the above year wise net energy export data.

c. Guaranteed month-wise net energy export into the grid as per simulation carried out using PVSYST version 5.5 or higher version /Sun simulator/equivalent software for correlating with the guaranteed month-wise net energy export data.

2.6.13 The procedure as in 2.6.10 & 2.6.11 shall be followed for the balance 10 years O & M period to calculate the annual net energy export as per annexure 3. For the balance 10 years O&M period, if the sum of difference in annual net energy export for the O & M period is (-) ve, then there is shortfall in net energy export, based on which compensation for shortfall will be calculated at the rate and levied as detailed in Annexure - 3. No incentive will be paid if there is excess net energy export. During 10 years O & M contract period if any repowering of solar PV modules and battery replacement/substitution is required to meet the annual net energy export, the same shall be included in the scope of work without any extra cost to NLCIL.

SECTION 2.7
QUALITY ASSURANCE, INSPECTION AND TESTING

2.7.1 GENERAL

2.7.1.1 The documents related to Manufacturing Quality plan shall be submitted for NLCIL approval.

2.7.2 QUALITY ASSURANCE AND QUALITY CONTROL

2.7.2.1 The Contractor shall submit technical documents along with, comprehensive QA & QC documents proposed to be adopted for this project.

2.7.2.2 All major equipments shall be inspected in line with Manufacturing Quality Plan (MQP) issued by OEM.

2.7.2.3 No dispatches shall be made by the supplier without obtaining clearance for dispatch from NLCIL. Wherever reworks are involved re-inspections may be conducted and all expenditure towards the same shall be borne by the Contractor.

2.7.3 FIELD INSPECTION & TESTING

2.7.3.1 Field Quality Plans (FQP) shall detail out all the site tests / checks to be carried out during receipt, storage, erection of the equipments. The Contractor shall furnish copies of the erection & commissioning manuals, reference documents and inspection procedure through soft as well as hard copy. In the Field Quality Plans, NLCIL will identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of NLCIL officials and beyond which the work will not proceed without consent of NLCIL in writing. After FQP finalization and approval, the same shall be submitted in compiled form.

SECTION – 2.8
SUB VENDORS & SUB CONTRACTORS

2.8.1 Sub Vendors

i. The Contractor is responsible for performance/guarantee of the complete project including bought out items and outsourced processes. The Contractor shall supply the equipment /Component system from the Sub vendors approved by NLCIL.

ii. Bidder shall furnish in their bid, the proposed list of sub vendors for each of the bought out items.

iii. The proposed list of sub vendors furnished by the successful bidder will be finalized before start of detailed engineering.

The categorization of Sub vendors are as follows:

a) **Category – I: Sub vendors accepted:**

The acceptance shall be based on past experience of NLCIL.

b) **Category – II: Sub vendors enlisted for future acceptance**:

Such acceptance shall be based on the various details regarding capacity, capability, and experience etc. of the sub-vendor proposed by the successful bidder. It is the responsibility of successful bidder to get the details and credentials of the sub vendors under category II, compiled and submitted to Purchaser for scrutiny and acceptance. The acceptance criteria are mentioned below. However, Purchaser reserves the right to accept or reject any of the proposed sub vendors based on information available with them.

iv. The consolidated list of sub vendors under category I and category II shall be made available to the successful bidder before start of detailed engineering.

v. Purchaser may consider the bidders proposal for inclusion of new sub vendors, if any, during the execution stage for approval, based on the merits, in the overall interest of the Project, after establishing that the sub vendor proposed meets the acceptance criteria specified. However, price advantage if any, arising out of the inclusion of new sub vendor shall be passed on to the purchaser.

vi. For all other components/equipment/systems which are not figuring in the bought out items list, bidder's standard practice of selecting of vendors may be carried out.

vii. Acceptance criteria for Sub Vendors:

(a) For all Mechanical, Electrical and Control & Instrumentation:

1. **For Class I Items:**

   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. The documentary evidence shall be in the form of Performance certificates furnished by the end user.

2. **For Class II Items:**

   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. The documentary evidence shall be in the form of Material Receipt Certificate/Site Inspection Report/ Installation or erection report etc. from the end user, site/purchaser premises for having received the material.

(b) For structural steel :

1. The structural steel should conform to relevant Indian / International Standards.
2. It should be of reputed make and should have been used in similar construction / infrastructure projects.
3. The Contractor should furnish documentary evidence to prove (1) and (2) above.

(c)For Cement and reinforcement steel:

1. It should conform to Indian / International Standard
2. It should be of reputed makes supplied to similar construction/ infrastructure projects
3. The Contractor should furnish documentary evidence to prove (1) and (2) above if required.

