BID DOCUMENT

E-TENDER for

Design, supply, installation and commissioning including integration to Grid of:

(i) 600 kW Grid connected Solar Power Plant at 132/33 kV Elangkhangpokpi Power Sub-Station, Kakching District, Manipur.

(ii) 800 kW Grid connected Solar Power Plant at 132/33 kV Kakching Power Sub-Station, Kakching District, Manipur.

(iii) 5 MW Grid connected Floating Solar Power Plant at Thoubal Multi-purpose Project Reservoir, near Chadong Village of Kamjong District, Manipur.

and 5 years Maintenance and Performance Warranty Contract (MPWC).

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 dated 25/07/2025

Manipur Renewable Energy Development Agency(MANIREDA)

2nd Floor, South Block, Secured Office Complex, A.T. Line, Near Hotel Imphal, Imphal-795001
E-mail :manireda99@yahoo.com, Website : www.manireda.mn.gov.in

July 2025

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SECTION - I

DISCLAIMER

1. Though adequate care has been taken while preparing the tender document, the bidder(s) shall satisfy themselves that the document is complete in all respect. Intimation regarding any discrepancy shall be given to the office of MANIREDA immediately. If no intimation is received from any bidder within 10 (Ten) days from the date of issuance of Tender documents, it shall be considered that the document is complete in all respect and has been received/ acknowledged by the bidder(s).

2. Manipur Renewable Energy Development Agency (MANIREDA) reserves the right to modify, amend or supplement this document.

3. While this tender document has been prepared in good faith, neither MANIREDA nor their employees or advisors make any representation or warranty, express or implied, or accept any responsibility or liability, whatsoever, in respect of any statements or omissions herein, or the accuracy, completeness or reliability of information, and shall incur no liability under any law, statute, rules or regulations as to the accuracy, reliability or completeness of this document, even if any loss or damage is caused by any act or omission on their part.

Sd/-

Place:
Date:

(N Praveen Singh)
Director, MANIREDA

Office of the

MANIPUR RENEWABLE ENERGY DEVELOPMENT AGENCY (MANIREDA)

(*An Autonomous Govt. Institute under the Power Department*)

2nd Floor, South Block, Secured Office Complex, Near 2nd M.R. Gate, Imphal-Dimapur Road, Imphal-795001

NOTICE INVITING BID

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 dated 25/07/2025

Online Tenders are invited from contending firms for Design, supply, installation and commissioning including integration to Grid of:

i. 600 kW Grid connected Solar Power Plant at 132/33 kV Elangkhangpokpi Power Sub-Station, Kakching District, Manipur.

ii. 800 kW Grid connected Solar Power Plant at 132/33 kV Kakching Power Sub-Station, Kakching District, Manipur.

iii. 5 MW Grid connected Floating Solar Power Plant at Thoubal Multi-purpose Project Reservoir, near Chadong Village of Kamjong District, Manipur.

and 5 years Maintenance and Performance Warranty Contract (MPWC).

Cost of Bid Document	Date &Time for Pre-Bid Meeting	Last date & time For submission of E-Tender	Last date & time for opening of E-Tender
Rs.1500/-	1st August, 2025 at 11.00 a.m	18th August, 2025 upto 12.00Noon	18th August, 2025 at 1.00 p.m.

Tender Document can be downloaded from the websites; www.manipurtenders.gov.in or www.manireda.mn.gov.in. Prospective bidders are requested to remain updated for any amendments/modifications/cancellation, etc. in the bid document conditions/terms from time to time. No separate notifications will be given for such amendments/modifications in the print media (press) or intimated to the bidders separately.

Director, MANIREDA reserves the right to modify/ cancel the Tender without assigning any reason thereof or without bearing any liability, whatsoever, consequent upon such decision.

Sd/-
(N. Praveen Singh)
Director, MANIREDA

BID AT A GLANCE

Sl	Description	Details
1.	Notice Inviting Bid (NIB) No.	MANIREDA/SPP(NESIDS)/2024-25/48 dated 25/07/2025
2.	Scope of Work	i. 600 kW Grid connected Solar Power Plant at 132/33 kV Elangkhangpokpi Power Sub-Station, Kakching District, Manipur. (Location: 24.439275° N, 93.933239° E) ii. 800 kW Grid connected Solar Power Plant at 132/33 kV Kakching Power Sub-Station, Kakching District, Manipur. (Location:24.479800°N ,94.012800°E) iii. 5 MW Grid connected Floating Solar Power Plant at Thoubal Multi-purpose Project Reservoir, near Chadong Village of Kamjong District, Manipur. (Location: 24.858719° N, 94.140437° E) and 5 years Maintenance and Performance Warranty Contract (MPWC).
3.	Cost of bid document	Rs. 1500 (Rupee One Thousand Five Hundred only) by way of NEFT to bank details given below. NEFT should be received by MANIREDA before the date and time specified above for submission of TECHNICAL BID. **Cost of Bid Document is exempted for MSME/NSIC registered Firms.**
4.	Earnest Money Deposit (Refundable for unsuccessful firms)	Rs. 53,39,000/- (Rupees FiftyThree LakhsThirty Nine Thousand) only through online transaction at the account of MANIREDA, and submit self-attested scanned copy mentioning transaction ID along with tender document. Bank details given below.
5.	Pre-Bid Meeting	Date :1st August, 2025 Time :11.00 a.m sharp. Venue: Office of the Director, MANIREDA, 2nd Floor,South Block, Secured Office Complex, AT Line, Imphal or ONLINE
6.	Last date of uploading of bid document in the tender portal	Date : Upto 12.00 noon of 18th August,2025 e-tendering site - https://manipurtenders.gov.in
7.	Opening of Technical Bid	Date :18th August, 2025 Time :1.00 pm sharp. Venue :Office of the Director, MANIREDA, 2nd Floor, South Block, Secured Office Complex, AT Line, Imphal.
8.	Opening of Financial Bid	Financial Bids will be opened only for Technically qualified bidders. Date and Time: Will be informed.
9.	Validity of offer	The offer shall remain valid up to 365 days from the date of submission of offer.

10.	Duration of project	12 (Twelve) months from the date of placement of work order
11.	Notices/amendments/ cancellation to be updated	Prospective bidders are requested to remain updated for any notices/ amendments/cancellation, etc. in the bid document conditions/terms, in the above-mentioned website. No separatenotifications will be issued for such notices/amendments/ clarifications etc. in the print media (press) or intimated to the bidders separately.

Note: The Tender Document Cost and the EMD can be paid through online mode in the following account and receipt / UTR Number shall be uploaded with the Technical Bid Document

Account Holder's Name	**ManipurRenewableEnergyDevelopmentAgency**
Name of Bank	**Bank of India (BOI)**
Account Number	**504210110009560**
IFSC Code	**BKID0005042**
Branch details	**Paona Bazar, Opp. Friends Talkies, Imphal**

2 DETAILED NOTICE INVITING TENDER

A. ABOUT THE BID AND ITS SUBMISSION PERIOD

1. Bid Document:

1.1 MANIREDA/SPP(NESIDS)/2024-25/48 dated 25/07/2025.

1.2 This Bid Document comprises of total 258 pages including Proformas. In addition, any other documents/ instructions/amendments/revisions issued by MANIREDA to the bidder till the due date of opening of the bids shall also be deemed to be the integral part of the bid document. Failure to furnish all the information as per the bid document in every respect will be at the bidder's risk.

1.3 The Technical Bids and Financial Bids will be opened on the date and time mentioned in the tender website in the Office of the Director, MANIREDA, 2nd Floor, South Block, Secured Office Complex, AT Line, Near Hotel Imphal, Imphal in presence of bidders or their authorized representatives. The representative should produce authorization letter to attend the bid opening meeting as per Proforma - 2.

2. Cost of Bid Document:

2.1 Bidders can download the Bid Document from Manipur E-Tender website (www.manipurtenders.gov.in) and MANIREDA website (www.manireda.mn.gov.in) and submit the cost of the bid document amounting Rs. 1500.00 along with Technical Bid. Cost of Bid Document is exempted for MSME/NSIC registered Firms.

3. Earnest Money:

3.1 EMD for an amount of Rs. 53,39,000/- (Rupees Fifty Three Lakhs Thirty Nine Thousand) only shall be submittedthrough online transaction at the account of MANIREDA, and submit self-attested scanned copy mentioning transaction ID alongwith the technical bid. However, the EMD will be exempted for MSME/NSIC registered Firms.

3.2 The earnest money shall be returned to all unsuccessful bidders in technical evaluation, within 3 weeks. No interest will be paid on EMD.

3.4 The earnest money shall be forfeited if –

- Any bidder withdraws his/her bid during the validity period of the bid.
- The successful bidder fails to furnish his acceptance of the Order within fifteen days of placement of Work Order by MANIREDA.
- The bidder fails to successfully complete the work within the stipulated time frame. Delay in completion due to extreme and unavoidable situations will have to get approved by Director, MANIREDA.

4. Pre- Bid Meeting:

4.1 A Pre-Bid Meeting will be held at the Office of Director, MANIREDA at 11.00 a.m. on 1st of August, 2025 in online /offline mode.

4.2 All the Bidders should visit and familiarize the installation sites before submission of their bids.

4.3 All the Bidders should attend the Pre-Bid Meeting, otherwise the Bid is liable to be rejected.

5. Submission of Bids:

Bidders have to upload the documents in the E-tender website (https://manipurtenders.gov.in).

5.1 Bidders are advised to submit their bids strictly based on the specifications, terms and conditions contained in the bid document and subsequent revisions/amendments, if any.

5.2 The bid shall be prepared and submitted by typing or printing in English with indelible black ink on white paper in consecutively numbered pages duly signed by the authorized signatory with company seal affixed on each page. Any part of the bid, which is not specifically signed by the authorized signatory and not affixed with company seal, shall not be considered for the purpose of evaluation.

5.3 Total number of pages should be clearly mentioned and certified by competent authority.

5.4 Original copy of bid document, amendments/revisions to bid document, including minutes of meeting(s), issued by MANIREDA, if any, shall be signed and submitted online along with the bid.

5.5 All the Proformas must be on the bidder's official letterhead. Any change in wording of the Proforma will lead to rejection of the bid application.

5.6 The offer shall contain no erasures or overwriting except as necessary to correct errors made by bidder. Such corrections, if any, shall be initialed by the person signing the offer.

5.7 MANIREDA reserves the right to reject part or whole of the bid/order without assigning any reason thereof, postpone the date of receipt and opening of the bids or cancel the bid without bearing any liability, whatsoever, consequent upon such decision.

5.8 Attestation of various documents enclosed along with the offer must be done by a competent authority or by the Proprietor of the Firm.

6. Mode of Submission of Bids:

Bidders have to upload document as stated below:

6.1 The bidder shall upload the scanned copies of the following documents with Digital Signature certificate in the E-tender:

(i) Scanned copy of Tender Fee and scanned copy of Earnest Money Deposit (EMD).
(ii) Forwarding Letter (Proforma -1).
(iii) Authorization letter for attending Bid Opening Meeting (Proforma-2).
(iv) Information about the Bidding Firm (Proforma-3).
(v) Details of Work Orders Received and Executed in Past 3 years (Proforma-4).
(vi) A summarized sheet of turnover for last 3 yrs certified by registered Chartered Accountant.
(vii) GST Registration Certificate of Company/Firm.
(viii) GST Clearance Certificate/ latest GST return filing proof.
(ix) Latest Professional Tax receipt/challan from the Deptt. of Taxes.

6.2. The bidder shall download the template of Price Bid/Schedule of Works /Bill of Quantity (BOQ) as mentioned in the Proforma-11 which is uploaded in the Tender in the aforesaid site (https://manipurtenders.gov.in). After downloading the BOQ, the bidder shall fill their rate & quantity of the items as per BOQ, digitally signed and upload the filled BOQ in the same site.

6.3. The Bidder shall quote price as per the Price Bid/Bill of Quantity (BOQ) uploaded on the E-Tender portal.

6.4. A person signing the bid document or any document forming part of the bid document shall be

deemed to warrant that he has authority to bind such offer/ document and if on enquiry it appears that the person signing had no authority to do so, MANIREDA may, without prejudice to other civil and criminal remedies, cancel the bid/contract and hold the signatory liable for all costs and damages.

B. ELIGIBILITY CRITERIA

7.0 QUALIFYING REQUIREMENTS (QR)

Qualification of the bidder(s) will be based on their meeting the minimum eligibility criteria specified below regarding the Bidder's General Standards, Technical Experience and Financial eligibility as demonstrated by the Bidder's responses in the corresponding Bid documents. The bid can be submitted by an individual company or by a Joint Venture/Consortium of not more than **02 (Two)** companies. (Specific requirements for Joint Ventures/Consortium are given below).

7.1 GENERAL ELIGIBILITY CONDITIONS

The bidder should be an Indian company registered in India and may be a Group companies or Holding company or Subsidiary company of a company meeting the technical and financial eligibility requirement (s) as set forth in this section. Further, Government owned Enterprises registered and incorporated in India are also allowed to participate in this tender. However, the bidders against whom sanction/debarment/blacklisting for conducting business is imposed by Government of India, are not allowed to participate.

In case of registered Companies, the copies of Certificate of Incorporation shall be provided along with the bid documents.

7.2 TECHNICAL ELIGIBILITY CONDITIONS

The bidder should have experience in EPC execution of Floating Solar Projects on Turnkey basis including Design, Supply, Installation and Commissioning of Grid connected Solar PV Power Plant of cumulative Capacity not less than 2.5 (Two point Five) MW AND EPC execution of Ground mounted Solar Projects on Turnkey basis including Design, Supply, Installation and Commissioning of Grid connected Solar PV Power Plant of cumulative Capacity not less than 600 (Six Hundred) kW in last three Financial years as on last date of bid submission. However, such Grid connected Solar PV Power Plant capacity must have been in satisfactory operation for at least six (06) months prior to the last date of bid submission.

7.3 FINANCIAL ELIGIBILITY CONDITIONS

The Minimum Average Annual Turnover (MAAT) of the bidder in the last 3 financial years should be over Rs. 10 crore only (for floating solar) and over Rs. 3 crore (for ground mounted solar power plant) each year. MAAT shall mean Revenue from Operations as incorporated in the profit & loss account excluding other income, e.g. sale of fixed assets. This must be the individual company's turnover and not that of any group of Companies. A summarized sheet of average turnover, certified by a practicing Chartered Accountant/Statutory Auditor should be

compulsorily enclosed along with corresponding annual accounts.

AND

The net worth for the last financial year should be positive. "Net Worth" of the Bidder shall be calculated as per the Companies Act, 2013.

7.4 JOINT VENTURE & CONSORTIUM CONDITIONS:

In case the bid is submitted by a Joint venture (JV) or Consortium of two companies as partners, they must meet the following requirements:

7.4.1 The Lead partner/member of the JV/Consortium shall meet individually 100% of Technical Eligibility Conditions given at para 7.2 above.

7.4.2 TheJV/Consortium partners/members must meet collectively 100% Financial Eligibility Conditions given at para 7.3 above.

7.4.3 In the case of a joint venture/Consortium, all members shall be jointly and severally liable for the execution of the entire Contract in accordance with the Contract terms. The JV/Consortium shall nominate the Lead partner/Member of the JV/Consortium who shall have the authority to conduct all business for and on behalf of any and all the members of the JV/Consortium during the Bidding process and, in the event the JV/Consortium is awarded the Contract, during contract execution.

7.4.4 MANIREDA may assess the capacity and capability of the bidder, to ascertain that the bidder can successfully execute the scope of work covered under the package within stipulated completion period. This assessment shall inter-alia include (i) document verification, (ii) bidder's facilities visit, (iii) details of works executed, works in hand, anticipated in future & the balance capacity available for the present scope of work, (iv) details of plant and machinery, testing facilities, design capabilities, manpower and financial resources, (v) details of quality systems in place, (vi) past experience and performance, (vii) customer feedback, (viii) banker's feedback etc.

7.4.5 All partners of JV / Consortium shall produce UDYOG Aadhaar Certificate of MSME to avail applicable exemptions for MSME.

MANIREDA reserves the right to waive minor deviations if they do not materially affect the capability of the Bidder to perform the contract.

7.5 Bidder should have Test Reports for the components of Solar Power Plants like Modules, PCU/Inverter, PV module, Energy Meter/Net Meter, ACDB, DCDB and other balance of materials etc. from an approved/ competent testing centres as per requirements under the JNNSM scheme of the MNRE, GOI.

7.6 The bidder should have/willing to open adequate field service setup to provide good after sale services including necessary repair and maintenance in the state of Manipur within a month after empanelment preferably in Imphal. The service centre should be located at customer friendly area with minimum infrastructural requirements, maintenance of adequate spares with competent and trained technicians.

7.7 The Bidder should have valid GST Registration certificate, GST Clearance Certificate/ latest GST return filing proof. Copies of all these must be enclosed.

7.8 A summarized sheet of turnover certified by registered CA should be compulsorily enclosed.

7.9 The Bidder must submit the latest Professional Tax receipt/challan from the Deptt. of Taxes.

C. SCOPE OF WORK

8.0 Scope of Work:

8.1 Detailed Scope of Work as mentioned in the Scope of Work and Technical Specifications section. MANIREDA reserves the right to amend the scope of work, accept or reject any or all the offers/bids, in part or in full or cancel/withdraw the invitation for bids without assigning any reasons whatsoever and in such case, the bidder/intending bidder shall have no claim arising out of such action.

8.2 The Bidder shall carefully check the specifications and shall satisfy him/herself regarding the technical requirement and completeness of the equipment/system. MANIREDA shall examine whether the bid is complete in all respects and conform to the stipulated requirement of the technical specifications and tests reports. The bid having material deviation shall be rejected as being non-responsive. If any amendment in specification is made by MNRE during implementation of this project, the same shall be followed by MANIREDA.

8.3 The bidders should beforehand thoroughly familiarized with the site to be installed, incidental expenditures/ charges on transportation, installation and maintenance expenses etc. They should also access the local conditions including prevailing law and order problems before submitting their offer. Any claim on change/ increase in the rate/price/cost of the work due to any reason will not be entertained at any circumstances.

8.4 MANIREDA, if required, may at its discretion obtain clarifications on offers by requesting clarifications from any or all the bidders at any time prior to Financial Bid opening. Such request for clarification and the response shall be in writing.

8.5 It is not necessary to select the lowest quoted rate. MANIREDA reserves the right to decide the reasonable price/rate for successful implementation of the project.

8.7 All the components including power plant, software's and other components mentioned should be quoted as a single item. No partial quotes are accepted. For all the equipment the bidder should have an authorisation certificate from OEM(Original Equipment Manufacturer).

The above stated requirements are compulsory to be fulfilled by the tenderer and MANIREDA may also ask for any additional information as may be deemed necessary in public interest.

D. PAYMENT TERMS

10.0 Terms of Payment

Subject to availability of fund, payment will be made as below:

10.1. Up to Thirty percent (30%) of amount of the work order value {excluding Maintenance and Performance Warranty Contract (MPWC) charges} shall be paid by the purchaser on Pro Rata basis against supply, receipt and acceptance of Materials at site on submission of Contractor's detailed invoice with packing list identifying contents of each shipment, evidence of dispatch (GR/ LR copy), Manufacturer's/ Contractor's Guarantee/Warranty certificate, and submission of the certificate by the MANIREDA's official that the item(s) have been received.