1.8.2 List of Bought out Items for which bidder to propose sub vendors:

2.8.2.1 Class I items:

Sl.No	Equipment list for Class I items	Sub Vendor name
1	Power Conditioning Unit	
2	Array junction Box/Combiner Box with String Monitoring Unit	
3	HT Oil filled Power Transformer	
4	HT indoor switchgear	

5	HT CT	
6	HT PT	
7	UPS	
8	33 KV outdoor breaker	
9	33 KV outdoor CT	
10	33 KV outdoor PT	
11	Surge Arrestor	
12	Isolator	
13	LT Transformer	
14	HT cables	
15	LT power cables/Control Cables	
16	DC Cables	
17	SCADA	
18	Energy Management System	
19	Solar PV Modules	
20	Battery cells(Modules)	
21	Battery Management System	
22	Power Conversion System for BESS	

2.8.2.2 Class II items:

Sl No	**Equipment list for Class II items**	**Sub Vendor name**
1	DC isolator	
2	DC contactor	
3	Numeric Relays	
4	ABT Energy Meter with software	
5	Surge Protection device for SMU	
6	Cable termination kits	
7	LED lamp fixtures for indoor	
8	Flood light fittings with LED for outdoor	
9	Fire protection system	
10	Fire detection alarm panel	
11	HVAC	

2.8.3 Acceptance Criteria for approval of Sub Contractors for erection works.

For Mechanical, Civil, Electrical and Control & Instrumentation erection works are as follows:

In case the bidder is engaging a sub contractor for Mechanical, Civil, Electrical and Control & Instrumentation erection works, documentary evidence shall be furnished in the form of contract award copy and performance certificate (End user's certificate) to show that similar works were carried out and the job has been completed satisfactorily by the sub contractor as on the original scheduled date of

Tender opening and approval shall be obtained from Purchaser, prior to engaging them for Mechanical, Civil, Electrical and Control & Instrumentation erection works.

SECTION 2.9

OPERATION AND MAINTENANCE (O&M)

2.9.1 GENERAL

2.9.1.1 The Bidder shall carry out O&M activities for the entire System including its associated civil structures, roads, Power export Switchyard and control room buildings, Security of the plant Buildings, Garden etc. The O & M activities also includes the entire power evacuation system comprising of UG Cables, transmission lines of grid take off points of the existing 33kV feeders connection point, gantries and allied equipments up to the terminal point of connectivity for a period of 11 years including one year warranty.

2.9.1.2 Operation work includes day-to-day operation of the entire system. The responsibility of ensuring uninterrupted operation of the entire system lies with the contractor or else it will attract penalty/loss of compensation as per relevant clauses of the specification.

2.9.1.3 The contractor shall furnish proposed maintenance (preventive) schedule for the operation and maintenance of the entire system for NLCIL approval. As the O&M contract period is for 11 years including warranty period, the long term maintenance/replacement schedule indicating the unit replacement of parts/equipments, if any, shall also be furnished considering the life of such parts/equipments. Equipment overhaul schedule indicating the loss of generation during such periods, if any, and the proposed catch up plans for maintaining the scheduled/committed generation shall also be furnished.

2.9.1.4 The maintenance staff for the Entire System shall be available at all times in the plant premises.

2.9.1.5 The Contractor shall maintain attendance register for all their staff deployed for carrying out jobs on regular basis and shall be produced for verification on demand by authorized personnel of NLCIL.

2.9.1.6 The Contractor shall ensure that all safety measures are taken at the site to avoid the accidents to his employees or his sub Contractor employees.

2.9.1.7 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.

2.9.1.8 The O & M charges as per price schedule are inclusive of replacement of parts/equipments, systems, spares, consumables, etc.

2.9.2 SCOPE

2.9.2.1 The Contractor shall provide his operation and maintenance staff for the entire system for day-to-day operation and maintenance. The operation and maintenance personnel shall be qualified, certified by competent authorities and well trained so that they can handle any type of operational hazards quickly and timely. The responsibility of providing suitable Personal Protection Equipments rests solely with the contractor.

2.9.2.2 The security of the entire plant area shall rest with the contractor, till final take over by NLCIL after completion of the contract period.

2.9.2.3 The maintenance personnel shall be in a position to check and test all the equipments regularly, so 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 NLCIL not later than 2 hours for taking appropriate action.

2.9.2.4 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 NLCIL indicating nature of fault & cause of damage etc. within 12 hours from the time of occurrence of the fault.

2.9.2.5 During operation and maintenance, if there is any loss or damage to any component of the power plant and the BESS 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 performance of the components shall not be degraded after repairing, otherwise the defective components shall have to be replaced by new one without any extra cost to NLCIL.

2.9.2.6 The scope of maintenance work shall include the following:

2.9.2.6.1 Regular operation and maintenance of the entire System and submission of daily performance to NLCIL. The Contractor shall maintain log book in this respect to clearly record the date of checking & comments for action taken etc.

2.9.2.6.2 The scope of operation and maintenance includes all equipments/accessories of the entire system and proper records of operation of the entire System shall be kept as per direction of NLCIL.

2.9.2.6.3 Cleaning of the entire areas, buildings, array yard, electrical panels, containers etc. shall be carried out on regular basis.

2.9.2.6.4 Normal and preventive maintenance of the entire system shall be carried out on regular basis.

2.9.2.6.5 Keeping & recording daily log sheet as per approved format shall be maintained after commissioning of the entire system.

2.9.2.6.6 Under no circumstances, the contractor shall run the system in such a way that will damage the grid.

2.9.2.6.7 The contractor shall submit monthly Performance report of entire system indicating net 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 system based on SCADA and EMC details for review. Day to day coordination with A & N Administration Electricity department and submitting reports, details required by them shall also under the scope of the O & M contract.

2.9.2.6.8 The Contractor shall preserve all recorded data in both hard copy and soft copy format and shall submit to NLCIL every month.

2.9.2.6.9 The Contractor shall develop & maintain gardens, which shall be developed by the Contractor himself as per landscaping including daily watering and manuring as and when necessary and on regular basis.

2.9.2.6.10 During operation and maintenance period, the Contractor shall refill the fire extinguishers as per manufacturer's recommendation before expiry.

2.9.3 TOOLS AND TACKLES

2.9.3.1 Tools and tackles is not a supply item. A list of tools and tackles which are required for O & M of the entire system shall be maintained by the contractor for use during the O & M period. The contractor shall maintain all regular/special O&M tools apart from the tools and tackles.

2.9.3.2 Such special tools used by the contractor during operation and maintenance period shall be handed over to NLCIL at the time of completion of 11 years O&M period including warranty period.

2.9.4 TESTING INSTRUMENTS FOR ELECTRICAL & ELECTRONICS

2.9.4.1 The Contractor shall provide all details of onsite testing instruments / equipments. Details of equipment / instrument, make, numbers, range, accuracy, etc shall be furnished to NLCIL

2.9.5 SCOPE OF CIVIL MAINTENANCE

2.9.5.1 Cleaning of surface drain, sewerage line, drainage outfall, down pipes, soil pipes, water pipe lines.

2.9.5.2 Repairs, replacements, cleaning of all joineries etc as and when necessary shall be carried out by the contractor.

2.9.5.3 Repairing or replacement, whatever necessary, of doors, window fixtures, toilet accessories, etc in control room and other buildings as and when necessary.

2.9.5.4 Cleaning & maintaining of power plant area clearing all weeds, leaves and other wood rejects. Vegetation removal inside the power plant and also vegetation removal & cutting of trees/branches en route the transmission lines of the power evacuation system up to Grid Connecting substation on periodical basis as directed by NLCIL.

2.9.5.5 Painting of iron parts of array structures posts once in a year.

2.9.5.6 Painting of the buildings, structures/PCSS, Security room, fencing posts, gates, transmission towers, and extension bays etc once in two years.

2.9.5.7 All minor repair maintenance in case of buildings and all other structures as and when required as per the instructions of Project Manager/NLCIL.

2.9.6 **OTHERS**

2.9.6.1 Any Electrical /Civil maintenance work which are not mentioned or included here but necessary for the entire life of the project shall be carried out by the Contractor.

ANNEXURE – 1

Guaranteed Month-wise Net Energy Export at metering station of 33KV switchyard outgoing feeders.

Sl.No.	Month	Estimated monthly average Global Solar Insolation on horizontal plane (kWh / m^2 / Day)	Guaranteed Net Energy Export during O&M			
			PG test period (1st Year) (kWh)	2rd Year (kWh)	3rd Year (kWh)	4th Year (kWh)
			Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points
1	January	5.65				
2	February	6.47				
3	March	6.83				
4	April	6.65				
5	May	5.08				
6	June	4.38				
7	July	4.45				
8	August	4.45				
9	September	4.64				
10	October	4.99				
11	November	4.86				
12	December	5.19				
	Annual	-				

Sl.No.	Month	Estimated monthly average Global Solar Insolation on horizontal plane (kWh / m^2 / Day)	Guaranteed Net Energy Export during O&M			
			5th Year (kWh)	6th Year (kWh)	7th Year (kWh)	8th Year (kWh)
			Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points
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	-				