10.2 60% of the amount of the work order value {excluding Maintenance and Performance Warranty Contract (MPWC) charges} shall be paid by the purchaser after successful installation, commissioning of all the THREE Solar PV Power Plants (5 MW FSPV plant, 800 kW Ground Mounted and 600 kW Ground Mounted Solar PV plants) and injection of power into the MSPCL/MSPDCL grid confirming to technical specification and OPERATIONAL ACCEPTANCE TEST as specified in this bid document and verification by MANIREDA, on

submission of invoice with all necessary test certificates to the purchaser.

10.3 10% of the total contract value shall be treated as performance security and shall be paid against satisfactory performance of the Solar PV Power Plant during warrantee, operation and maintenance period which includes maintaining a minimum annual performance ratio of 75%. This amount shall be paid by the purchaser in 5 equal annual instalments, starting from completion of one year from the Date of Commissioning at site.

The Date of Commissioning at site to be considered will be the last Date of Commissioning among all the three plants (5 MW FSPV plant, 800 kW Ground Mounted and 600 kW Ground Mounted Solar PV plants).

The bidder shall have to submit annual performance & functionality report duly attested by the MANIREDA official for the release of these payments in annual basis.

10.4 Copies of invoices after inspection shall be submitted to MANIREDA along with Project Completion Report, Photographs along with details of module, inverter/PCU, Net- metering etc. for the Grid connected Solar power plant installed, and other required documents.

10.5 Tax clearance certificates of the firm should be produced as and when insisted by MANIREDA.

10.6 All payments shall be released by MANIREDA through e-payment through RTGS/account transfer for which the following mandatory information is to be furnished by the contractor as below:

Name of the Firm to whom paymentistobe made	Nameo f bank	Bank Branch address	Account Number	Type of account	MICR Code	IFSC code	PAN No.

E. PERFORMANCE GUARANTEE

11. Performance Guarantee:

The contractor has to deposit @5% of the project cost (excluding MPWC cost) as Performance Guarantee in terms of irrevocable Bank Guarantee for the tenure of the contract including MPWC period. For the successful bidders, the EMD submitted may also be adjusted as part of the Performance Guarantee, but the firm has to submit the balance in the form of BG to make requisite 5% Performance Guarantee. If the performance of the Solar systems fails to confirm to the laid down systems specifications mentioned in this Bid Document or any deviation/compromise has been observed in the system specifications etc., the performance guarantee deposit of the firm shall be forfeited.

F. Bid evaluation

12 **Bid Evaluation Process:**

The evaluation process comprises of the following steps:

Step I - Evaluation check of Bid as per the eligibility criteria

Step II – Evaluation of Technical Bid

Step III - Evaluation of Price Bid

Step IV - Selection of successful Bidder.

12.1 Responsiveness check of technical bid

The evaluation check of Bid submitted by Bidders shall be scrutinized to establish responsiveness to the requirements laid down in the bid document.

- Bids that are incomplete, i.e. not accompanied by any of the applicable formats inter alia covering letter, power of attorney, format for disclosure, valid Bid Bond etc.;
- Bid not signed by Bidder in the manner indicated in this bid document;
- Material inconsistencies in the information /documents submitted by the Bidder, affecting the Eligibility Criteria;
- Information not submitted in the formats specified in this bid document;
- Bid being conditional in nature;
- Bid not received by the Bid deadline;
- Bid having Conflict of Interest;
- Bidder delaying in submission of additional information or clarifications sought by MANIREDA as applicable;
- Bidder makes any misrepresentation.

Each Bid shall be checked for compliance with the submission requirements set forth in this bid document before the evaluation of Bidder's responsiveness for fulfilment of Eligibility.

12.2 Evaluation of bidder's fulfilment of eligibility criteria:

Evaluation of Bidder's eligibility will be carried out based on the information furnished by the Bidder as per the prescribed Formats and related documentary evidence in support of meeting the Eligibility Criteria. Non-availability of information and related documentary evidence for the satisfaction of Eligibility Criteria may cause the Bid to be non-responsive.

G. GENERAL TERMS AND CONDITIONS:

13.0 Cost of Bidding and Contract Price:

13.1 The Bidder shall bear all costs associated with the preparation and submission of the Bid. MANIREDA will in no case, be responsible or liable for these costs, regardless of the outcome of the bidding process.

13.2 The bidder whose bid is not accepted shall not be entitled to claim any costs, charges, expenses and incidental incurred by him through or in connection with his submission of bid, even though MANIREDA may decide to withdraw the notice inviting bid.

13.3 It is specially emphasized that it shall be the responsibility of the Bidders to have themselves familiarized with the prevailing conditions and that no claim relating thereto for additional payment or adjustment of a Contract price will be acceptable after the submission of their Bid.

14.0 Validity of Offer:

14.1 Unless otherwise specified, the bidder shall keep his tender valid initially for a period of 365 days from the due date of submission of the offer.

15.0 Award of Contract/Work Order:

15.1 The contract/work order shall be awarded to the bidder whose financial Bid is acceptable/approved by the Appropriate Tender Committee to undertake the work at the discovered rate and on approval of the authority of MANIREDA.

16.0 Effective Date of Contract:

16.1 The effective date of commencement of execution of the order by the selected contractor shall be the date of issue of the Purchase/Work Order.

17.0 Contract Price:

17.1 The total contract price and 5 years MPWC in full and complete set including Floating Platforms, Anchoring and Mooring Systems, SPV modules, Control electronics, Inverter, Energy meter/Net Meter, mechanical components, Transformers, Switchgears, SCADA etc. should be quoted online in Price Schedule/BOQ.

17.2 The income tax shall be deducted as applicable at the existing rate.

17.3 During the period of the contract, MANIREDA may increase or decrease in quantities/capacities which the bidder shall comply. The adjustment in Contract Price shall be made at the same unit rate as per Price Schedule/BOQ.

18.0 Statutory Variations in Taxes and Duties:

18.1 The adjustment in the Contract Price towards imposition of new taxes or abrogation of existing taxes due to statutory variation shall be applicable only if the new tax is enacted or existing tax is abrogated within contractual delivery/execution period. For any upward variation due to enactment of new tax or abrogation of existing tax after contractual delivery/execution period, adjustment in the Contract Price shall not apply, although for any downward variation, MANIREDA shall make necessary adjustment in the rate of the items.

18.2 The Supplier shall bear and pay all liabilities in respect of statutory variations in taxes and duties and imposition of new taxes and duties that may be imposed after the contractual delivery/execution dates, as originally stipulated, in case the delivery dates are extended due to reasons attributable to Supplier.

19.0 Agreement:

19.1 The Supplier/Contractor(s) have to enter into an agreement within two weeks, in the office of the Director, MANIREDA in prescribed format before commencement of supply/services.

20.0 Inspection of the Factory and Tests:

20.1 MANIREDA reserves the right to inspect the manufacturer's works/factory to ascertain the capability/availability of necessary equipment & infrastructure required for the items offered before dispatch of the materials.

20.2 MANIREDA shall have access and right to inspect the work or any part thereof at any stage.

20.3 MANIREDA shall have the right to inspect and test the goods to confirm their conformity to the technical specifications after delivery of goods to consignee.

20.4 Successful bidder shall inform MANIREDA at least 25 days in advance of schedule dispatch.

21.0 Dispatch Instructions:

21.1 All items/equipment may be subjected to pre-dispatch inspection by Director, MANIREDA or its authorized representative(s) as per relative standards/provisions approved by MANIREDA before dispatch of items. Cost of inspection by officials (not more than two) would be borne by the successful bidder.

22.0 Transit Insurance:

22.1 Transit Insurance shall be arranged by the Supplier for his total supplies. In case of any damage/loss/pilferage/non-delivery during transit, the Supplier shall lodge the claim and settle the claim with the insurance agency. The Supplier shall also arrange replacement of the damaged, lost/pilfered items expeditiously pending settlement of commercial implications with insurance agency, if any, so as not to hamper the working of the system. The resultant loss if any due to failure of Supplier to comply with the above shall be to the account of the contractor.

23.0 After Sales Service and Availability of Spare Parts:

23.1 The Supplier shall depute authorized Service Engineer within 3 days from the date of the intimation of fault, and establish sufficient inventory of spares, well trained technicians in the State of Manipur in consultation with MANIREDA to provide satisfactory and uninterrupted services during the guarantee/ MPWC period for which a servicing centre must be established at Imphal. Address, contact number etc. of the Servicing centre must be submitted before commencement of the work.

24.0 Completion Schedule:

24.1 The completion of project as per scope of work and conditions of the contract/order shall be completed within 12 (Twelve) months from the date of issue of the Work Order whichever is earlier.

25.0 Guarantee/Warranty Period:

25.1 The manufacturer must provide guarantee which include servicing & replacement guarantee for parts and components (such as electronics, inverters, meters etc.) of grid connected rooftop Solar Power Plant for 5 (five) years. For PV modules, it must be warranted for its output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years from the date of commissioning the SPPs at site & demonstration of performance to the MANIREDA (As per MNRE guidelines).

25.2 The guarantee card to be supplied with the systems must be in original and contain the details of the system supplied as given in the Proforma - 6. The manufacturers can also provide additional information about the system and condition of guarantee as necessary.

25.3 Supplier/contractor shall without prejudice to any other clauses of the order repair/replace the defective parts and restore the system to satisfactory working/performance within 7(seven) days of intimation of fault without any additional cost to MANIREDA within the period of guarantee/ MPWC.

26.0 Assignment/Sub Letting/Pre Bidding Tie Up:

26.1 The Supplier/contractor shall not assign or sublet the supply, shop testing, packing & forwarding, transportation, transit insurance etc., in whole or part, its obligationsto any third party to perform under the order/contract.

26.2 In the event the Supplier contravenes this condition, MANIREDA reserves the right to reject the equipment/work sub-contracted and procure the same from elsewhere at Supplier's risk and cost. The Supplier shall be solely liable for any loss or damage which MANIREDA may sustain in consequence or arising out of such replacing of the contract work.

26.3 In case, the installation & commissioning and MPWC is planned to be carried out in collaboration with other party, the bidder has to sign MoU with the party on a Non-judicial stamp paper of value not less than Rs. 100/- and submit a copy of the MoU along with the bid. The MoU shall clearly indicate division of scope of work between the prime bidder and his sub-vendor and terms of payment. However, the total responsibility of work will remain with the prime bidder.

27.0 Liquidated Damages for Delay in Completion:

27.1 The completion period for the assignment must carefully be worked out and all resource & work planning is to be done accordingly with flexibility for adjustments.

27.2 If the Supplier fails in the due performance of the contract to deliver and commission any part of the equipment or complete the work within the scheduled date for any reason other than due to Force Majeure conditions or any extension thereof granted to him/her by MANIREDA, he/she shall be liable to pay to MANIREDA as pre-agreed liquidated damages but not by way of penalty on account of delayed successful commissioning, a sum equal to 0.1% of total contract value per week of such delay, or part thereof, subject to maximum of 5% of the Total Contract Value.

27.3 The liquidated damages for delayed completion shall be recovered from the Supplier’s Bill / Bank Guarantee deposited as Performance Guarantee.

27.4 Deductions/payment of liquidated damages shall in no way relieve the Supplier from his contractual responsibility to complete the works.

28.0 Cancellation of Order:

28.1 MANIREDA will be at liberty to terminate in part or full the awarded contract without prejudicing its rights and affecting the obligations of the Contractor by giving Fifteen (15) days notice in writing in the following events:

(a) If the Supplier is found defaulter for delayed supply or failure to deliver satisfactory performance or supply of substandard materials pursuant to NIB conditions.

(b) If the Supplier/Vendor fails to comply with the provision(s) of the contract including the responsibilities to fulfill the 5 years maintenance and performance warrantee contract as per the provisions mentioned in this bid document.

(c) If the Supplier/Vendor is involved in any action of moral turpitude.

29.0 Arbitration:

29.1 All disputes or differences, whatsoever, arising between the parties out of or in relation to the construction, meaning and operation or effect of this contract or breach thereof shall be settled amicably.

29.2 If, however, the parties are not able to resolve them amicably, the same shall be settled by arbitration in accordance with the Rules of Arbitration of the Indian Council of Arbitration and Conciliation & Arbitration Act 1996 and the award in pursuance thereof shall be binding on the parties.

29.3 The venue of arbitration proceeding shall be within Jurisdiction of Court of Law at Imphal only.

29.4 Work under this contract shall be continued by the Supplier during the arbitration proceedings, unless otherwise directed in writing by MANIREDA or unless matter is such that the work cannot possibly be continued until the decision of the Arbitrator is obtained.

30.0 Force Majeure:

30.1 Should at any time during the continuance of the contract the performance in whole or in part of any obligations by either party under this contract be held up by reasons of any war, hostility, acts of foreign enemy, civil commotion, sabotage, fires, floods, earthquakes, explosions, epidemics, cyclones, quarantine restrictions, Governmental regulations, law & order and other proclamation etc. (hereinafter referred to as "Events") then, provided notice of the happening of any such eventuality is given by either party to the other within 15 days from the date of occurrence thereof neither party shall, by reasons of such eventuality, be entitled to terminate this contract, nor shall either party have any claim for damages against the other in respect of such non-performance or delay in performance, and the work under this contract shall be resumed as soon as practicable after such eventuality has come to an end or ceased to exist.

30.2 Should one or both the parties be prevented from fulfilling their contractual obligations by a state of force majeure, lasting continuously for a period of at least four (4) weeks, the two parties should consult each other regarding the further implementation of the contract.

30.3 The above-mentioned force majeure conditions/clause shall also apply in the works of sub-contractors/suppliers of the contractor.

30.4 However, the Supplier shall not be liable for liquidated damages or termination/ cancellation of order/contract if and to the extent that its delay in performance or other failure to perform its obligations under the contract is the result of an event of force majeure.

SECTION - II

Scope of Work & Technical Specifications

PART – I

600 kW (AC) and 800 kW AC Ground Mounted Solar PV Plant

DISCLAMER:

(1) Though adequate care has been taken while preparing the Bidding documents, the Bidders shall satisfy themselves that the document is complete in all respects. Intimation of any discrepancy shall be given to this office immediately. If no intimation is received from any Bidder within a week (7) days from the date of notification of Bid documents, it shall be considered that the Bid documents are complete in all respects has been received by the Bidder.

(2) MANIREDA reserves the right to modify, amend or supplement this Bid documents including all formats and Annexure.

(3) While this bidding documents have been prepared in good faith, neither MANIREDA or its authorized representatives make any representation or warranty, express or implied, or accept any responsibility or liability, whatsoever, in respect of any statements or omissions herein, or the accuracy, completeness or reliability of information, and shall incur no liability under any law, statute, rules or regulations as to the accuracy, reliability or completeness of this bidding documents, even if any loss or damage is caused by any act of omission on their part.

(4) The specifications mentioned for all the equipment which include Solar modules, PCU, combiner boxes, DC cables, module mounting structures, transformer, CT, PT, LT/ HT cables, interfacing panels, switch gears & other associated equipment etc., to complete the power generation and evacuation to the designated substation, in the present bidding documents are for Reference only. It is subject to revision/ alteration as per the design/ planning/ good engineering practices etc., to be carried out by the selected bidder, to the satisfaction of MANIREDA or its authorized representatives. It is advised that the bidders must satisfy him/her with the prevailing sites conditions before design/plan. The design must be optimized as per the sites conditions and to achieve the maximum output from the installed capacity at all times. Moreover, the components not separately mentioned, but are required to complete the project for operation is also included in the scope of bidder and shall be vetted by MANIREDA or its authorized representatives.

Design Philosophy

(1) The main objective of the design philosophy is to construct the project with in-built Quality and appropriate redundancy to achieve high availability and reliability with minimum maintenance efforts. In order to achieve this, the following principles shall be adopted while designing the system.

- Adequate capacity of SPV modules, PCUs, Junction boxes etc. to ensure generation of power as per design estimates. This will be done by applying liberal de-rating factors for the array and recognizing the efficiency parameters of PCUs, transformers, conductor losses, system losses, sites conditions etc.
- Use of equipment and systems with proven design and performance that have high availability track records under similar service conditions.
- Selection of the equipment and adoption of a project layout to ensure ease of maintenance.
- Strict compliance with approved and proven quality assurance (QA) systems and procedures during different stages of the project, starting from sizing, selection of make, shipment, storage (at sites), during erection, testing and commissioning.
- Proper monitoring of synchronization and recording, to ensure availability of power to the grid.

- The project Data Acquisition and Control System should be designed to ensure high availability and reliability of the project to assist the operators in the safe and efficient operation of the project with minimum effort.
- It should also provide the analysis of the historical data and help in the project maintenance people to take up the project and equipment on predictive maintenance.
- System design shall have intelligent protection mechanism which may include very fast responsive microprocessor-based relays etc., so that any disturbance from the grid will not cause any damage to the equipment of the Solar Power Project.

(2) The basic and detailed engineering of the project shall aim at achieving high standards of operational performance especially considering following:

- Solar Power Project should be designed to operate satisfactorily in synchronization with the grid within permissible limits of high voltage and frequency fluctuation conditions. It is also extremely important to safeguard the system during major disturbances, internal and external surge conditions while ensuring safe operation of the project.
- Module Mounting Structures shall be designed for stability under design wind load conditions specified in this document while optimizing energy generation.
- Shadow free project layout to ensure minimum losses in generation during the day time.
- Higher system voltage and lower current options to be followed to minimize ohmic losses.
- Selection of PCUs with proven reliability and minimum downtime. Ready availability of requisites spares.
- Careful logging of operational data / historical information from the Data Monitoring Systems, and periodical analysis of the same to identify any abnormal or slowly deteriorating conditions.
- The designed array capacity at STC shall be suitably determined to meet the proposed guaranteed generation output at the point of interconnection by the contractor in his/her bid. The contractor shall take care of first year degradation also by installing additional DC capacity as the CUF calculations will not factor the first-year degradation of the modules.
- Each component offered by the bidder shall be of established reliability. The minimum target reliability of each equipment shall be established by the bidder considering its mean time between failures and mean time to restore, such that the availability of complete system is assured. Bidder's recommendation of the spares shall be on the basis of established reliability.
- Bidder shall design the project and equipment in order to have sustained life of 25 years with minimum maintenance efforts.
- The work execution planning for supply, erection, commissioning and all other allied works for Solar Power Project shall be such, that it is completed within stipulated time from the date of placement of award letter.
- The specifications provided with this bid document are functional ones; any design provided in this document is only meant as an example. The Contractor must submit a detailed design philosophy document for the project to meet the functional requirements based upon their own design in-line with the above. The bidders are advised to visit the sites and satisfy themselves before bidding.

(3) **Approval of drawings and documents prepared by the Contractor:**

All documents and drawings shall be submitted to the MANIREDA in soft copies for review and approval. Drawing shall also be submitted in '*.dwg' format, if required. In case of design calculations done in spread sheet, editable (working) soft copy of the spread sheet shall also be submitted along with 'pdf' copies during every submission. MANIREDA shall return, as suitable, either soft or hard copies to the Contractor with category of approval marked thereon. The drawings/documents shall be approved in any one of the following categories based on nature of the comments/ type of drawing or document.