Sl.No.	Month	Estimated monthly average Global Solar Insolation on horizontal plane (kWh / m^2 / Day)	Guaranteed Net Energy Export during O&M			
			9th Year (kWh)	10th Year (kWh)	11th Year (kWh)	
			Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	Annual Guaranteed Net Energy Export in Kwhr of the smoothened Power from BESS and Solar plant combined measured at 33KV switchyard metering station of the Grid interconnection take off points	
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 for Annexure -1:

1) The basis and reference standards used for arriving at these data shall be furnished.
2) PV Syst Calculations, Design Report with simulation parameters / variants, shading diagrams, production charts, loss diagrams, etc. shall be furnished correlating with the above month wise Guaranteed Net Energy Export data.
3) Design Report calculations and parameters of BESS shall be furnished correlating with the above month wise Guaranteed Net Energy Export data of the smoothened power from BESS and Solar Plant combined, measured at 33KV switchyard metering station of the Grid interconnection take off points .

ANNEXURE 2
COMPUTATION OF SHORTFALL IN NET ENERGY EXPORT (for PG test period)

Sl. No.	Month/ Day/Time	Estimated monthly average Global Solar Insolation on horizontal plane (kWh / m^2 / Day) (a)	Guaranteed Net Energy Export in Kwhr of the smoothened power from BESS + solar combined measured at 33KV switchyard metering station of the Grid interconnection take off points (b)	Measured average Global Solar Radiation on the horizontal surface during PG period at site by Pyrometer kWh / m2 / day (c)	Measured Net Energy Export in Kwhr of the smoothened power from BESS+ solar combined measured at 33KV switchyard metering station of the Grid interconnection take off points (d)	Base Net Energy Export at metering stations of 33KV switchyard outgoing feeders in kWh (e) = (b) x (c)/(a)	Difference in Net energy export in KWhr for the PG period, report as + ve (or) -ve (f)=(d)-(e)
1	Jan	5.65					
2	Feb	6.47					
3	Mar	6.83					
4	April	6.65					
5	May	5.08					
6	Jun	4.38					
7	Jul	4.45					
8	Aug	4.45					
9	Sep	4.64					
10	Oct	4.99					
11	Nov	4.86					
12	Dec	5.19					
Annual		-					

Note for Annexure - 2: (for PG test period)

1. The measured Net Energy export shall be calculated by adding all the net export values of the billing meters installed in the 33 KV Power Export switchyard outgoing feeders.
2. If sum (f) is negative (-), there is shortfall in annual guaranteed Net Energy export during solar hours for PG test period
   I. Short fall in Net Energy export for PG test period (Annually) : _____kWh
   II. LD for shortfall in net energy export for PG test period : Rs. _____Per kWh
   III. Total Penalty payable : Rs. _____ Item (i) x Item (ii)