- Category-I: Approved
- Category-II: Approved subject to incorporation of comments. Re-submit for approval after incorporation of comments
- Category-III: Not approved. Re-submit for approval after incorporation of comments
- Category-IV: Kept for record/ reference
- Category-IV (R): Re-submit for record/ reference after incorporation of comments

Note: Approval of document neither relieves the Vendor/ Contractor of his/her contractual obligations and responsibilities for correctness of design, drawings, dimensions, quality & specifications of materials, weights, quantities, assembly fits, systems/ performance requirement and conformity of supplies with Technical Specifications, Indian statutory laws as may be applicable, nor does it limit MANIREDA rights under the contract.

The Contractor shall submit complete Master Document & Drawing list (MDL) to MANIREDA within 2 weeks after issue of LOA, The MDL shall list all the Drawings & Documents envisaged for submission/ approval from MANIREDA and shall also have all the required information like drawing number, title, scheduled date of submission, actual date of submission and approval. The category of approval shall be decided mutually between Contractor and MANIREDA at the time of finalization of the MDL which shall be the basis for drawing & document approval process during project execution.

A. Electrical System

Solar Photovoltaic (SPV) Modules

1 Standards and Codes

Solar Photovoltaic Modules shall comply with the specified edition of the following standards and codes.

Standard	Description
IEC 61215-1:2016 Ed.1	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements
IEC 61215-1-1:2016 Ed.1	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61730-1:2016 Ed.2	Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
IEC 61730-2:2016 Ed.2	Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing
IEC 62716:2013 Ed.1	Photovoltaic (PV) modules - Ammonia corrosion testing
IEC TS 62804-1:2015 Ed.1	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation - Part 1: Crystalline silicon (under conditions of 85oC/85% RH for minimum 192 hours)
As per the Solar Photovoltaic Systems, Devices and Components Goods (Requirements for Compulsory Registration) Order, 2017, PV Modules used in the grid connected solar power projects, shall be registered with BIS and bear the Standard Mark as notified by the Bureau of Indian Standards. Further, PV Modules should be listed in the ALMM, as per MNRE Approved Models and Manufacturers of Solar Photovoltaic Modules (Requirements forCompulsory Registration)Order, 2019 including subsequent amendments/order, if any.	

2 Technical Requirements

Parameter	Specification
Cell type	Mono-crystalline
Module Efficiency	≥ 21%
Rated power at STC	No negative tolerance is allowed
Temperature co-efficient of power	Not less than -0.35%/°C
Application Class as per IEC 61730	Class A

The SPV Modules to be used in the project must be as per the list of ALMM.

3 Component Specifications

- The SPV Modules glass panel shall have transmittance of above 90%. The minimum thickness of glass shall be 3.2 mm.
- The encapsulated material to be used for the PV modules should be UV resistant and PID resistant in nature. No yellowing of the encapsulant with prolonged exposure should occur. The encapsulant shall have the following properties.

Parameter	Value
Volume resistivity	> 1×1014 Ω.cm
Peeling strength with glass	> 40 N/cm

For Crystalline Silicon Glass/Polymer PV Modules, the back sheet used in the PV modules shall be of three-layered structure durable for humid– hot conditions with properties of moisture barrier, elongation retention and UV resistance. The back sheet shall have the following properties:

Parameter	Value
Material Thickness	≥ 300 microns
Water Vapor Transmission Rate	≤ 2 g/m2/day
Partial Discharge Test Voltage	≥ 1500V
Elongation at break	≥ 100%
Adhesion strength with encapsulant	≥ 40 N/cm
Interlayer adhesion strength	≥ 4 N/cm

- The sealant used for edge sealing of PV modules shall have excellent moisture ingress protection with good electrical insulation (Break down voltage >15 kV/mm) and with good adhesion strength. Edge tapes for sealing are not allowed.

- The module frame shall be made of anodized Aluminum, which shall be electrically & chemically compatible with the structural material used for mounting the modules. It is required to have provision for earthling to connect it to the earthling grid.

- The material used for junction box shall be UV resistant to avoid degradation during module life. The degree of protection of the junction box shall be at least IP 67. Minimum three number of bypass diodes and two number of IEC 62852/EN 50521 certified MC4 compatible connectors with appropriate length of IEC 62930/EN 50618 certified 4 sq.mm copper cable shall be provided. The cable length shall be in accordance with the PV Module wiring strategy and adequate to ensure that the cable bending radius standard is not exceeded.

- Each PV Module shall be provided a RFID code which is embedded inside the module lamination and must be able to withstand harsh environmental conditions. The RFID code data base shall contain the following information.
    1. Name of the manufacturer of PV Module
    2. Name of the Manufacturer of Solar cells

3. Type of cell: Mono
4. Month and year of the manufacture (separately for solar cells and module)
5. Country of origin (separately for solar cells and module)
6. I-V curve for the module
7. Peak Wattage, I_m, V_m and FF for the module
8. Unique Serial No. and Model No. of the module.
9. Date and year of obtaining IEC PV module qualification certificate
10. Name of the test lab issuing IEC certificate
11. Other relevant information on traceability of solar cells and modules as per ISO 9000 series.

RFID code scanner and database of all the modules containing the above information shall also be provided.

4 Warranty

- PV modules must be warranted with linear degradation rate of power output except for first year (up to 3% including Light Induced Degradation (LID)) and shall guarantee minimum 80% of the initial rated power output at the end of 25 years from the date of supply.

- The modules shall be warranted for minimum of 10 years from the date of supply against all material/ manufacturing defects and workmanship.

- The above warranties shall be backed by third party insurance.

- The Contractor shall also provide test certificates corresponding to the standards mentioned above along with complete test reports for the proposed module. The tests should have been conducted at a test laboratory compliant with ISO 17025 for testing and calibration and accredited by an ILAC/IECEE member signatory. Laboratory accreditation certificate or web link along with scope of accreditation shall also be submitted.

- The Contractor shall submit a detailed Manufacturing Quality Plan (MQP) for the PV Module with list of checks/tests performed during incoming material inspection, production, pre-dispatch and package.

- The Contractor shall obtain the approval of the proposed module make & model prior to manufacturing/ inspection call.

5 Manufacturing and Inspection

- The Contractor shall inform the module manufacturing schedule to MANIREDA at least 7 (seven) working days before the start of proposed schedule.

- MANIREDA shall perform material inspection at the Manufacturer's factory before the start of proposed manufacturing schedule. Proof of procurement of components as per the approved BOM mentioning manufacturer name, manufacturing date and relevant test certificate shall be submitted during material inspection for verification.

- The Manufacturing shall start only after the clearance by MANIREDA after the material inspection.
- The cells used for module making shall be free from all defects like edge chipping, breakages, printing defects, discoloration of top surface etc. Only Class A solar cell shall be used.
- The modules shall be uniformly laminated without any lamination defects.
- Current binning of modules shall be employed to limit current mismatch of modules. Different color codes shall be provided on the modules as well as pallet for identification of different bins. Note: Current Bin size shall be proposed to MANIREDA for approval prior to manufacturing.
- Pre-dispatch inspection of modules shall be performed as per the inspection protocol to be given during the time of inspection.

6 Transportation, Handling, Storage and Installation

Transportation, handling, storage and installation of modules shall be in accordance with the manufacturer manual so as not to breach warranty conditions. The Standard Operating Procedure (SOP) for the same shall be shared by the Contractor prior to dispatch for approval.

String Combiner Box (SCB)

The String Combiner Box (SCB) specifications mentioned in this section are applicable in case central inverters are employed.

1 Standards and Codes

Standard/Code	Description
IEC 60529	Enclosure Ingress Protection
IEC 62262	Enclosure Impact Protection
IEC 60296	Fuse
IEC 61643-11	Surge Protection Device
IEC 62852 or EN 50521	Solar cable connector

2 Construction

- Enclosure shall be made of UV resistant, fire retardant, thermoplastic material. Enclosure degree of protection shall be at least IP65 and mechanical impact resistance shall be at least IK08.

- Not more than two strings can be connected in parallel to a single input of SCB. One spare input terminal along with connector shall be provided for each SCB.

- Every SCB input shall be provided with fuses on both positive and negative side. The rating of the fuses shall be selected such that it protects the modules from reverse current overload. The fuses shall be 'gPV' type conforming to IEC 60269-6.

- DC disconnect or switch of suitable rating shall be provided at SCB output to disconnect.

- Both positive and negative side simultaneously.

- Type-II surge protective device (SPD) conforming to IEC 61643-11 shall be connected between positive/negative bus and earth.

- MC4 connector conforming to IEC 62852 or EN 50521 shall be provided at each SCB input. Cable gland (double compression metallic) of suitable size for DC cables shall be provided at the SCB output.

- UV resistant printed cable ferrules for solar cables and punched/embossed aluminum tags for DC cables shall be provided at cable termination points for identification.

3 Warranty

The SCB unit shall be warranted against all material/ manufacturing defects and workmanship for minimum of 5 (five) years from the date of supply.

Tests

Routine tests and acceptance tests for the assembled unit shall be as per the Quality Assurance Plan (QAP) approved by MANIREDA.

Solar and DC Cables

1 Standards and Codes

Cable	From	To	Conductor/ Insulation	Voltage Rating	Applicable Standard
Solar Cable*	Module	SCB	Copper/ XLPO	1.5 kV DC	IEC 62930/ EN 50618
DC Cable	SCB	Power Conditioning Unit	Copper or Aluminum /XLPE	1.5 kV DC	IS 7098 Part II
* Cable used for module interconnection shall also be referred as solar cable.					

- Solar cable outer sheath shall be flaming retardant, UV resistant and black in color. Solar cable with positive polarity should have marking of red line on black outer sheath.

- DC cables shall be single core, armored, Flame Retardant Low smoke (FRLS), PVC outer sheath conforming to IS 7098-II. DC cable with positive polarity should have marking of red line on black outer sheath.

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

  i. Cable size and voltage grade

  ii. Word 'FRNC/ FRLS' (as applicable) at every meter

  iii. Sequential marking of length of the cable in meters at every meter

  Cables shall be sized based on the following considerations:

  i. Rated current of module

  ii. In case of central inverters, average voltage drops in the cables (from PV Modules to PCU) shall be limited to 1.5 % of the rated voltage. In case of string Inverters, average voltage drops (from PV module to string inverter) shall be limited to 0.5%

of the rated voltage drop. The Contractor shall provide voltage drop calculations in excel sheet.

iii. Short circuit withstand capability

iv. De-rating factors according to laying pattern

2 Warranty

The cables (Solar and DC) shall be warranted against all material/ manufacturing defects and workmanship for minimum of 5 (five) year from the date of supply.

Tests

Type test, routine test and acceptance tests requirements shall be as per IEC 62930/EN 50618 for solar cables and IS 7098-II for DC cables. As part of Routine tests, cables should also be subject to Cold Bend and Cold Impact Tests.

3 Installation

- Cable installation shall be as per IS 1255.
- Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted. Cable terminations shall be made with connectors complying IEC 62852/IS16781. The connectors shall have degree of protection of IP 68.

- Solar cables shall be provided with UV resistant printed ferrules and DC cables shall be provided with punched/ embossed aluminum tags. The marking shall be done with good quality letter and numbers of proper size so that the cables can be identified easily.

- Cable terminations shall be made with properly crimped lugs and passed through cable glands at the entry & exit point of the cubicles. Bimetallic lugs shall be used for connecting Cu bus bar and Al cables or vice-versa.

- Solar cables, wherever exposed to direct sunlight and buried underground, shall be laid through Double Wall Corrugated (DWC) HDPE conduits. The size of the conduit or pipe shall be selected on the basis of 40% fill criteria.

- Solar cables shall be aesthetically tied to Module Mounting Structure using UV resistant cable-ties suitable for outdoor application.

- A.C. and D.C. cables shall be kept in separate trenches.

- Cable Sealing System: Modular multi-diameter cable sealing system consisting of frames, blocks and accessories shall be installed where the underground and over ground cables enter or leave LCR/MCR enclosures/Buildings. Cable sealing system shall consist of multi-diameter type peel-able blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system. Solid blocks shall not be used on frame. Frames & stay-plate material shall be of galvanized steel and for compression, single piece wedge with galvanized steel bolts shall be used. 30% spare blocks on the frame shall be provided for expansion in future. Cable sealing system should have been tested for fire/water /smoke tightness.

Power Conditioning Unit

The Power Conditioning Unit (PCU) specifications mentioned in this section are applicable for both string & central inverters.

1 Standards and Codes

Power Conditioning Unit (PCU) shall comply with the specified edition of the following standards and codes.

Standard	Description
IEC 61683 Ed. 1	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
IEC 62109-1 Ed. 1	Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
IEC 62109-2 Ed. 1	Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters
IEC 61000-6-2 Ed. 2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
IEC 61000-6-4 Ed. 2.1	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
IEC 62116 Ed. 2	Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures
IEC 60068-2-1:2007	Environmental testing - Part 2-1: Tests - Test A: Cold
IEC 60068-2-2:2007	Environmental testing - Part 2-2: Tests - Test B: Dry heat
IEC 60068-2-14:2009	Environmental testing - Part 2-14: Tests - Test N: Change of temperature
IEC 60068-2-30:2005	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)
CEA Technical Standards for Connectivity to the Grid Regulations 2007 with 2013 and 2019 Amendment	
As per the Solar Photovoltaics, Systems, Devices and Components Goods (Requirements for Compulsory Registration) Order, 2017, Inverters used in the grid connected solar power projects shall be registered with BIS and bear the Standard Mark as notified by the Bureau of Indian Standards.	

2 Technical Requirements

Parameter	Specification
Type	String/Central
Rated AC power	As per design
Maximum input voltage	1500 V
Rated AC output voltage	As per design
Tolerance on rated AC output voltage	+/-10%
Rated frequency	50 Hz
Operating frequency range	47.5 Hz to 52 Hz
Power factor control range	0.9 lag to 0.9 lead
European efficiency	Minimum 98%
Maximum loss in Sleep Mode	0.05% of rated AC power
Total Harmonic Distortion	Less than 3% at 100% load
Degree of protection	Central Inverter – IP 20 (Indoor)/IP 54 (Outdoor), String Inverter – IP 65

The rated/ name plate AC capacity of the PCU shall be AC power output of the PCU at 25°C.

Maximum power point tracker (MPPT) shall be integrated in the PCU to maximize energy drawn from the Solar PV array. The MPPT voltage window shall be sufficient to accommodate the output voltage of the PV array at extreme temperatures prevailing at sites.

The PCU output shall always follow the grid in terms of voltage and frequency. The operating voltage and frequency range of the PCU shall be sufficient enough to accommodate the allowable grid voltage and frequency variations.

3 Construction

- Power Conditioning Unit (PCU) shall consist of an electronic three phase inverter along with associated control, protection, filtering, measurement and data logging devices.
- Every DC input terminal of PCU shall be provided with fuse / MCB / MCCB of appropriate rating. The combined DC feeder shall have suitably rated isolators for safe start up and shut down of the system. One spare DC input terminal shall be provided for each PCU. String inverters without DC fuse may be acceptable in case not more than two strings are connected to the same MPPT.
- Type-II surge protective device (SPD) conforming to IEC 61643-11 / IEC 61643-31 / EN 50539-11 shall be connected between positive/ negative bus and earth.
- In case external auxiliary power supply is required, UPS shall be used to meet auxiliary power requirement of PCU. It shall have a backup storage capacity of 2 hours.

- Circuit Breaker of appropriate voltage and current rating shall be provided at the output to isolate the PCU from grid in case of faults.

- The PCU shall be tropicalized and the design shall be compatible with conditions prevailing at sites. Suitable number of exhaust fan with proper ducting shall be provided for cooling keeping in mind the extreme climatic condition of the sites as per the recommendations of OEM to achieve desired performance and life expectancy.

- All the conducting parts of the PCU that are not intended to carry current shall be bonded together and connected to dedicated earth pits through protective conductor of appropriate size. DC negative terminal shall be grounded. In case DC negative grounding is not possible, appropriate anti-PID device shall be provided.

- Dedicated communication interface shall be provided to monitor the PCU from SCADA. PCU front panel shall be provided with LCD/ LED to display all the relevant parameters related to PCU operation and fault conditions. It shall include, but not limited to, the following parameters:
    i. DC input power
    ii. DC input voltage
    iii. DC input current
    iv. AC output power
    v. AC output voltage (all the 3 phases and line)
    vi. AC output current (all the 3 phases and line)
    vii. Frequency
    viii. Power Factor

- AC combiner box for string inverter configuration shall comply with Clause 10 of the Technical Specifications with exception of the following:
    i. Rated System Voltage – Inverter Output Voltage
    ii. IP Rating – IP 55
    iii. Metering System – Not required
    iv. CBCT – Not Applicable

4 Operating Modes

Operating modes of PCU shall include, but not limited to, the following modes. These operating modes and conditions for transition are indicative only. The Contractor shall provide the detailed flow chart indicating the various operating modes and conditions for transition during detailed engineering.

- Standby Mode

  The PCU shall continuously monitor the input DC voltage and remain on Standby Mode until it reaches the pre-set value.

- MPPT Mode

When the input DC voltage is above the pre-set value and AC grid connection conditions are fulfilled, the PCU shall enter into MPPT mode.

- Sleep Mode

  When the AC output power/DC input voltage decreases below the pre-set value for pre- set time delay, the PCU shall switch into Sleep Mode.

5 Protection Features

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.

The PCU shall provide protection against the following type of faults, among others.

i. DC/AC over current
ii. DC/AC over voltage
iii. DC reverse polarity
iv. DC earth fault
v. AC under voltage
vi. AC under frequency/over frequency
vii. Islanding
viii. Over temperature
ix. Lightning surges

6 Grid Support Functions

- **Active power regulation**

  The PCU shall be able to limit the active power exported to the grid based on the set point provided through PCU front control panel. The PCU shall also be able to automatically the limit the active power after an increase in grid frequency above a pre-set value. The ramp rate shall be adjustable during operation and start-up after fault. The applicability of the requirement shall be as per CEA regulation and compliance.

- **Reactive power control**

  The PCU shall be able to inject /absorb reactive power to/ from the grid based on the set point provided through PCU front control panel. The same shall be performed automatically with adjustable ramp rate based on dynamic changes in grid voltage or reactive power reference.

- **Voltage Ride Through**

  The PCU shall remain connected to the grid during temporary dip or rise in grid voltage as per the LVRT and HVRT requirements of CEA Technical Standards for Connectivity to the

Grid Regulations. The PCU shall also be able to inject/absorb reactive power during the period of voltage dip/surge

7 Warranty

The complete Power Conditioning Unit shall be warranted for minimum of 5 (five) years

against all material/ manufacturing defects and workmanship.

8 Tests

Type Tests

The type test certificates as per the standards mentioned above should be from any of the ILAC/IECEE member signatory accredited Test Centers. Laboratory accreditation certificate or weblink along with scope of accreditation shall also be submitted. It is the responsibility of the Contractor to substantiate the compliance for CEA Regulations using test reports.

Routine Tests

Routine tests and acceptance tests shall be as per the Quality Assurance Plan (QAP)approved by MANIREDA.

Inverter Transformer

1 Standards and Codes

Inverter transformer and auxiliary transformer, wherever applicable, shall comply with the latest edition of the following standards and codes including amendments.

Standard	Description
IS:2026, IEC:60076	Specification of Power Transformers
IS 11171	Dry-Type Power Transformers
IS:2099, IEC:60137	Bushings for alternate voltage above 1000 V
IS: 335, IEC 60296	Insulating oil
IS: 3639	Fittings and Accessories for Power Transformers
CEA Regulations and other statutory regulations with any latest amendments	
CBIP publication no. 295	
Additional for Auxiliary Transformers: MoP Notification on Energy Consumption Standards for Star Labelled Distribution Transformer dated 12th January, 2009 and subsequent amendments BEE (Particulars and Manner of their Display on Labels of Distribution Transformers) Regulations, 2009 and subsequent amendments	

2 Technical Requirements

Parameters	Inverter Transformer	Auxiliary Transformer
Type	Oil-Type	Oil Type/Dry-type
VA Rating	As per requirement	As per system design
Voltage Ratio	33 kV/ Inverter output voltage	As per system design
Duty, Service & Application	Continuous Solar Inverter application and converter Duty	Continuous application (Outdoor/Indoor)
Winding	2	2
Frequency	50 Hz	50Hz
Nos. of Phase	3	3

Vector Group & Neutral earthing	As per system/inverter manufacturer requirement	Dyn11
Cooling	ONAN	ONAN/ AN
Tap Changer	OCTC, No. of steps shall be as per system requirement	OCTC, No. of steps shall be as per system requirement
Impedance at 75°C	As per Inverter Manufacturer requirement	As per system requirement
Permissible Temperature rise over an ambient of 50°C (irrespective of tap)		
Top Oil	As per IS/IEC	As per applicable IS/IEC
Winding	As per IS/IEC	As per applicable IS/IEC
SC withstand time (thermal)	2 second	2 second
Short Circuit Apparent Power	As per system requirement	As per system requirement
Termination	As per system requirement	As per system design
Bushing rating, Insulation class (Winding & bushing)	HV side - 36 kV porcelain LV side – 1.1 kV epoxy	As per system requirement
Noise level	As per NEMA TR-1	
Loading Capability	Continuous operation at rated MVA on any tap with voltage variation of +/-3%, also transformer shall be capable of being loaded in accordance with IEC 60076-7	
Flux density	Not to exceed 1.9 Wb/sq.m. at any tap position with combined frequency and voltage variation from rated V/f ratio by 10% corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations:	

3	Construction	a) 110% for continuous rating b) 125% for at least one minute c) 140% for at least five seconds. Bidder shall furnish over fluxing characteristic up to 150%
		Air Clearance: As per IS/IEC

- The transformer shall be provided with conventional single compartment conservator with prismatic toughened glass oil gauge. The top of the conservator shall be connectedto the atmosphere through indicating type cobalt free silica gel breather with transparent enclosure. Silica gel shall be isolated from atmosphere by an oil seal. Inverter transformers shall be provided with Magnetic Oil Gauge (MOG) with low oil level alarmcontact.

- It is the responsibility of the Contractor to ensure that the inverter transformer comply with all the requirements of inverter provided by the inverter manufacturer.
- Inverter Transformer shall be designed for at least 5% total harmonic distortion (THD) to withstand distortion generated by the inverter as well as possible outside harmonics from the network.

- The transformer shall be suitable for continuous operation with a frequency variation of ± 2.5% from nominal frequency of 50 Hz without exceeding the specified temperature rise.

- Inverter Transformer shall have shield winding between LV & HV windings. Each LV winding must be capable of handling non-sinusoidal voltage with voltage gradient as specified by the inverter manufacturer. Also, shield winding shall be taken out from tankthrough shield bushing and the same shall be brought down to the bottom of the tank using copper flat and support insulator for independent grounding.

- Neutral bushing of Inverter duty transformer shall be brought outside the tank for the testing purpose. It shall be covered with MS sheet and a sticker “For testing purpose only. Do not earth”. Neutral bushing of auxiliary transformer shall be brought outside the tank and earthed.

- Oil-type Transformers shall have 150 mm dial type Oil Temperature Indicator (OTI) and Winding Temperature Indicator (WTI) with alarm and trip contacts. All indicators shall have accuracy of 1.5%. For inverter transformers, WTI shall be provided for all the windings.

- The radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/ valve at the bottom and air release plug at the top.

- Marshalling Box shall be of sheet steel, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 10% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Wiring scheme (TB details) shall be engraved in a stainless-steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.
- In Oil type transformers, Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement shall be provided.

- In Inverter transformer shall be provided with spring operated Pressure Relief Device (with trip contacts) with suitable discharge arrangement for oil. For Oil-type Auxiliary transformers, diaphragm type explosion vent shall be provided.

- In Oil-type transformers, filter valve at top the tank and drain cum sampling valve at bottom of the tank shall be provided.

- All external surface of the transformer shall be painted with two coats of epoxy-based paint of color shade RAL 7032. Internal surface of cable boxes and marshalling box shall be painted with epoxy enamel white paint. The minimum dry film thickness (DFT)shall be 100 microns.

- LV and HV cable box shall be provided with disconnecting chamber to facilitate the movement of transformer without disturbing cable box and termination.

- Air release plug, bi-directional wheel/skids, cover lifting eyes, transformer lifting lugs, jacking pads, towing holes, core and winding lifting lugs, inspection cover, rating plate, valve schedule plate, accessories and terminal marking plates, two nos. of earthing terminals shall be provided.

- Rain hoods to be provided on Buchholz, MOG & PRD, when provided. Entry points of wires shall be suitably sealed.

- The accessories listed above are indicative only. Accessories which are not mentioned above but required for satisfactory operation of the transformers are deemed to be included in the contract without extra charges.

For Dry-type Auxiliary Transformer:

- Transformer shall be cast resin encapsulated, and made of cold rolled grain-oriented silicon steel laminations of M4 grade or better. Winding conductor shall be electrolytic Copper/Aluminum and insulation shall be Class F or better.

- The transformer shall be housed in a metal protective housing having minimum degree of protection of IP 55 (Outdoor). Enclosure shall be of a tested quality sheet steel of minimum thickness 2 mm and shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting. Suitable bi-directional skids with pre-drilled holes shall be provided integral with the enclosure or bi-directional rollers shall be provided with suitable lockingarrangement.

- Neutral earthing shall be done as per system requirement. In case neutral is earthed, it shall be brought outside the cable box through bushing for connection to earth grid

4 Warranty

The transformer shall be warranted for minimum of 5 (five) years against all material/ manufacturing defects and workmanship.

5 Testing and Inspection

Type Tests and Special Tests

The following type test and special test reports shall be submitted during detailed engineering. The tests should have been conducted on the similar transformer by NABL accredited laboratory.

A. **Type Tests**

i. Lightning impulse (Full & Chopped Wave) test on windings as per IEC 60076-3 (Oiltype)/ IS 1180-1 or IS 11171 / IEC 60076-11 (Dry-type)

ii. Temperature Rise test at a tap corresponding to maximum losses as per IEC 600762 (Oil-type)/ IS 1180-1 or IS 11171 / IEC 60076-11 (Dry-type)

B. Special Tests

i. Measurement of zero-sequence impedance as per IEC 60076-1

ii. Measurement of harmonics of no-load current as per IEC 60076-1

iii. Measurement of acoustic noise level as per NEMA TR-1

iv. Short-circuit withstand test as per IEC 60076-5

In case the contractor is not able to submit the test reports during detailed engineering, the contractor shall submit the reports of type/special tests either conducted by NABL accredited laboratory or witnessed by Employer.

C. Routine Tests

Each completed transformer (Oil-type) shall be subjected to following routine tests as perthe latest edition of IEC 60076 unless specified otherwise.

i. Measurement of winding resistance at each tap

ii. Measurement of voltage ratio between HV and LV windings at each tap

iii. Check of vector group

iv. Measurement of no-load loss and no-load current

v. Measurement of short-circuit impedance and load loss

vi. Magnetic balance test as per CBIP manual publication no. 295

vii. Separate source voltage withstand test

viii. Induced over voltage withstand test

ix. Measurement of insulation resistance

x. Marshalling box functional test

xi. IR Measurement on wiring of marshalling box

xii. Breakdown voltage test on transformer oil as per IS 335

xiii. Oil leakage test on completely assembled transformer along with radiators

For completed Dry-type Auxiliary transformers, Routine tests as per the latest edition of IS1180-1 or IS 11171 / IEC 60076-11 shall be conducted.

Tests at Sites

After erection at sites all transformer(s) shall be subjected to the following tests.

i. Measurement of voltage ratio

ii. Check of vector group

iii. Magnetic balance test

iv. Measurement of insulation resistance

v. Breakdown voltage test on transformer oil

In case the equipment is not found as per the requirements of the Technical Specifications of NIT, all expenses incurred during sites testing will be to the Contractor's account and the equipment shall be replaced by him at free of cost.

HT Switchgear

1 Standards and Codes

All equipment provided under HT switchgear shall comply with latest editions and amendments of the relevant IEC standards and IS codes. In particular, the switchgear shall comply with the following standards and codes.

Standard/Code	Description
IS/IEC 62271-1	High Voltage Switchgear and Control gear - Part 1: Common Specifications
IS/IEC 62271-100	High Voltage Switchgear and Control gear - Part 100: AC Circuit Breakers
IS/IEC 62271-102	High Voltage Switchgear and Control gear - Part 102: AC Disconnectors and Earthing Switches
IS/IEC 62271-200	High Voltage Switchgear and Control gear - Part 200: AC Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV
IEC 62271-206	High-voltage Switchgear and Control gear - Part 206: Voltage presence indicating systems for rated voltages above 1 kV andup to and including 52 kV
IEC 61869	Instrument Transformers
IS 3231	Electrical relays for power systems protection
IEC 60255	Measuring relays and protection equipment
IEC 61850	Communication networks and systems for power utility automation
IEC 61131-3	Programmable controllers - Part 3: Programming languages
IS 9385	High voltage fuses
IS 9431	Indoor post insulators of organic material for systems with nominalvoltages greater than 1000 V up to and including 300 kV
IEC 60099-4	Surge arresters - Part 4: Metal-oxide surge arresters without gaps forA.C. systems
IS 3070-3	Lightning Arresters for Alternating Current Systems - Part 3 : MetalOxide Lightning Arresters Without Gaps
IEC 62052-11	Electricity metering equipment (A.C.) - General requirements, testsand test conditions - Part 11: Metering equipment
IEC 62053	Electricity metering equipment (A.C.) - Particular requirements
IS 14697	AC Static Transformer Operated Watthour and Var-hour

	Meters,Class 0.2S and 0.5S

2 Technical Parameters

Parameter	Specification
System Parameters	
Highest system voltage	36 kV
Rated system voltage	33 kV
Rated frequency	50 Hz
Number of phases	3
Power frequency withstand voltage	50 kV (r.m.s.)
Lightning impulse withstand voltage	125 kV (peak)
System fault current	As per system requirement
Internal Arc Classification	IAC-A, FLR, System fault current for 1s
Circuit Breaker	
Type	Vacuum type
Operating duty cycle	O – 0.3sec – CO – 3min – CO
Short circuit breaking current	As per system requirement
Re-strike performance class	C2
Mechanical endurance class	M1
Current Transformer	
Accuracy class	0.2 for metering (0.2s for metering at outgoing feeder)5P20 for protection
Rated VA burden	As per requirement
Insulation class	Class E or better
Voltage Transformer	
Accuracy class	0.2 for metering 3P for protection
Rated VA burden	As per requirement
Insulation class	Class E or better
Rated VA burden	As per requirement
Insulation class	Class E or better

3 Switchgear Panel

- The switchgear panel shall be free standing, floor mounted, single front, single tier fully compartmentalized, metal enclosed construction. Each panel shall have separate compartments for circuit breaker, bus bars, cable termination and auxiliary circuit.

- The circuit breakers shall be mounted on horizontally withdrawable trucks with locking facility in SERVICE and TEST positions.
- The panel enclosure shall be constructed with CRCA steel/Aluzinc sheet. The thickness of load bearing members shall be minimum 3 mm and that of non-load bearing members shall be minimum 2 mm.
- All surfaces shall be painted with two coats of epoxy-based paint of color shade RAL 7032. The minimum dry film thickness (DFT) shall be 100 microns.
- The circuit breaker and auxiliary circuit compartments provided on the front side shall have separate concealed hinged doors. Cable and bus bar compartments provided on the rear side shall have separate bolted covers. All doors and covers shall be provided with neoprene/synthetic rubber gaskets to prevent entry of vermin and dust.
- Pressure relief device shall be provided in each high voltage compartment of a panel to safely vent the gases in the event of internal arc. Seal-off bushing arrangement shall be provided between the breaker compartment and bus bar/cable compartments to prevent transfer of arc from one compartment to other.
- Automatic safety shutters shall be provided to cover up the fixed high voltage contacts on bus bar and cable sides when the truck is moved to TEST position.
- Degree of protection shall not be less than IP 5X for auxiliary circuit compartment. However, for remaining compartments it shall not be less than IP 4X. For outdoor panels, degree of protection shall not be less than IP 55.
- Mechanical /Electrical interlocks shall be provided to prevent mal-operation.
- Panel shall be provided with local bus-bar protection.
- Each switchgear panel shall be provided with thermostatically controlled space heaters, separately for breaker, cable and bus bar compartments, to prevent condensation within the compartment. The space heater shall be connected to 240 V, 50 Hz, single phase AC supply through suitable switch and fuse.
- 240 V, 5 A, SPN industrial socket-outlet with ON/OFF switch shall be provided in eachpanel.
- Each panel shall be provided with LED lamp rated for 240 V, 50 Hz, single phase AC supply for interior illumination controlled by door switch.
- Gapless, metal-oxide surge arrestors shall be provided between line and earth in cable compartment of the switchgear panel.
- Suitable lifting hooks shall be provided for each panel.

4 Circuit Breakers

- Circuit breakers shall be of vacuum type. It shall comprise of three separate identical single pole units operated through the common shaft and shall be fully interchangeable both electrically and mechanically.

- The circuit breaker operating mechanism shall be based on motor operated spring charging and it shall be re-strike free, trip free both electrically and mechanically, with anti-pumping feature.

- The rated control voltage of the spring charging motor shall be 110 VDC/220 VDC. Closing coil shall operate at all values of voltages between 85% and 110% of rated voltage. Opening coil shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity and at all values of supply voltage between 70% and 110% of rated voltage.

- The spring charging motor shall have adequate thermal rating such that continuous sequence of the closing and opening operations is possible as long as power supply is available to the motor. It shall also be possible to charge the spring manually and close the breaker in the event of failure of motor / control supply to motor. Operating handle shall be provided for charging the operating mechanism. After failure of control supply to the motor, one open-close-open operation shall be possible with the energy contained in the operating mechanism.

- The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring. Closing action of the circuit breaker shall compress the opening spring ready for tripping. When closing springs are discharged after closing the breaker, they shall be automatically charged for the next operation.

- Mechanical indicators shall be provided to indicate OPEN/CLOSED positions of the circuit breaker and CHARGED/ DISCHARGED positions of the closing spring. An operation counter shall also be provided. These indicators and counter shall be visible from the panel front door without opening it.

5 Relays

- All relays shall be microprocessor based numerical type. However, auxiliary relays can be static or electromechanical type. The relays shall be flush mounted on panel frontwith connections from the inside.

- The relays shall be capable of operating continuously between 80 – 120% of auxiliary voltage.
- All numerical relays shall have adequate number of freely configurable, opticallyisolated, Binary Inputs (BI) and potential free Binary Outputs (BO).

- All numerical relays shall have minimum four no. of current inputs, three for phase current and one for earth current, suitable for CT secondary current of 1A. The current inputs shall be compatible with both residual connected CT and Core Balance CT (CBCT). In addition, numerical relay in main outgoing feeder shall have three no. of voltage inputs for Under Voltage/Over Voltage protection.

- All I/O's shall have galvanic isolation. Analog inputs shall be protected against switching surges and harmonics.

- Making, breaking and continuous capacity of the relay contacts shall be adequate enough for the circuits in which they are used.

- The numerical relay shall have the following protection functions with at least two independent protection setting groups. The protection functions shall be selectable from any of the IEC characteristic curves.
    (a) Definite time (DT) phase over current protection
    (b) Inverse Definite Minimum Time (IDMT) phase over current protection
    (c) Definite time (DT) earth fault current protection

(d) Inverse Definite Minimum Time (IDMT) earth fault current protection
(e) Under Voltage protection
(f) Over Voltage protection

- Each feeder shall have two locks out relays powered through two independent DC supplies. Each lock out relay shall send through two separate potential free outputcontacts signals to each of the two independent trip coils.

- Transformer feeder protection relay shall have provision for the following protection functions, as applicable (depending on Type of Transformer).
  i. Buchholz alarm & trip
  ii. Oil Temperature Indicator (OTI) alarm & trip
  iii. Winding Temperature Indicator (WTI) alarm & trip
  iv. Pressure Relief Valve (PRV) trip
  v. Magnetic Oil Gauge (MOG) alarm

All numerical relays shall have provision for measurement and storage of electrical parameters such as voltage, current, frequency, active power, reactive power etc.

The numerical relay shall be able to record faults and events in non-volatile memory.

i. Fault record – At least 5 recent faults including the protection function operated, operating phase(s), voltages and currents along with date and time stamp.

ii. Event record – with date and time stamp.
- The numerical relay shall have trip circuit supervision facility to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions. The relay shall also be able to provide circuit breaker monitoring, CT and VT supervision.

- The numerical relay shall have self-diagnostic feature with separate output contact for indication of any internal relay failure.

- The numerical relays and meters at 33kV and above voltage level shall be IEC 61850 compliant for communicating with the SCADA system.

- The numerical relay shall have feature for time synchronization through the SCADA System/ networking.

- The numerical relay shall be provided with backlit alphanumeric LCD to access protection settings, measurement parameters, fault and event records. Read and write access to protection settings shall be password protected.

6 Earthing

- An earth bus made of copper shall be provided throughout the length of the panel. It shall be bolted to the framework of each panel and brazed to each breaker earthing contact bar.

- The earth bus shall have sufficient cross section to carry maximum fault current without exceeding the allowable temperature rise.

- All non-current carrying conductors of the panel shall be connected to the earth bus. All joints to the earth bus shall be made through at least two bolts. Hinged doors shall be earthed

through flexible earthing braid of adequate cross section. Suitable provision shall be provided at each end of the earth bus for connection with Owner's Earth conductor.

- Positive earthing of the breaker truck and frame shall be maintained when it is in the connected position and in all other positions whilst the auxiliary circuits are not totally disconnected.

- All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth bus by independent copper wires of size not less than 2.5 sq. mm with green colour insulation.

- Instrument transformer secondary neutral point shall be earthed at one place only on the terminal block. Such earthing shall be made through links so that earthing of one circuit may be removed without disturbing the earthing of other circuits.

- Separate earthing trucks shall be provided for earthing of bus bars and incoming/outgoing feeders. The trucks shall have voltage transformer to indicate presence of voltage prior to earthing. An audible alarm shall also be provided in case of voltage on the earthing terminal. Integral earth switches may also be considered instead of earthing trucks. The earthing truck/switch shall have short circuit withstand capability equal to that of the associated switchgear panel.