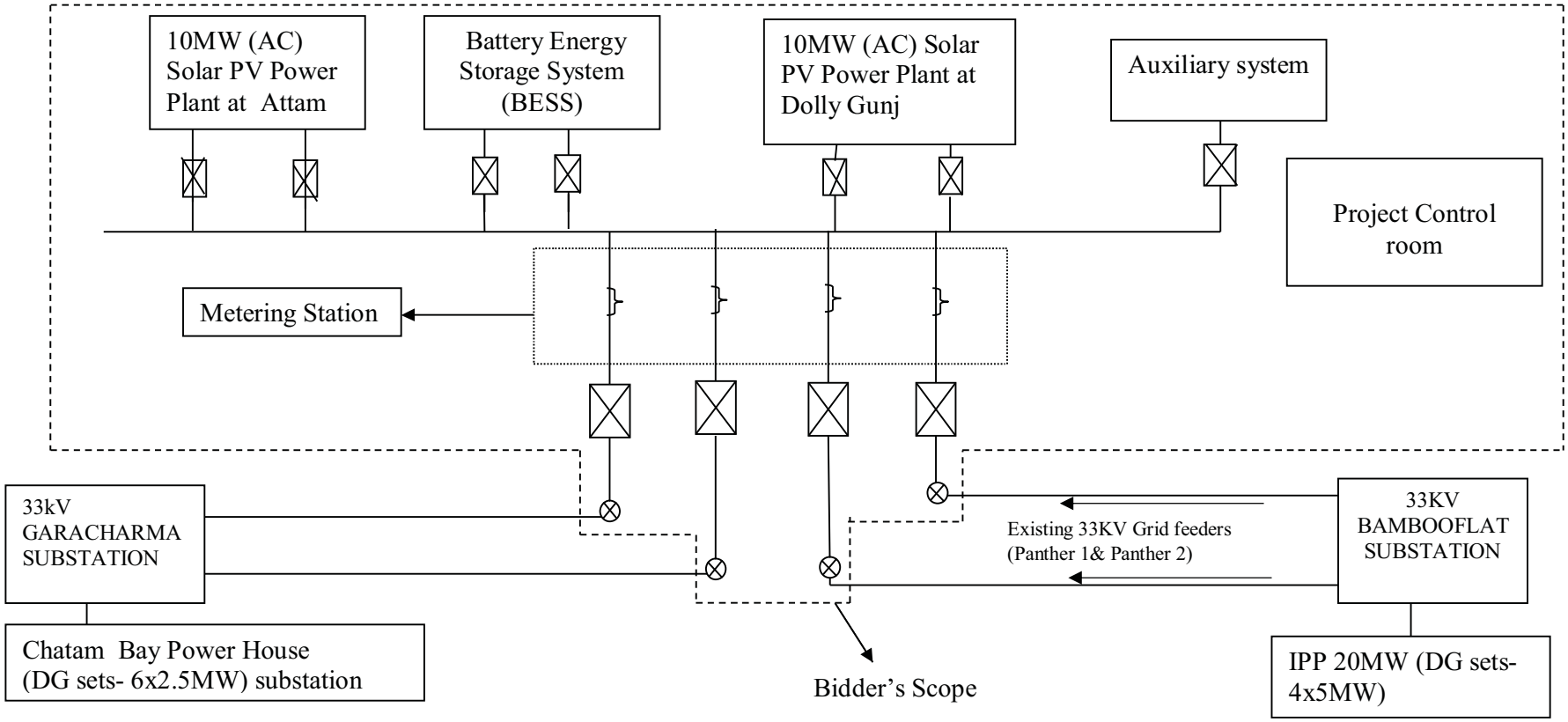
ANNEXURE 3
COMPUTATION OF NET ENERGY EXPORT DURING O & M PERIOD

Sl. No.	Month/ Day/Time	Estimated monthly average Global Solar Insolation on horizontal plane (kWh / m^2 / Day) (a)	Guaranteed Net Energy Export in Kwhr of the smoothened power from solar + BESS combined measured at 33KV switchyard metering station of the Grid interconnection take off points (b)	Measured average Global Solar Radiation on the horizontal surface during PG period at site by Pyranometer kWh / m2 / day (c)	Measured Net Energy Export in Kwhr of the smoothened power from solar + BESS combined measured at 33KV switchyard metering station of the Grid interconnection take off points (d)	Base Net Energy Export at metering stations of 33KV switchyard outgoing feeders in kWh. (e) = (b) x (c)/(a)	Difference in Net energy export in KWhr for the PG period, report as + ve (or) -ve (f)=(d)-(e)
1	Jan						
2	Feb						
3	Mar						
4	April						
5	May						
6	Jun						
7	Jul						
8	Aug						
9	Sep						
10	Oct						
11	Nov						
12	Dec						
Annual		-					

Note for Annexure 3 (For balance 10 years O & M period):

1. The measured Net Energy export shall be calculated by adding all the net export values of the billing meters installed in the 33 KV Power Export switchyard outgoing feeders.
2. If sum (f) is negative (-), there is shortfall in annual guaranteed Net Energy export for balance 10 years O & M period.
   - I. Short fall in Net Energy export for O & M period (Annually) : _____kWh
   - II. Compensation for shortfall in net energy export for O & M period : Rs. _____Per kWh
   - III. Total Compensation payable : Rs. _____ Item (i) x Item (ii)

3. During the O & M period due to Battery replacements/substitutions if any short fall in sum (f) occurs, the corresponding penalty as per 3(iii) shall be deducted in that year/years. If the above shortfall is compensated in the subsequent years Annual Net Energy Export (which shall be limited to maximum three years), then the corresponding amount of compensation shall be returned in the corresponding subsequent years



Note: 1. This block diagram is tentative and for tender purpose only.

2. The entire scheme shall be finalised during detailed engineering to suit Grid/system requirement as per contract conditions.

NLC India Limited	PROJECT: 2X10MW (AC) SOLAR PV PROJECT INTEGRATED WITH 8MWHr BESS, AT ATTAM PAHAD AND DOLLY GUNJ, PORT BLAIR, SOUTH ANDAMN	Title	Drawing No	Rev No: 00
		General Block Diagram	NLCIL/PBD/Andaman/01	Date: 02.03.2018