The interlocks shall be provided to ensure the following.

i. It is not possible to rack-in the earthing truck/close the earthing switch when the breaker truck is in SERVICE position.

ii. It is not possible to rack-in the breaker truck into SERVICE position when earthing truck is connected/earthing switch is in closed position.

7 Bus bar

- Bus bar shall be made of copper or aluminum with uniform cross section throughout their length. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit current.

- All bus bars joints shall be thoroughly cleaned and anti-oxide grease shall be applied. Plain and spring washers shall be provided to ensure good contacts at the joints and taps. Wherever aluminum to copper connections is required, suitable bimetallic connectors or clamps shall be used.

- Bus bars shall be provided with heat shrinkable sleeves of suitable insulation class throughout their length with proper color coding. All bus bar joints and taps shall be shrouded.

- Bus bar support insulators shall be made of non-hygroscopic, arc and track resistant, high strength material suitable to withstand stresses due to over voltage and short circuit current.

- The Contractor shall submit bus bar sizing calculation for specified continuous and short time current ratings during detailed engineering.

8 Measuring Instruments

- All the measuring instruments shall be digital, flush mounting type with communication facility. Meters at 33 kV and above voltage level shall be IEC 61850 compliant for communicating with the SCADA system.

All feeders except main outgoing feeder shall be provided with digital Multi-Function Meter (MFM). Tri Vector Meter (TVM) shall be provided for the main outgoing feeder (in the HT Panel). Accuracy class of MFM shall be 0.2 and that of TVM shall be 0.2S. Measuring instruments shall have provision to display the following parameters.

i. Line and phase voltages
ii. Line and phase currents
iii. Active power, Reactive power, Apparent power
iv. Frequency
v. Power factor
vi. Total Harmonic Distortion (THD)

9 Wiring and Terminal blocks

- All internal wiring shall be done with 650 V grade, 1.5 sq.mm. PVC insulated stranded flexible copper wire. For CT secondary circuits, 2.5 sq.mm copper wire shall be used. Wire terminations shall be made with solder less crimping type tinned copper lugs,which shall firmly grip the conductor. Insulation sleeves shall be provided at all the wireterminations.

- Printed identification ferrules, marked to correspond with panel wiring diagram shall be provided at both ends of each wire. The ferrules shall be firmly located on each wire so that they cannot move or turn freely on the wire. Wire identification shall be done in accordance with IS 11353.

- The Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.

- All internal wiring to be connected to the external equipment shall terminate on terminal blocks. Terminal blocks shall be rated for 650 V, 10 A and made of non-inflammable material.

- CT and VT secondary circuits shall be terminated on stud type, disconnecting terminal blocks.

- At least 10% spare terminals shall be provided on each panel and these spare terminals shall be distributed on all terminal blocks.

10 Warranty

The HT panel unit shall be warranted against all material/ manufacturing defects and workmanship for minimum of 5 (five) years from the date of installation.

Testing and Inspection

Type Tests

The switchgear panel shall be of type tested design. The following type test reports shall be submitted during detailed engineering. The tests should have been conducted on the similar equipment by NABL accredited laboratory. Validity period of type tests conducted on the equipment shall be as per 'CEA Guidelines for the Validity Period of Type Test(s) conducted on Major Electrical Equipment in Power Transmission'.

Test	Standard	Relevant IECClause

Switchgear Panel		
Dielectric tests		
Power frequency voltage test	IEC 62271-200	6.2.6.1
Lightning impulse voltage test	IEC 62271-200	6.2.6.2
Dielectric tests on auxiliary and controlcircuits	IEC 62271-200	6.2.10
Measurement of the resistance of the main circuit	IEC 62271-200	6.4.1
Temperature-rise tests	IEC 62271-200	6.5
Short-time withstand current and peak withstand current tests	IEC 62271-200	6.6
Verification of the IP coding	IEC 62271-200	6.7.1
Verification of making and breakingcapacities	IEC 62271-200	6.101
Mechanical operation test	IEC 62271-200	6.102
Internal arc test	IEC 62271-200	6.106
Circuit Breaker		
Mechanical operation test at ambient air temperature (M2 Class)	IEC 62271-100	6.101.2
Basic short-circuit test-duties	IEC 62271-100	6.106

Relays		
Vibration tests	IEC 60255-21-1	
Shock and bump tests	IEC 60255-21-2	
Seismic tests	IEC 60255-21-3	
Electromagnetic compatibilityrequirements	IEC 60255-26	
Product safety requirements	IEC 60255-27	
Common requirements	IEC 60255-1	
Functional requirements	Relevant parts of IEC 60255-100series	
Communication requirements	IEC 61850	
Current Transformers		
Temperature-rise test	IEC 61869-2	7.2.2
Impulse voltage withstand test on primary terminals	IEC 61869-2	7.2.3
Tests for accuracy	IEC 61869-2	7.2.6
Short-time current tests	IEC 61869-2	7.2.201
Voltage Transformer		

Temperature-rise test	IEC 61869-3	7.2.2
Impulse voltage withstand test on primary terminals	IEC 61869-3	7.2.3
Test for accuracy	IEC 61869-3	7.2.6
Short-circuit withstand capability test	IEC 61869-3	7.2.301

In case the contractor is not able to submit the test reports during detailed engineering, the contractor shall submit the reports of type/special tests either conducted by NABL accredited laboratory or witnessed by MANIREDA.

11 Routine Tests

Routine tests and acceptance tests shall be as per the Quality Assurance Plan (QAP)approved by the MANIREDA.

AC Cables

1 Standards and Codes

All AC Cables shall conform to the following standards and codes.

Standard	Description
IS 7098-I	Crosslinked Polyethylene Insulated Thermoplastic Sheathed Cables, Part 1: For working voltage up to and including 1100 V
IS 7098-II	Crosslinked Polyethylene Insulated Thermoplastics Sheathed Cables Part 2: For Working Voltages from 3.3 kV up to and including 33 kV

Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted. However, cable joints may be allowed if the route length is more than maximum available drum length subject to MANIREDA approval.

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

i) Cable size and voltage grade

ii) Word 'FRLS' at every meter

iii) Sequential marking of length of the cable in meters at every meter

Cables shall be sized based on the following considerations:

i) Rated current the equipment

ii) In case of Central inverters, maximum voltage drops in LT cable (from PCU to inverter transformer) shall be limited to 0.5% of the rated voltage. In case of String inverters, maximum voltage drops (from string inverter to LT combiner panel and from LT combiner panel to Inverter duty transformer) shall be limited to 1.5%. For HT cables (from inverter transformer to project take off point), maximum voltage drop shall be limited to 0.5 % of the rated voltage. The Contactor shall provide voltage drop calculations in excel sheet.

iii) Short circuit withstand capability as per design.

iv) De-rating factors according to laying pattern.

2 Warranty

All cables shall be warranted for minimum of 5 (five) years against all material/ manufacturing defects and workmanship from the date of supply.

3 Testing

Routine test and acceptance tests requirements shall be as per relevant standards for all cable sizes. As part of Routine tests, cables should also be subject to Cold Bend and Cold Impact Tests.

4 Installation

- Cable installation on-shore shall be as per IS 1255.

- Cable terminations shall be made with properly crimped lugs and passed through cable glands at the entry & exit point of the cubicles. Bimetallic lugs shall be used for connecting Cu bus bar and Al cables or vice-versa.

- All AC cables shall be provided with punched/embossed aluminum tags. The marking shall bedone with good quality letter and numbers of proper size so that the cables can be identified easily.

5 Auxiliary supply system

- Scheme for auxiliary supply system shall be submitted by the Contractor during detailed engineering for the approval by EMPLOYER.

- It shall mainly comprise of auxiliary transformer, AC distribution board(s) (ACDB), emergency lighting network, Uninterrupted power supply (UPS), Batteries and Distribution cables and metering & protective devices.

- Following consideration shall be taken into account while sizing the auxiliary transformer:
    i. 20% future load margin
    ii. 20% design margin
    iii. Total connected load at 0.8 power factor

LT Switchgear

The LT switchgear specifications mentioned in this section are applicable for auxiliary supply distribution panel, AC combiner box and LT switchgear panels in case of string inverter configuration.

1 Standards and Codes

All equipment provided under LT switchgear shall comply with latest revisions and amendments of the relevant IEC standards and IS codes. In particular, the switchgear shall comply with the following standards and codes.

Standard/Code	Description
IS/IEC 61439-1	Low-voltage switchgear and control gear assemblies - Part 1: General rules
IS/IEC 61439-2	Low-voltage switchgear and control gear assemblies - Part 2: Power switchgear and control gear assemblies
IEC 60947-1	Low-voltage switchgear and control gear - Part 1: General rules
IEC 60947-2	Low-Voltage Switchgear and Control gear: Circuit Breakers
IEC 60947-3	Low voltage switchgear and control gear: Part 3 Switches, disconnectors, switch-disconnectors and fuse combination units
IEC 60947-4-1	Low-voltage switchgear and control gear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
IEC 60947-5-1	Low-voltage switchgear and control gear - Part 5-1: Control circuit devices and switching elements - Elect
IEC 62052-11	Electricity metering equipment (a.c.) - General requirements, tests and test conditions - Part 11: Metering equipment

2 Technical Parameters

System Details	
Rated system voltage	415 V ± 10%, 3 Phase, 4 wire, Neutral SolidlyEarthed
Rated frequency	50 Hz ± 5%
System fault current	As per system requirement
Air Circuit Breaker (ACB)	
Type	Air break

Rated Current	As per system requirement
Rated Ultimate Short-Circuit Breaking Capacity & Rated Service Short-Circuit Breaking Capacity	As per system fault current
Rated short-time withstand current duration	1s
Molded case circuit breaker (MCCB)	
Rated Voltage	415 V
Release	Thermal-Magnetic/Microprocessor
Rated current	As per system requirement
Poles	4 poles
Rated insulation level	690 V
Rated Ultimate Short-Circuit Breaking Capacity & Rated Service Short-Circuit Breaking Capacity	As per system fault current
Rated Short-Circuit MakingCapacity	2.1 X Short circuit breaking Capacity
Rated short-time withstand current duration	1s
Utilization category	A
Current transformer (CT)	
Type	Cast Resin Bar Primary
Voltage class and frequency	650 V, 50 Hz

3 Constructional Details

- The panel shall be metal enclosed, free standing, floor mounted, modular type with compartmentalized construction having degree of protection of IP 2X (Indoor) and IP 54 (Outdoor) as per IS/IEC 60529. All doors and covers shall be provided with neoprenegaskets to prevent entry of vermin and dust.
- All switches, push buttons etc. shall be operated front and shall be flush/semi-flush mounted.
- The panel shall be fabricated from 2 mm CRCA sheet steel for frame & load bearing surfaces. Partitions may be fabricated from 1.6 mm CRCA if no components are mountedon them.
- Cable entries shall be from bottom. The opening of cable entry shall be covered by 3mm thick gland plates with proper sealing to avoid water and rodent entry.
- Earthing bus bar of suitable cross section shall be provided throughout the length of panel.

- The panel shall be duly wired with suitable size of 1.1kV, PVC insulated cable and terminals shall be brought out for cable connections. 10% spare terminals subjected to minimum one of each rating shall be provided on each distribution switchgear. All wire shall have ferrules as per wiring diagram.

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

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

- 240 V, 5 A, 3 pin industrial socket-outlet with ON/OFF switch shall be provided in each panel.

- Each panel shall be provided with LED lamp rated for 240 V, 50 Hz, single phase AC supply for interior illumination controlled by door switch.

- Suitable lifting hooks shall be provided for each panel.

- Each switchgear panel shall be provided with thermostatically controlled space heaters to prevent condensation within the enclosure. The space heater shall be connected to 240 V, 50 Hz, single phase AC supply through suitable switch and fuse.

- Earth leakage relay with Core balance CTs (CBCT) shall be provided on main incoming feeders having phase CT ratio more than 50/1A. CBCT's shall be circular window type with window size based on the overall diameter of the cables, to be finalized during detailed engineering.

4 Air Circuit Breaker

- The circuit breaker shall be three pole, air break, horizontal draw-out type.

- The circuit breaker shall have three positions, i.e. SERVICE, TEST and ISOLATED.

- The circuit breaker operating mechanism shall be based on motor operated spring charging and it shall be re-strike free, trip free both electrically and mechanically, with anti-pumping feature.

- The rated control voltage of the spring charging motor shall be 110 VDC. Closing coil shall operate at all values of voltages between 85% and 110% of rated voltage. Opening coil shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity and at all values of supply voltage between 70% and 110% of rated voltage.

- The spring charging motor shall have adequate thermal rating such that continuous sequence of the closing and opening operations is possible as long as power supply is available to the motor. It shall also be possible to charge the spring manually and close the breaker in the event of failure of motor / control supply to motor. Operating handle shall be provided for charging the operating mechanism. After failure of control supply to the motor, one open-close-open operation shall be possible with the energy contained in the operating mechanism.

- The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring. Closing action of the circuit breaker shall compress the opening spring ready for tripping. When closing springs are discharged after closing the breaker, they shall be automatically charged for the next operation.

- Mechanical indicators shall be provided to indicate OPEN/CLOSE, SERVICE/TEST positions of the circuit breaker and CHARGED/ DISCHARGED positions of the closing spring. An operation counter shall also be provided.
- The circuit breaker shall be provided with microprocessor based front adjustable protection release for overload, short circuit and earth fault.

- Mechanical/Electrical interlocks shall be provided to prevent mal-operation and in particular to ensure the following:

  i. It shall be possible to close the circuit breaker only if it is in SERVICE or TEST position.
  ii. It shall be possible to open the door only when the breaker is in TEST position.
  iii. Movement of the circuit breaker between SERVICE and TEST positions shall be possible only if the breaker is OFF.
  iv. Racking in the circuit breaker from TEST to SERVICE position shall be possible only if door is closed.

Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit breaker. The trolley shall be such that the top most breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. The telescopic trolley shall be such that all type, size and rating of breaker can be withdrawn/inserted. The circuit breaker shall have suitable provision for integration with SCADA.

5 Instrument Transformers

- Instrument transformers shall be completely encapsulated cast resin type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchgear is operating at its rated load and the outside ambienttemperature is 50°C.

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

- HRC fuses of suitable rating shall be provided on primary side of voltage transformers. For secondary side, four pole Miniature Circuit Breakers (MCB) shall be provided.

- For auxiliary supply switchgear, earth leakage relay with Core balance CTs (CBCT) shall be provided on main incoming feeders having phase CT ratio more than 50/1A. CBCT's shall be circular window type with window size based on the overall diameter of the cables, to be finalized during detailed engineering.

6 Bus bar

- Bus bar shall be made of copper or aluminum with uniform cross section throughout their length. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit current.

- All bus bars joints shall be thoroughly cleaned and anti-oxide grease shall be applied. Plain and spring washers shall be provided to ensure good contacts at the joints and taps. Wherever aluminum to copper connections are required, suitable bimetallic connectors or clamps shall be used.
- Bus bars shall be provided with heat shrinkable sleeves of suitable insulation class throughouttheir length with proper color coding. All bus bar joints and taps shall beshrouded.

- Bus bar support insulators shall be made of non-hygroscopic, arc and track resistant, highstrength material suitable to withstand stresses due to over voltage and short circuit current.

- The Contractor shall submit busbar sizing calculation for specified continuous and short time current ratings during detailed engineering.

7 Earthing

- An earth bus made of copper or aluminum shall be provided throughout the length of the panel. It shall be bolted to the framework of each panel and brazed to each breaker earthing contact bar.

- The earth bus shall have sufficient cross section to carry maximum fault current without exceeding the allowable temperature rise.

- All non-current carrying conductors of the panel shall be connected to the earth bus. All joints to the earth bus shall be made through at least two bolts. Hinged doors shall be earthed through flexible earthing braid of adequate cross section. Suitable provision shall be provided at each end of the earth bus for connection with Owner's Earth conductor.

- Positive earthing of the carriage and breaker frame shall be maintained when it is in the connected position and in all other positions whilst the auxiliary circuits are not totally disconnected.

- All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth bus by independent copper wires of size not less than 2.5 sq. mm with green colour insulation.

- Instrument transformer secondary neutral point shall be earthed at one place only on the terminal block. Such earthing shall be made through links so that earthing of one circuit may be removed without disturbing the earthing of other circuits.

8 Multi-Function Meter

Digital, flush mounting type Multi-Function Meter (MFM) of 0.5 accuracy class shall be provided. It shall have provision for integration with SCADA.

MFM shall have provision to display the following parameters.

i. Line and phase voltages
ii. Line and phase currents
iii. Active power, Reactive power, Apparent power
iv. Frequency
v. Power factor
vi. Total Harmonic Distortion (THD)

9 Wiring and Terminal blocks

- All internal wiring shall be done with 650 V grade, 1.5 sq.mm. PVC insulated stranded flexible copper wire. For CT secondary circuits, 2.5 sq.mm copper wire shall be used.
- Wire terminations shall be made with solderless crimping type tinned copper lugs, which shall firmly grip the conductor. Insulation sleeves shall be provided at all the wireterminations.
- Printed identification ferrules, marked to correspond with panel wiring diagram shall be provided at both ends of each wire. The ferrules shall be firmly located on each wire so that they cannot move or turn freely on the wire. Wire identification shall be done in accordance with IS 11353.
- The Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.
- All internal wiring to be connected to the external equipment shall terminate on terminal blocks. Terminal blocks shall be rated for 650 V, 10 A and made of non-inflammable material.
- CT and VT secondary circuits shall be terminated on stud type, disconnecting terminal blocks.
- At least 10% spare terminals shall be provided on each panel and these spare terminals shall be distributed on all terminal blocks.

10 Warranty

LT Switchgear shall be warranted against all material/ manufacturing defects and workmanship for minimum of 5 (five) year from the date of installation.

11 Testing and Inspection

Type Tests

The switchgear panel shall be of type tested design. Type test reports as per the following standards shall be submitted during detailed engineering. The tests should have been conducted on the similar equipment by NABL accredited laboratory. Validity period of type tests conducted on the equipment shall be as per 'CEA Guidelines for the Validity Period of Type Test(s) conducted on Major Electrical Equipment in Power Transmission'.

Equipment	Standard

Switchgear Panel	Relevant parts of IEC 61439
Air Circuit Breaker	IEC 60947-2
Molded Case Circuit Breaker	IEC 60947-2
Current Transformer	Relevant parts of IEC 61869
Voltage Transformer	Relevant parts of IEC 61869

In case the contractor is not able to submit the test reports during detailed engineering, the contractor shall submit the reports of type/special tests either conducted by NABL accredited laboratory or witnessed by MANIREDA.

12 Routine Tests

Routine tests and acceptance tests shall be as per the Quality Assurance Plan (QAP) approved by MANIREDA.

Uninterrupted Power Supply (UPS)

1 Standards and Codes

Uninterrupted Power Supply shall comply with the following standards and codes orequivalent Indian Standards, wherever applicable.

Standard/Code	Description
IEC 62040-1	Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS
IEC 62040-2	Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements
IEC 62040-3	Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements
IEC 62619 / IS 16805	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications
IEC 62620 / IS 16822	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications
IEC 60896-21	Stationary lead-acid batteries - Part 21: Valve regulated types - Methods of test
IEC 60896-22	Stationary lead-acid batteries - Part 22: Valve regulated types - Requirements
IS 15549	Stationary valve regulated lead acid batteries - Specification

2 General Requirements

The Uninterrupted Power Supply (UPS) system shall be designed to supply power tofollowing loads (but not limited to).

i. Data logger / SCADA / EMS
ii. Fire Detection/ Alarm Panel
iii. HMI of SCADA
iv. Emergency Lighting
v. Inverter's Auxiliary supply (if applicable)
vi. HT panel auxiliary
vii. CCTV

Sizing of UPS shall be done considering the above-mentioned load at power factor of 0.8 laggininclusive of 10% design margin at 50 ˚C.

3 System Description

The UPS shall automatically provide continuous, regulated AC power to critical loads under normal and abnormal conditions, including loss of input AC power. The UPS system shall consist of the following major equipment.

i. UPS Module
   (a) Insulated Gate Bipolar Transistor (IGBT) Converter
   (b) Insulated Gate Bipolar Transistor (IGBT) Inverter
   (c) Digital Signal Processor (DSP) using Pulse Width Modulation (PWM) for Direct Digital Control (DDC) of all UPS control and monitoring functions
   (d) Static bypass switch
ii. Battery system for 4 hours
iii. Battery protective and disconnect device
iv. Maintenance bypass switch
v. LCD display panel and LED indications
vi. Integrated UPS Communications Protocols capable of communicating with SCADA system

The UPS shall meet the following minimum specifications.

Parameter	Specification
Topology	Online double conversion UPS
Input	
Voltage	230 V ± 10% AC for UPS Rating of less than 5 kVA 415 V ± 10% AC for UPS Rating of 5 kVA and above
Frequency	50 ± 5 Hz
Power factor	0.95
Output	
Voltage	230 V ± 1% AC
Frequency	50 Hz
Power factor	0.8
Battery	
Type	Off-shore: Lithium-ion battery On-shore: Lithium-ion battery OR Sealed, Maintenance-Free (AGM) battery
Capacity	100% UPS load for 2 hours
Monitoring and communication	
LED Indicators	Load on Inverter, Battery operation, Load on Bypass, Overload, LCD Fault, UPS Fault
Electrical contacts	Closing contacts for each of the following conditions:

	Unit on Battery Low Battery Summary Alarm UPS On Input Fail
Local Display	LCD/ LED
SCADA communications	RS-485 Interface Port
Overall efficiency	>90%
Electrical Protection	Input/ output under voltage, over temperature, overload, Short circuit, battery low trip

The UPS shall be forced air cooled by internally mounted fans. The fans shall be redundant in nature to ensure maximum reliability. The fans shall be easily replaceable without the use of special tools.

Contractor shall provide the Operation & Maintenance Manual and mandatory spare parts list along with the equipment.

4 Warranty

UPS shall be warranted for minimum of 5 (five) years against all material/ manufacturing defects and workmanshipfrom the date of installation.

5 Tests

Routine tests and acceptance tests on final product shall be done as per QAP approved by MANIREDA. On completion of installation and commissioning of the equipment on sites tests shall be carried out with the maximum available load, which does not exceed the rated continuous load. An on-sites test procedure shall be submitted by contractor include a check of controls and indicators after installation of the equipment.

Earthing

1 Standards and Codes

Earthing system shall comply with latest revisions and amendments of the relevant IEC standards and IS codes. In particular, earthing system shall comply with the followingstandards and codes.

Standard/Code	Description
IS 3043	Code of Practice for Earthing
IEEE 80	IEEE Guide for Safety in AC Substation Grounding
IEC 62561-2	Requirements for conductors and earth electrodes
IEC 62561-7	Requirements for earthing enhancing compounds
IEEE 142	IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
Indian Electricity Rules	

2 General Requirements

- Earthing system shall be designed based on system fault current and soil/water resistivity value obtained from geo-technical investigation/hydrography report. Earth grid shall be formed consisting of number of earth electrodes sufficient enough to dissipatethe system fault current interconnected by earthing conductors.

- The earth electrode shall be made of high tensile low carbon steel rod, molecularly bonded by high conductivity copper on outer surface with coating thickness not less than 250 microns as per relevant standards. Suitable earth enhancing material shall be filled around the electrode to lower the resistance to earth. Inspection chamber and lid shall be providedas per IS 3043.

- Earth conductors shall be made of copper bonded steel or galvanized steel of sufficient cross section to carry the fault current and withstand corrosion.

- Earth conductors buried in ground shall be laid minimum 600 mm below ground level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures.

- Earth electrodes shall not be situated within 1.5 m from any building whose installation system is being earthed. Minimum distance between earth electrodes shall be two times the driven depth of the electrode.

- Transformer yard and switchyard fence shall be connected to the earth grid by one GS flat and gates by flexible lead to the earthed post.

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

3 PCU Earthing

DC negative bus bar of the PCU shall be earthed to avoid Potential Induced Degradation (PID). DC negative bus bar and PCU equipment earth shall be bonded to the PCU earth bus and connected to earth electrodes through flexible copper cable of sufficient cross section as mentioned by the manufacturer. The interconnection of PCU earth electrodes with DC earth grid shall be as per PCU manufacturer recommendation. In case earthing of DC negative bus bar of PCU is not allowed by the manufacturer, suitable anti-PID device shall be provided with the consent of PV Module and PCU manufacturer. However, PCU equipment earth shall be connected to earth electrodes through flexible copper cable of sufficient cross section as mentioned by the manufacturer.

4 Transformer Earthing

Inverter transformer neutral shall be floating, not to be earthed. However, recommendation of inverter manufacturer shall also be taken into account.

Transformer body, cable box, marshalling box and all other body earth points shall be earthed.

Inverter transformer shield shall be earthed separately using minimum two no. of earth electrodes. Earthing conductor between shield bushing and earth electrodes shall be copper flat of suitable size not less than 25 x 6 mm.

Neutral and body of the auxiliary transformer shall be earthed.

5 Main Control Room Earthing

Metallic enclosure of all electrical equipment inside the main control room shall be connected to the earth grid by two separate and distinct connections.

Cable racks and trays shall be connected to the earth grid at minimum two places using galvanized steel flat.

SCADA and other related electronic devices shall be earthed separately using minimum two no. of earth electrodes.

6 Switchyard Earthing

The metallic frame work of all switchyard equipment and support structures shall be connected to the earth grid by means of two separate and distinct connections.

Switch yard shall be shielded against direct lightning strike by provision of overhead shield wire or earth wire or spikes (masts) or combination thereof as per CEA 2010(Technical standards)-42(2)(c).

7 Tests

Type test reports for earthing electrode, earth enhancing compound and its associated accessories shall be submitted during detailed engineering for approval. On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. The earth plate shall be provided to facilitate its identification and for carrying out periodical inspection.

Lightning Protection System

Lightning Protection System (LPS) for the entire project against direct and indirect lighting strokes shall be provided as per IS/IEC 62305:2010.Lightning Protection Level for the entire project shall be Level – III. Air terminals, down conductors and earth termination system shall be designed as per relevant parts of IS/IEC 62305:2010.Necessary foundation/anchoring for holding the air terminals in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at sites in future. The product shall be warranted for minimum of 5 (five) years against all material/ manufacturing defects and workmanship. Type test reports as per IS/IEC 62305:2010 shall be submitted during detailed engineering for approval.

Communication Cables

- Optical Fiber Cables
- Optic Fiber cable shall be 4/8/12 core, galvanized corrugated steel taped armored, fully water blocked with dielectric central member for outdoor/ indoor application so as to prevent any physical damage.
- The cable shall have multiple single-mode or multimode fibres on as required basis so as to avoid the usage of any repeaters.
- The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturing, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.
- The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling.
- All testing of the optic fiber cable being supplied shall be as per the relevant IEC, EIA and other international standards.
- The Contractor shall ensure that minimum 100% cores are kept as spare in all types of optical fiber cables.
- Cables shall be suitable for laying in conduits, ducts, trenches, racks and undergroundburied installation.
- Spliced/ Repaired cables are not acceptable. Penetration of water resistance and impactresistance shall be as per IEC standard.

Communication Cable (Modbus)

Data (Modbus) Cable to be used shall be shielded type with stranded copper conductor. Cable shall have minimum 2 pair each with conductor size of 0.5 Sq.mm. Cable shall be flaming retardant according to IEC 60332-1-2.

Cable shall be tested for Peak working voltage of not less than 300 V and shall be suitable for serial interfaces (RS 422 and RS 485).

Communication cable shall be laid through suitable HDPE ducts.

Control Cables

Control Cables shall have stranded copper conductor, PVC insulation, PVC inner sheath, FRLS PVC outer sheath according to IS 1554-1. Color of the outer sheath shall be grey in color.

The minimum cross section of the conductor shall be 2.5 sq.mm.

At least one (1) core shall be kept as spare in each control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10C or higher size.

SCADA

1 General Requirements

The Contractor shall provide complete SCADA system with all accessories, auxiliaries and associated equipment and cables for the safe, efficient and reliable operation and monitoring of entire solar project and its auxiliary systems.

The Contractor shall provide all the components including, but not limited to, Hardware, Software, Panels, Power Supply, HMI, Laser Printer, Gateway, Networking equipment and associated Cables, firewall etc. needed for the completeness.

SCADA System shall have the provision to perform the following features and/or functions:

i. Web enabled Operator Dashboards: Showing key information on Generation, Performance and Current Status of various equipment in Single Line Diagram (SLD) format with capability to monitor PV array Zone level (i.e. SCB/ String Inverter Level) parameters.

ii. Real time Data Logging with Integrated Analytics & Reporting: Logging of all parameters - AC, DC, Weather, System Run Hours, Equipment Status and Alarms as well as derived/ calculated/ integrated values. The SCADA User interface shall be customizable and enable Report Generation and Graphical Analysis.

iii. Fault and System Diagnostics with time stamped event logging.

iv. Support for O&M Activities: The interface shall allow integration with Module Cleaning System to monitor the water consumption for Module Cleaning

v. Generate, store and retrieve user configurable Sequence of Event (SOE) Reports.

vi. Interface with different field equipment in the project and work seamlessly with field equipment supplied by different companies.

vii. Transfer of project data reliably, to a Cloud server on any kind of remote network including low bandwidth and wireless links such as 4G/5G/VSAT

(**Note**: Telecom Lease line connection, if required for transferring data from Project overinternet shall be taken by Contractor in the name of MANIREDA for O&M period)

The Control system shall be designed to operate in non-air-conditioned area.

2 Architecture

The SCADA System shall be built over Industrial IoT architecture with integrated Analytics, secure web access, enterprise software and Database. The SCADA architecture shall be compliant with principles identified in Article 1 a. of CEA (Cyber Security in Power Sector) Guidelines, 2021. (Note: Appointment of CISO shall be the responsibility of Owner).

Data acquisition shall be distributed across MCR and LCRs while project level data aggregation shall be done in both local and remote server (as specified by Owner).

Analog and Digital IO modules shall have integrated processor for distributed IO processing and control.

Data communication system shall be built over fibre optic cables/ wireless network with high bandwidth TCP/IP communication (Fast Ethernet or 802.11a/b/g/n) across all Inverter and Control Rooms with Internet/Intranet access at Main Control Room. Firewall shall be provided for network security.

Project SCADA Server shall have Industrial Grade server hardware running SCADA & Monitoring Software with data storage (complete project data) space for 2 years.

Project data for monitoring and control operations should be accessible without dependence on external network.

A virtual/cloud server running SCADA & Monitoring Software shall be configured in parallel with Project Server to enable easy access to project data from outside the project without having to login to project server. Effectively, the project data shall be replicated in both places i.e. between systems at the Project Server and Remote Server to provide data redundancy for complete project data.

Note: Configuration of Cloud server and procurement of associated subscription services shall be in the scope of the EPC Contractor.

Operator Workstation/PC shall be of Industrial Grade for browser-based access to project data from Project or remote server. Project control & SLDC/Utility related operations shall only be initiated through browser-based interface requiring no client software or database to be installed on the Workstation. All critical software and Project Data shall be installed/stored on local and remote servers only with user access control for protecting the software and data assets from accidental deletion or corruption.

Internet/Intranet at Project: Public or private network access shall be provided at the project through any broadband/VSAT connectivity of 2Mbps or higher bandwidth. In case no broadband/VSAT connectivity can be provided at the project, a 4G/5G data card from any Internet Service Provider (ISP) may be provided. SCADA system shall be capable of sending all project data in real time to the Remote Server.

GPS based Time Synchronization System: The SCADA system shall have a Master/Slave Clock system along with antenna, receiver, cabinet and internal interconnection cables. All SCADA controllers, servers, OWS and communicating equipment shall be synchronized to the GPS clock.

3 Industrial IoT Controllers & Data Acquisition

- The Project SCADA and Monitoring System may use one or more IIoT Controllers at each Inverter Control Room and MCR for the purpose of data acquisition and data forwarding to the Local and Remote SCADA Servers. The IIoT Controllers shall meet the following minimum requirements:

i. The IIoT Controllers shall be distributed in nature.

ii. Shall be capable of supporting wide range of field protocols to communicate with different field equipment (Modbus over RS 485/Ethernet, etc.)

iii. Shall have local storage for a minimum of 2 weeks (in case of network failure).

iv. Provide web-based interface to configure the controller for various equipment in the field. IO Functionality: Shall support status monitoring of VCBs & Trip relays on GIS/HT & Transformer panels through distributed DI/AI modules.

v. Controls: Shall be capable of Controlling breakers (ON/OFF). Both ON/OFF and Parameter control of inverters shall be supported.

vi. Data Communication with Servers: Shall send the data collected, from all the equipment at Inverter Control Room and/or Main Control Room, to the Monitoring & Control Server. Controllers shall be capable of sending data over Internet connections USB data cards.

4 Functionalities

- In case of central inverter, SCADA system shall enable PV array Zone monitoring i.e. the total current from each String Combiner Box shall be monitored on the DC side.

- The SCADA system shall monitor instantaneous and cumulative electrical parameters from all DC& AC Equipment including inverters, string combiner boxes, weather station, MFM, Transformer and Switchgear (LT & HT Panels) at regular intervals not greater thanone minute.

- The SCADA system shall monitor Instantaneous and cumulative environment parameters from weather sensors or data loggers at same interval as electrical parameters and provide PR, CUF on the fly. The SCADA shall also monitor water quality and flow parameters.

- The SCADA system shall provide Alarms and Alerts on equipment faults and failure in less than 5 seconds. Alarms on status change of hardwired DI shall also be provided.

- The SCADA system shall provide configurable alerts on any parameter crossing settable thresholds. The list of such parameters shall be finalized in consultation with the Owner. The SCADA system shall have user-friendly browser-based User Interface for secureaccess from anywhere, for minimum ten concurrent connections from the Operator PC orother securely connected laptop/mobile, for project monitoring, O&M, daily reporting, andanalysis. A dashboard providing summary details of total project generation, day's export,irradiance, Inverter Control Room level generation and performance indicators like PR andCUF.

- Reporting: The SCADA system shall provide downloadable reports in Excel/PDF, configurable for equipment parameters across the project.
- Mobile User Interface: summary of project performance and issues should be accessible in a mobile Native UI or browser UI.

- Data Communication to SLDC: SCADA system shall provide required interface to integrate with TRANSCO-SLDC, in compliance with grid code, to send any parameters specified bySLDC.

  Note: The methodology and specification of SLDC interface will be provided separately by SLDC/TRANSCO and it shall be the responsibility of the Contractor to determine the same.

- Power Project Control: SCADA system shall provide required interface to the local SCADA operator to set various power control modes (active/reactive power/frequency/PF) through the inverters over industry standard communication protocols like Modbus over TCP/IP. All programming functionalities shall be password protected to avoid unauthorizedmodification.

- The Contractor shall provide software locks and passwords to EMPLOYER for all operating & application software. Also, the Contractor shall provide sufficient documentation and program listing so that it is possible for the EMPLOYER to carry out modification at a later date.

5 Earthing

- Two isolated electronic earth pits near to SCADA panel at every Inverter and Control Roomwith < 1 Ohm resistance shall be provided. One earth pit shall be used for protective/body earth and the other to be used for Signal Earth.

- Apart from providing separate earth pits, manufacturer specified earthing recommendations shall be followed for all communicating equipment connected to SCADA. This includes but is not limited to Inverters, WMS and Switchgear panels.

6 Communication Cable Laying

- All RS485, IO and CAT6 cables shall be laid in separate conduits with a minimum separation of1.5ft from AC/DC power cables all along.

- Power cables shall be laid deep in the trenches first. Data cables shall be laid in separate conduits after partially filling the trenches to ensure minimum 1.5 ft separation between power and communication cables all along the trench.

- IO Cables between switch gear panels and SCADA panel shall be laid on separate cable trays, with a minimum of 1.5ft separation from trays carrying AC Power cables.

- RS485 & CAT6 cables between switch gear panels or Inverters and SCADA panel shall be laid on separate cable trays, with a minimum of 1.5ft separation from trays carrying ACPower cables.

7 Control Cabinets / Panels / Desks at Main Control Room

The cabinets shall be IP 22 protection class. The Contractor shall ensure that the temperature rise is well within the safe limits for system components even under the worst condition and specification requirements for remote I/O cabinets.

The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per firm's standard practice for similar applications.

8 Software Licenses

The Contractor shall provide software license for all software being used in Contractor’s System. The software licenses shall be provided for the project and shall not be hardware/ machine-specific.

9 Hardware at Main Control Room

The Hardware as specified shall be based on latest state of the art Workstations and Servers and technology suitable for industrial application & power project environment.

The Local Monitoring & Control Server and the Operating Work station, to be deployed in the Project Control Room, shall have the following server hardware and operating system along with accessories:

Project Server	
Server Hardware	Hex/Octal Core Xeon, 32GB RAM (expandable to 64 GB RAM), 4 X 2TB SATA hard discs in RAID 5 configuration, 2TB external USB hard disc (for backup), dual power supplies, 2 LAN ports, LCD console, keyboard & mouse. The server hardware shall be housed in a rugged fan-cooled, and rodent-proof Server Rack.
Operating System	Operating System and Database shall be of enterprise scale(RedHat Linux or equivalent Linux OS or Windows, Oracle/MySQLor equivalent DB), withrequired AMC for 5 years.
Accessories	Monitor: Min 22” LED Flat Monitor with non- interfaced refresh rate min. 75 Hz. Keyboard: ASCII type Pointing Device: Mouse Intelligent UPS (on line): Minimum 2-hour battery backup.
Operator Workstation	
Hardware	i7 CPU running at 3.0 GHz or faster with 16GB RAM, 500GB hard disk, 25” LED monitor, keyboard Andmouse, 4 USB ports, LAN port
Operating System	Windows operating system with necessary tools, anti- virus software.
Accessories	Screen Display Unit: Min 50” LED Flat Monitor with wallmounted arrangement for the display of SCADA screen A4 size monochrome laser printer.
	3. UPS of required capacity with 2-hour battery backup.

All network components of LAN and Workstations shall be compatible to the LAN, without degrading its performance.

10 Factory Acceptance Test (FAT)

FAT procedure shall be submitted by bidder for approval. SCADA shall communicate with all third devices which are part of solar project and same shall be demonstrated during the FAT.

Illumination

1 Standards and Codes

LED luminaires shall be tested at independent laboratory as per the following teststandards.

Standard/Code	Description
LM 79-08	Electrical and Photometric Measurements of Solid-State Lighting Products
LM 80-15	Measuring Luminous Flux andColor Maintenance of LED Packages, Arrays and Modules

2 General Specification

This specification covers design, supply and installation of Illumination system along the peripheral & internal roads, main control room & inverter rooms, switchyard and other facilities including entry points/gate(s) inside the project area.

The Contractor shall furnish Guaranteed Technical Particulars of the LED luminaires, from renowned brands available in the market for approval of MANIREDA.

Lighting system shall work on the auxiliary supply and same shall be incorporated in auxiliary loads. The Contractor shall provide minimum 20% of total lighting points as emergency lighting points, fed from UPS DB or DCDB as per scheme adopted by the Contractor. Indoor and outdoor emergency lights shall be provided at each inverter room,main control room.

3 Lighting Levels

The average LUX level of 10 lumen is to be maintained in switchyard. However, a lux level of20 lumen (comprising of minimum 2 sources of 10 lumen each) is to be maintained in switchyard on transformer.

The lighting system for outdoor and indoor areas of solar power project shall be designed in such a way that uniform illumination is achieved. Average LUX level to be maintained in different areas shall be as under:

Area	LUX
Control Room and equipment rooms	300
Office	300
Internal / Periphery Roads	4
Transformer Switchyard	20
H – pole and metering point	10

The lighting level shall take into account appropriate light output ratio of luminaires, coefficient of utilization maintenance factor (of 0.7 or less) to take into account deterioration with time and dust deposition and luminance uniformity (Uo) shall be minimum 0.3.

4 LED Luminaries for Outdoor Applications:

LED luminaries shall meet the following parameters.

Parameter	Specification
Input voltage	170 - 260 V
Input Frequency	50 Hz +/-1 Hz
Power Factor	0.90 (Minimum)
Luminaries' efficacy	> 90 lumens per watt
Beam Angle	Minimum 120°
Total Harmonic Distortion	< 10 %
Working Humidity	10% - 90% RH (Preferably Hermetically sealed unit)
Degree of Protection	Minimum IP 65 (for Outdoor fixtures)
Luminaries Casing	Powder coated metal / Aluminum.
Color Temperature	5700 K (cool day light)
Color Rendering Index	> 65
Moisture protection in case of casing damage	IP 65 (driver unit shall preferably be totallyencapsulated)

- The LED luminaries (outdoor) housing, heat sink, pole mounting bracket, individual LED reflectors and front heat-resistant tempered glass should be provided.
- The LED luminaries (outdoor) housing should be made of non-corrosive, high-pressure, die-cast aluminum and the housing should be power coated grey, so as to ensure good weather ability. Each individual LED source should be provided with an asymmetrical distribution high reflectance aluminized reflector, which should ensure that the light distribution of the luminaries is suitable for road lighting applications (wide beam distribution) and should ensure high pole to pole spacing.
- The luminaries should be provided with in-built power unit and electronic driver.
- The luminaries should be suitable for standard street light poles and should be suitable for side entry and bottom entry (post top).
- GI Lighting pole of suitable diameter capable of withstanding system and wind load, shall be provided with average Zn coating thickness of 80micron. The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.

- All outdoor lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.

- Lighting panels shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, etc. shall be earthed by means of separate earth continuity conductor. Cable armor shall be connected to earthing system at both the ends. Proper earthing of street light poles shall be ensured.

- Junction box for lighting shall be made of fire-retardant material. The degree of protection shall be IP 55 for outdoor JB.

- Lighting cables, wherever exposed to direct sunlight, shall be laid through Double Wall Corrugated (DWC) HDPE conduits.

- LED Luminaries/Lamps for Indoor Applications:
- LED luminaries/lamps shall have minimum 3-star BEE rating.
- All indoor LED luminaries/lamps shall be supplied with proper diffuser to avoid direct visibility of LED and suitable heat sink for longer life.

5 Warranty

All luminaries shall be warranted for minimum of 5 (five) years against all material/ manufacturing defects and workmanship from the date of installation.

Fire Alarm System

1 Standards and Codes

Standard/Code	Description
IS 2189	Selection, Installation and Maintenance of Automatic FireDetection and Alarm System Code of Practice
IS 2171	Portable Fire Extinguishers, Dry Powder (Cartridge Type)
IS 8149	Functional requirements for twin CO2 fire extinguishers (trolley mounted)
IS 2546	Galvanized mild steel fire bucket
National Building code 2016	

The Contractor shall ensure the compliance of fire detection and alarm system as per relevant standards and regulations. The installation shall meet all applicable statutory requirements and safety regulations of state/central fire department/body or any other competent authority in terms of fire protection.

Firefighting system for the proposed power project for fire protection shall be consisting of but not limited to:

i. Sand buckets
ii. Portable fire extinguishers (CO2 and dry powder type)
iii. Microprocessor based fire alarm panel
iv. Multi sensor smoke detectors
v. Hooter cum strobe
vi. Manual call points
vii. Cables from sensor to fire Panel.

Minimum two numbers of fire extinguishers (CO2 and Foam type each, of capacity 9 kg having BIS certification marking as per IS 2171) shall be provided at every building/ enclosure, transformer yard and switchyard. However, the Contractor must comply with existing building code for fire protection and relevant IS codes.

Four numbers of stand with four sand buckets on each stand shall be provided in the Transformer Yard. Sand buckets inside the building shall be provided at strategic locations as decided during detailed engineering.

Digital output from the fire detection system shall be integrated with SCADA.

The Contractor shall submit the plan for fire and smoke detection system for MANIREDA approval.

Testing Instruments

The Contractor shall provide the following set of instruments for on-sites testing.

1 Earth resistance tester

Parameter	Specification
Display	Backlit LCD or LED display
Range	Earth Resistance: up to 2000 Ω Earth Voltage: 200 V
Accuracy	± (2% + 5)
Safety Ratings	IP 56
Programmable Limits setting	Enabled
Accessories	
Earth Ground Stakes – 4 Nos.	
Cable Reels – 3 Nos.	
Battery – 2 set	
Carry Case with sufficient space for accommodating accessories	

2 Array tester

Parameter	Specification
Display	Backlit LCD or LED display
Functionality	All electrical tests required by IEC 62446-1:2016
Memory	Up to 200 records & USB downloadable to Computer
Accessories	
A set of two, 4mm fused leads for extra protection during installation tests.	
Leads which enable the array tester to connect directly to PV arrays	
Battery – 2 set	
Carry Case with sufficient space for accommodating accessories	

3 Insulation tester

Parameter	Specification

Display	Backlit LCD or LED display
Insulation Test Range	0.1 MΩ to 10 GΩ
Test Voltage	250V, 500V, 1000V, 5000V
Test Voltage accuracy	+20% on positive side only no negative variation is allowed
Accessories	
Heavy duty Test Leads with Alligator Clips – 1 set	
Battery – 2 set	
Carry Case with sufficient space for accommodating accessories.	

4 Digital Multimeter

Parameter	Specification
Voltage Range	1500 V DC / 1000 V AC (True RMS)
Display	4 ½ digits, Backlit LCD or LED
Measuring Category	1000V CAT III as per IEC 61010-1
Additional Functions	Resistance, Temperature, Continuity, Diode, Capacitance, Frequency, Duty cycle measurement
Accessories	
Temperature Probe – 1 No.	
Test Leads with Alligator Clips – 1 set	
Battery – 2 set	
Carry Case with sufficient space for accommodating accessories.	

5 Clamp meter

Parameter	Specification
Current Range	400 A DC / 1000 A AC (True RMS)
Display	Backlit LCD or LED display
Measuring Category	1000V CAT III as per IEC 61010-1
Additional Functions	Active, Reactive and Apparent Power, THD, PF
Accessories	
Test leads – 1 set	

6 Digital lux meter

Parameter	Specification
Range	0 – 1000 lux
Accuracy	± (2% + 5)
Resolution	1 lux
Display	3½ digits, Backlit LCD/LED
Accessories	
Battery – 2 set	
Carry Case with sufficient space for accommodating accessories.	

All testing equipment shall possess valid calibration certificate issued from approved NABLlabs. Instruments of superior rating is allowed after seeking consent of MANIREDA.

Maintenance, calibration, up keeping, repair & replacement of these tools will be in the scopeof the Contractor during O&M.

It is Contractor's responsibility to arrange for tools, tackles, logistics, test kits, manpower, experts etc. required for trouble free operation of Project.

Power Evacuation System

Design, Construction, Testing and Commissioning of the power evacuation system and its integration to the designated interconnection point via either overhead transmission line or underground cables at specified grid voltage with all necessary infrastructure such as protection switchgears and metering systems shall be as per the requirement of theMSPDCL/MANIREDA.

The Contractor shall get the route approval from MANIREDA prior to start of the construction. Any changes in the route or scheme at any point of the time prior to commissioning shall be complied without any additional cost to MANIREDA.

Only MSPCL/MSPDCL approved components shall be used for construction of transmission line and underground cables.

1 Overhead Transmission Line

In case the power evacuation is planned with overhead transmission line for project external evacuation, the design of tower and its accessories shall be as per MSPDCL requirement and the design shall be submitted to MANIREDA for approval/ accord.

2 Underground cable

In case the power evacuation is planned with underground cable for project internal evacuation, the cable shall be approved by MANIREDA. In case of external power evacuation, the evacuation plan shall be as per MSPDCL requirement and the same shall be submitted to MANIREDA for approval/ accord.

Civil, Mechanical and Plumbing Works

1 General Requirement

- This section of Technical Specifications describes detailed technical and functional requirements of all civil, structural, mechanical & plumbing works included in the scope.

2 Standards & Codes

- All design and construction of civil works shall conform to relevant Indian standards suchas BIS, IRC, MORTH, NBC etc.
- Design of steel structures shall conform to IS: 800, 801 or 802 as applicable. Design of concrete structures shall conform to IS: 456. For design of liquid retaining structure IS: 3370 shall be followed. Only in case of non-availability of Indian standard, equivalent American or British standard may be used for design with prior approval of the Engineer and the contractor shall submit proper justification for the same along with his request to the Engineer for reviewand approval, and the decision of the Engineer shall be final and binding.
- All the design/ drawings shall be prepared/ approved either by in-house Engineering Team of the contractor (or by his Engineering Consultant) with qualified engineering staff with relevant experience in successful design of solar SPV projects.

- The design calculations for MMS, RCC structure, Steel structure, Foundation system, Road work, Drainage work, etc. shall be submitted for prior approval of Engineer before commencement of construction.

- As per project requirements, the Employer may ask for approval of all civil designs and drawings by a Chartered Civil/ Structural Engineer.

- The design calculations shall be supplemented with a neat sketch showing the structure geometry, node and member nos., lengths of various typical members, support points and type of supports, types of materials & type of sections with properties considered in analysis & design. The report shall also include back-up calculations for various loads adopted in design, brief write-up on primary load cases and design load combinations considered and conclusions on design results (with supporting sketches) for easy reference and clarity. Where a computer program (other than Structure Analysis and Design Program (STAAD)) is used for analysis and design, the contractor shall include a write-up on the computer program used along with examples for validation check. Design Input (format suitable to the programme used and also in STAAD format) and output file shall also be given in the design report and in soft copy to facilitate its review and approval by the Engineer.

- The methodology for construction of MMS and its foundations, Road & drainage works and procedure for pile load test shall also be submitted for prior approval of Engineer before start of these works

3 Other Investigations

- The contractor shall also obtain and study other input data at proposed project sites for designof the project from metrological department/ local govt. authorities. This shall include data related to Rainfall, Maximum & Minimum ambient Temperature, Humidity, HFL etc.

- The contractor shall carry out Shadow Analysis at proposed sites and accordingly design strings and array layout with optimum use of space, material and man power. In case of large variations in topography (3o to the horizontal) the study shall also include the effect of topographical variations on array layout and MMS structure design adequacy and stability. The contractor shall submit all the details/ design to the Engineer for review/ approval.

- The contractor shall also identify potential quarry areas for coarse and fine aggregates to be used for concrete and shall carry out the concrete mix design for different grades of concrete to be used before start of work. The concrete mix shall be designed for each source of cement and aggregates as per provisions of relevant BIS Standard. The concrete mix design shall be carried out through NABL accredited Laboratory or any Govt. agency approved by the Engineer. In case the contractor proposes to use RMC, he shall submit the Concrete mix design report from the RMC firm for review and approval by the Engineer. (In case of RMC, reports for periodic cube tests from the supply batch shall also be submitted for reviewand record)

4 Area Grading and Land Development

- The Finished Grade Level (FGL) of the proposed project shall be fixed with reference to the highest flood level (HFL) and surrounding ground profile at proposed sites to avoid flooding of project sites. The data regarding HFL at proposed sites shall be obtained from the metrological department by the contractor. In case of absence of this data, the contractor shall assess therequired information through local sites reconnaissance. The area at and around all buildings/ open installations (ICR, MCR etc.), transformer yard and switch-yard shall be uniformly levelled at suitable RL to be finalized considering topography and HFL at sites. The

minimum plinth level of all buildings/ open installations shall be 1000 mm above FGL. Module mounting structure foundation/ Pile cap or any other pedestal shall be min. 200mm above FGL.

- A detailed drawing for sites levelling and grading (if necessary) shall be submitted by the contractor before commencement of grading and area development works. The estimated volume of cutting and filling shall also be marked on the Grading drawings for reference. The final grade levels to be adopted for different blocks shall be clearly marked on the Project Layout/ Module Layout drawing.

- The contractor is responsible for making the sites ready and easily approachable by clearingbushes, felling of trees (mandatory permissions/ licenses/ statutory clearances from competent authorities if required for cutting of trees, blasting or mining operations, disposal of waste material etc. shall be obtained by the contractor), cutting, filling with selected excavated earth or borrowed earth including identifying borrow areas. Except in exceptional cases (with approval of the Engineer), filling shall be made up of cohesive non-swelling material. The filling for levelling/ reclaiming the ground/ area shall be done in layers not more than 150mm of compacted thickness in case of cohesive (clayey) soils and 250mm compacted thickness in case of granular (sandy) soils with compaction up to 95% (of modified proctor density) and 80% (of relative density) respectively. The slope at edge of graded areas shall not be steeper than 1:1.5 (1 Vertical: 1.5 Horizontal) in cutting and 1:2 (1 Vertical: 2 Horizontal) in filling. In case of filling with rock material, the edges shall be provided in line with provisions of relevant BIS standard.

- It shall be ensured that the land is graded or leveled properly for free flow of surface run-off and the grade levels shall be fixed with respect to high flood level at sites, drainage pattern and system requirements. It shall be ensured that the land is used optimally to have maximum solar power generation considering full utilization of the plot areas. It is advisable to follow the natural flow of water at the ground as far as possible for drainage design.

- In case the filled-up earth is brought from outside the project or borrow areas (when the material inside project area is not found suitable for grading work or if directed by the Engineer), the contractor shall carry out all required soil investigations to ascertain the suitability of the borrowed soil for land development and filling purposes. Contractor's scope shall also include arranging land lease, getting all necessary statutory approvals for mining, payment of necessary challan etc. Excess earth, if any, shall be disposed of properly at location as directed by the Engineer.

5 Roads

Suitable approach road (as applicable) from nearest public road up to project Main gate, Access Road from Main gate to Main control cum office room (MCR), Internal roads connecting MCR and other facilities/ buildings/ open installations like Local control room(s) (LCR)/ Inverter control room(s) (ICR), Sub-station & Switch yard (as applicable) etc. shall be provided for safe and easy transportation of men, material and equipment during construction and maintenance.

6 Peripheral Fence & Main Gate

The project peripheral boundary shall be provided with chain link Project Layout

- The contractor shall submit drawing showing proposed Project and SPV module Layout.

- The Project and SPV module layout shall be a comprehensive drawing showing various requirements of the project like, Reference coordinate grid, Geographical and Project

North,Layout of boundary fence including coordinates of all corner points, Location of main entrance gate and any other access gates as per project needs, Block wise FGL, Layout of main approach road to the project, Internal and peripheral roads, Security Room/ cabin (s), all Buildings and Open installations with coordinates, Temporary Storage yard/ facility to be used by the contractor during construction, Proposed Array layout, Lightening arrester, UG/Over ground water Tank(s), Storm water drains, Corridor for buried cables etc.

- The cable corridor shall be laid through clear gap between arrays and shall not be laid below modules for easy maintenance.
- All the facilities and buildings shall be presented with suitable Legend. The drawing shall be in suitable scale to have proper representation of the information.
- The Project & SPV module layout drawing shall be submitted by the contractor for review/ approval by the Engineer.

7 Design Loads

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

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

S.No.	Area	Imposed(Live) Load
1	Roof(Accessible/Non-accessible)	1.50 kN/ Sqm
2	Building floors (GF) & Grade Slab	10.00 kN/ Sqm
3	RCC Floors (General)	5.00 kN/ Sqm
4	Outdoor platforms, Stairs, Landing and Balconies, Walkway, Chequred plate & Grating (except cable trench cover)	5.00 kN/ Sqm
5	Road culverts & allied structures over drain & pipe crossings subjected to vehicular traffic	Design for Class – 'AA' loading (Wheeled & Tracked both) and check for Class – 'A' loading asper IRC Standard
6	Underground structures such as Sump, Pit, Trench, Drain, UG tank etc.	In addition to Earth pressure and Ground water table at FGL, a surcharge of 20kN /Sqm (10kN/Sqm for drains) shall also beconsidered. The structure shall be designed for following criteria – (a) Inside empty with outside fill+ surcharge and water table at GL & (b) Insidewater with no fill & water table outside

7	Pre-cast and Chequered plate cover over cable trench	4.00 kN/ Sqm
8	Main access & Internal Roads	As per IRC SP 20 corresponding to vehicular traffic of 150 commercial vehicles per day andcritical in-field CBR

8 Primary Loads

i. Dead Load (DL)

ii. Live Load (LL)

iii. Wind Load (WL) – Both along ±X & ±Z horizontal direction

iv. Seismic Load (EL) – Both along ±X & ±Z horizontal direction

- Seismic Load is to be considered as per as per IS 1893 Part 4.
- Seismic Zone = IV, Zone Factor Z = 0.24
- Importance Factor, I = 1.5
- Response Reduction Factor, R = 3

v. Temperature Load (TL)

- Minimum Recorded Temperature = -27.5 ˚C
- Maximum Recorded Temperature = 12 ˚C
- Reference Temperature at time of erection for temperature load calculation =5 ˚C
- The structure shall be designed for a rise in temperature of 7 ˚C and for a fall in temperature of 32.5 ˚C.

Basic wind speed (Vb) at project sites shall be taken as per IS 875 (part-3) unless otherwise specified elsewhere.

To calculate the design wind speed (Vz), the factors k1 (probability factor or risk coefficient), k2 (terrain roughness and height factor) and k3 (topography factor) shall be considered as per IS 875 (Part-3). However, minimum values for k1, k2 and k3 shall be 0.94, 1.0 and 1.0 respectively.

Topography factor ‘k3’ shall be taken as 1.0 up to upwards slope of 3°.

In case of project sites within 60 km of sea coast, the importance factor for cyclonic region,‘k4’ shall be taken as 1.15.

To calculate the design wind pressure ‘pd’, factors ‘ka’ (area averaging factor) and ‘kc’(combination factor) shall be taken as 1.0.

The Seismic Load shall be considered corresponding to Earth quake zone at sites as perIS: 1893 (Part- 4) with Importance factor 1.5. Ductile design and detailing as per IS 13920shall be followed in all RCC structures including MCR, plinth supporting open installationsof inverter transformers and control panels, etc.

9 Module Mounting Structure (MMS)

- The module mounting structure design shall generally follow the existing landprofile.The top of the table shall be in one plane.

- In MMS analysis the column support shall be assumed at EGL/NGL.

- In case of topographical variations more than 3o, the contractor shall carry out detailed study of its effect on array layout, shadow analysis and structural stability of MMS.
- The structure shall be designed to allow easy replacement of any module and shall bein line with sites requirements.

- The MMS stub/ column, rafter, purlin, ties and bracing members shall conform to following Indian standards:
  - IS: 2062 – Hot rolled Medium and High tensile structural steel
  - IS: 811 – Cold formed light gauge structural steel sections
  - IS: 1161 – Steel tubes for structural purposes
  - IS: 4923 – Hollow steel sections for structural use
  - Minimum grade of steel for sections conforming to IS: 811 & IS: 4923 shall be E350(quality 'C' conforming to IS 2062:2011.

- The minimum thickness excluding anti corrosive treatment (BMT) of various elements ofMMS structure shall be as following:
  - ctub/ column – 3.15mm,
  - Rafter – 2.5mm
  - Purlin – 2 mm.
  - Other members – 2.0 mm

- The primary loads and load combinations for design of MMS structure shall be as specified under Clause No. 10. The design shall be done by Working stress method and no increase in allowable stress shall be permitted.

- The maximum permissible deflection/ side sway limits for various elements of MMSunderserviceability conditions shall be as following:
  - Lateral deflection/ side sway for Column – Span/ 240
  - Vertical deflection for Rafter and Purlin – Span/ 180
  - Lateral deflection for Purlin – Span/240

  In case of natural frequency in first mode less than 5 Hz, the design of the MMS structure shall also be checked against dynamic effects of wind as per provisions of IS – 875 (Part- 3) using gust factor method.

- The purlins shall be provided with min. following tie/sag rods or angles or channels:
  - 1 no., in the mid of each span and shall connect all the purlin members
  - 1 no., diagonal, at each corner in end spans

- Lateral restraint to compression flange if any due to PV panels is not permitted in purlindesign.

- The vertical diagonal bracing shall be provided in end spans and every alternate spanof each unit (table) of MMS.
- MMS shall support SPV modules at a given orientation & tilt and shall absorb and transfer the mechanical loads to the ground properly.

- Welding of structure at sites shall not be allowed and only bolted connections shall be used.
- The MMS structure shall be hot dip galvanized with minimum GSM 610 kg/ sqm and/or minimum coating thickness of 80 microns for protection against corrosion. Galvanization shall conform to IS-2629, 4759 & 4736 as applicable.
- It is to ensure that before application of this coating, the steel surface shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or any foreign material likely to interfere with the coating process.
- The bidder shall ensure that inner side is also provided with galvanization coating.
- The galvanization shall be done after fabrication of members and cutting of holes toensure galvanization of all cut/ exposed edges.
- In case the proposed section is made up of Aluminum, anodized coating shall be Gr. AC25 and shall conform to IS: 1868.
- The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels at the same time.
- Two numbers of anti-theft fasteners of stainless steel on two diagonally opposites corners for each module shall be provided. All fasteners and washers (2 round + 1 spring) both for MMS connections and fixing of PV Module shall be adequately protected from atmosphere and weather prevailing in the area.
- Fasteners and washers to be used for erection of mounting structures and fixing of Modules over MMS shall be of stainless-steel grade SS 304 with property class A2-70 conforming to relevant ISO standard.
- Min. diameter of bolt for MMS connections shall be 10mm (12 mm in case of single boltconnection for seasonal tilt) except at column-rafter connection, where it shall not be less than 12mm (not less than 16mm in case of single bolt connection for seasonal tilt). In case of fixed tilt, min. two number of bolts shall be provided at each joint.
- Modules shall be clamped or bolted with the structure properly. The material of clamps shall be Al / SS having weather resistant properties. Clamp/bolt shall have EPDM rubber washer and shall be designed in such a way so as not to cast any shadow on the activepart of a module.
- MMS column post supported with base plate secured to foundation shall be fixed with galvanized high strength “J” bolts conforming to specifications of IS: 4000/ IS: 1367 and relevant IS code. Installation of foundation bolts and embedment of column leg in foundation concrete shall be done by using template to ensure proper alignment. The underside of base plate shall be provided with anti- shrink grout.
- In case the contractor proposes to extend the column leg to embed it in the pile/pedestal as an alternate fixing arrangement, the column member shall be extended for full depth of the pile (100mm cover at tip of the pile) with an end plate of min. 4mm thickness to be welded at the bottom of column leg. (However, for projects in coastal area or in case of marshy soil the column post shall be supported only with base secured to foundation through base plate and anchor bolt assembly and no embedment of column leg in foundation is permitted)

- The array structure shall be grounded properly using maintenance free earthing kit.
- The bidder/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagram and drawings.
- The Bidder should design the structure height considering highest flood level at the sites and the finished grade level. The minimum clearance between the lower edge of the module and the finished grade shall be the higher of (i) Highest flood level + 100mm and1000 mm, as applicable.
- The length of one unit (Table) of MMS shall not generally be more than 20m.
- The contractor shall submit the detailed design calculations and drawings for MMS structure, bill of materials and their specifications/ standards to the Employer for approval before start of fabrication work as per the engineering work program (L2 schedule) as finalized during kick-off meeting.
- The length of any cold formed section (CFS) shall not be more than 5.5 m.
- In case of seasonal tilt, the front and back bracing members (subject to seasonal rotation) shall be connected to the column through gusset plate and shall not be connected directly to the column.
- The purlin splice shall be near the zone of contra-flexure, i.e. within a distance of 0.15Lto 0.25L from the support, where L is the respective span within which splicing is located.
- The purlin splice shall comprise of flange and web splice plates and splice design shall conform to BIS:800. For simplicity in fabrication, the splice member may be of CFS channel section without lips (CU).
- For same member type, same section shall be used.
- When any sag or tie member to the purlin (rod, angle or channel) is provided, it shall not be considered in modelling the structure for analysis except its effect as lateral support to the purlin members in strength design.

10 Concrete Works

- Construction of all RCC works shall be done with approved design mix as per IS 456 and the materials used viz. Cement, coarse & fine aggregate, Reinforcement steel etc. shall conform to relevant BIS standards.
- The min. grade of concrete shall be M25 for MMS piling works, M30 for other RCC works except liquid retaining structures like underground water tank, septic tank, etc. where minimum grade of concrete shall be M35.
- Cement higher than 43 Grade shall not be used in construction.
- Unless otherwise specified elsewhere, PCC shall be of min. grade M10 (nominal mix 1:3:6) except for mud mat, back filling of ground pockets or leveling course which shall be of grade M7.5 (nominal mix 1:4:8).

- Reinforcement steel shall be of high strength TMT bars of grade Fe500D conforming to IS: 1786.

- Unless specified otherwise for grouting works, anti-shrink ready mix grout of approved make or cement mortar (CM) grout with non-shrink compound shall be used. The grout shall be high strength grout having min. characteristic strength of 35 N/mm2 at 28 days.

11 Miscellaneous Steel Works

Unless otherwise specified elsewhere, all structural steel work shall be designed as per provisions of IS: 800 with working stress method of design (WSD).

Structural steel hot rolled sections, flats and plates shall conform IS: 2062, structural Pipes shall be medium (M)/ high (H) grade conforming to IS: 1161, chequered plate shall conform to IS: 3502 and Hollow steel sections for structural purposes shall conform to IS:4923.

12 Buildings and Plinth for Open Installations

General Requirement

- Project buildings and plinth for open installations are required to be constructed for housing the electrical equipment/ panel (Local Control Room Building - LCR) and Control room cum office cum store (Main Control Room Building - MCR) for operation and maintenance of Solar Power Project.

- Unless otherwise specified elsewhere, all buildings and plinth for open installations shall have RCC framed structure.

- All buildings shall have provision of adequate windows for natural light & ventilation, fire safety provisions and shall be designed as per provisions of National building code (NBC).

- The contractor shall submit the proposed equipment layout drawings to the Engineer for approval before development of Architectural drawings. The building layout, exterior elevations shall be aesthetically designed following good architectural practices to get a pleasant look. Horizontal/ vertical bands through projections/ groves in external plaster may be provided to break the monotony. Roof slab shall have projection of 450mm beyond external walls with RCC parapet wall of 450 mm clear height all-around which shall form a projected band at roof level. For weather protection all doors and windows shall be provided with 450mm wide RCC chajja.

  All items shall be of reputed make. Only Items with approved samples by the Engineer shall be used.

Painting & Other Finishes

Painting and white wash/ color wash for the buildings shall conform to relevant BIS standards. The make and color shade of the finish shall be as advised and approved by the Engineer.

Internal Walls except toilets & battery room	Acrylic emulsion (for MCR) & Oil bound distemper (for LCR/ Security Room)
Toilet	Oil bound distemper
External Walls	All weather proof cement based acrylic emulsion paint, exterior grade

MMS foundations/ Earth pit Enclosure	Cement paint
Underside of roof slab	White wash
Air-conditioned areas	Underside of roof slab- Under deck insulation with 50mmthick mineral wool, min. density 45 kg/ m3 and Gypsum board false ceiling with GI grid/ Gypsum tile (600x600 mm x 12 thick) false ceiling with AL grid as per manufacturer's details
Structural steel work	2 coats of synthetic enamel paint over 2 coats of suitable primer

13 Fire Extinguishers

All buildings shall be installed with required no. of fire extinguishers as per relevant BIS standard and NBC. Liquefied CO2 / foam / DCP type fire extinguisher shall be upright type of capacity 9 kg conforming to IS 15683 / IS 2878.

The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes,Electrical Wiring, Live Machinery Fires, and all Flammable Liquid & Gas.

Sign Boards and Danger Boards

The sign board containing brief description of major components of the power project as well as the complete power project in general shall be installed at appropriate locations of the power project as approved by Engineer.

The Signboard shall be made of steel plate of not less than 3 mm. Letters on the board shall be with appropriate illumination arrangements.

Safety signs, building evacuation plan and direction signs, assembly points shall also be placed at strategic locations.

The Contractor shall provide to the Engineer, detailed specifications of the sign boards.

14 Pipe & Cable Trenches

All trenches inside the building and transformer area shall be of RCC. The min. wall and base slab thickness shall be 100mm for depth ≤ 850mm and 150mm for depths > 850mm.

The trench shall be designed for loads as specified under 'Design Loads'. External trenches shall be kept min. 100mm above FGL to avoid entry of rain water. In case of straight length of the trench being more than 40m, suitable expansion joints with PVC water stop shall be provided.

Internal trenches (inside buildings) shall be provided with chequered plate (min. 8mm thick with stiffening angle ISA 50x50x6 @ 750 mm c/c for trench width greater than 800 mm) covers while external trench shall have precast concrete covers.

Min. thickness of precast cover shall be 50mm. Both bearing edges of the cable trench and all edges of pre-cast concrete covers shall be provided with min. 50x50x6 mm edge protection angle with lugs.

The trench cover (chequered or pre – cast both) shall be provided with suitable lifting hooks.

As required, suitable MS insert plates shall be provided on trench wall to support the cable rack/ pipe.

The trench bed shall have a slope of approx. 1(V):250(H) along and 1(V):50(H) across the length of the trench. The cable trench shall have a dewatering sump(s) of size 450x450x450 mm depth at suitable location to facilitate collection & pumping out of rain water from the trench.

The external buried cables shall be laid in excavated trench as specified under specifications for Electrical works.

15 PV Module Cleaning System

Wet Cleaning System

The Contractor shall estimate the water requirements for cleaning the photovoltaic modules at least once in two weeks or at a closer frequency as per the soiling conditions prevailing at sites. Also, the contractor is required to plan the water storage accordingly with provision of a tank of suitable capacity for this purpose. However, min. consumption of 2 Ltr / Sqm of surface area ofSPV module shall be considered in estimation of required quantity of water storage.

A regular supply of suitable quantity of water shall be ensured by the contractor to cater day-to-day requirement of drinking water and for cleaning of PV modules during entireO&M period.

Water used for drinking & PV module cleaning purpose shall generally be of potable quality and fit for cleaning the modules with TDS generally not more than 75 PPM. In case of higher salt contents, the water shall be thoroughly squeezed off to prevent salt deposition over module surface. However, water with TDS more than 200 PPM shall not be used directly for module cleaning without suitable treatment to control the TDS within acceptable limits. The water must be free from any grit and any physical contaminants that could damage the panel surface.

16 Transmission Line Structures

Power will be evacuated from the sites at 11/33 KV and the transmission line length will be approx. 0.5 km to1 km to the interconnection point of MSPDCL.

17 Quality Assurance and Inspection of Civil & Structural Works

Introduction

This part of the specification covers the sampling, testing and quality assurance requirement (including construction tolerances and acceptance criteria) for all civil and structural works covered in this specification.

- This part of the technical specification shall be read in conjunction with other parts of the technical specifications, general technical requirements & erection conditions of the contract which covers common QA requirements. Wherever IS code or standards have been referred they shall be the latest revisions.

- The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part of the technical specifications.

- The QA and QC activities in all respects as specified in the technical specifications/ drawings/ data sheets / quality plans / contract documents shall be carried out at no extra cost.

- The contractor shall prepare detailed construction and erection methodology scheme which shall be compatible to the requirements of the desired progress of work execution, quality measures, prior approvals from statutory authorities etc. if any and the same shall be got approved from the Engineer.

- If required, work methodology may be revised/ reviewed at every stage of execution of work at sites, to suit the sites conditions, work progress commensurate with project schedule by the contractor at no extra cost to the Engineer.

QA and QC Manpower

- The contractor shall nominate one overall QA coordinator for the contract detailing the name, designation, contact details and address at the time of post bid discussions.

- All correspondence related to Quality Assurance shall be addressed by the contractor's QAcoordinator to the Engineer.

- Employer/ Consultant shall address all correspondence related to Quality issues to the contractor's QA coordinator. The contractor's QA coordinator shall be responsible for co- ordination of Quality activities between various divisions of the contractor and their sub- vendors on one hand & with Engineer on the other hand.

- The contractor shall appoint a dedicated, experienced and competent QA & QC in-charge at sites, preferably directly reporting to the concerned Project Officer, supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP.

- The contractor shall finalize and submit a deployment schedule of QA & QC personnel along with their details to Engineer for approval/ acceptance and further shall ensure their availability well before the start of the concern activity.

Sampling and Testing of Construction Materials

- The method of sampling for testing of construction materials and work / job samples shall beas per the relevant BIS / standards / codes and in line with the requirements of the technical specifications / quality plans.

- All samples shall be jointly drawn, signed and sealed wherever required, by the contractor and the engineer or his authorized representative.

- The contractor shall carry out testing in accordance with the relevant IS standards/ codes and in line with the requirements of the technical specifications / quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer.

- All testing shall be done in the presence of Engineer or his authorized representative in a NABL accredited / Govt. Laboratory acceptable to Engineer.

- The test samples shall be jointly selected and sealed and signed by the Sites-in-charge and thereafter these shall be sent to the concerned laboratory.

- The test report along with the recommendations shall be obtained from the laboratory without delay and submitted to Engineer.

Purchase and Service

- All structural steel shall be procured only from main steel producers In case of non-availability of some of the sections with main steel producers, the contractor may propose to procure the sections from the re-rollers of the main steel producers, the name of such re-rollers will have to be cleared by the Engineer for which details such as BIS approval, main steel producer's approval, past experience for production of sections of specified material, details of machines, project, testing facilities etc.

- Confirmation that the process control and manufacturing of steel sections by re-rollers shall be same as that of main steel producers, that billets for re-rolling will only be sourced from main steel producers shall be furnished with regard to re-roller

- For Module Mounting Structures (MMS), sources of steel other than those specified under this clause may also be used subject to the condition that they otherwise meet the requirements of the Technical Specifications / Bid documents. Even after clearance of re- rollers, induction of billets with identified and correlated Mill tests certificates (MTC) in the process of re-rolling, sampling of steel, quality checks thereof and stamping of final product for further identification and correlation with MTC prior to dispatch shall be the responsibility of the contractor and these shall be performed in presence of the authorized representative of the main Contractor.

- Reinforcement steel shall be procured only from main steel producers and Mill test certificates (MTC) shall be obtained and submitted to the Engineer for correlation.

Field Quality Plan

Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans to MANIREDA for approval, which shall detail out for all the works, equipment, services, quality practices and procedures etc. in line with the requirement of the technical specifications to be followed by the contractor at sites.

This FQP shall cover all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at sites.

Performance Measurement Procedure

Performance Ratio (PR)

PR test procedure to be followed will be as described in Section –II, Part -II, and clause 5-A: OPERATIONAL ACCEPTANCE TEST

PART – II

5 MW (AC) Floating Solar PV Plant

DISCLAIMER

A. The information contained in this Document or subsequently provided to Bidder(s), in documentary or in any other form, by or on behalf of MANIREDA, any of their employees or Consultants, is provided to Bidder(s) on the terms and conditions set out in this TENDER DOCUMENT and such other terms and conditions subject to which such information is provided.

B. This TENDER DOCUMENT is not an agreement and is neither an offer nor invitation by MANIREDA to the prospective Bidders or any other person. The purpose of this TENDER DOCUMENT is to provide interested parties with information that may be useful to them in the formulation of their Bid for qualification pursuant to this TENDER DOCUMENT. This TENDER DOCUMENT includes statements, which reflect various assumptions and assessments arrived at by MANIREDA or their consultants or employees or agents, in relation to the Project. Such assumptions, assessments and statements do not purport to contain all the information that each Bidder may require. This TENDER DOCUMENT may not be appropriate for all persons, and it is not possible for MANIREDA, their employees or advisors to consider the investment objectives, financial situation and particular needs of each party who reads or uses this TENDER DOCUMENT.

C. The assumptions, assessments, statements and information contained in this TENDER DOCUMENT may not be complete, accurate, adequate or correct. Each Bidder should therefore, conduct its own investigations and analysis and should check the accuracy, adequacy, correctness, reliability and completeness of the assumptions, assessments, statements and information contained in this TENDER DOCUMENT and obtain independent advice from appropriate sources.

D. Information provided in this TENDER DOCUMENT to the Bidder(s) is on a wide range of matters, some of which depends upon interpretation of law. The information given is not an exhaustive account of statutory requirements and should not be regarded as a complete or authoritative statement of law. MANIREDA would not have any responsibility for the accuracy or otherwise for any interpretation or opinion on law expressed herein.

E. MANIREDA, their employees and Consultants make no representation or warranty and shall have no liability to any person, including any Bidder or Bidder(s), under any law, statute, rules or regulations or tort, principles of restitution or unjust enrichment or otherwise for any loss, damages, cost or expense which may arise from or be incurred or suffered on account of anything contained in this Bid or otherwise, including the accuracy, adequacy, correctness, completeness or reliability of the TENDER DOCUMENT and any assessment, assumption, statement or information contained therein or deemed to form part of this TENDER DOCUMENT or arising in any way with prequalification of Bidders for participation in the Bidding process.

F. MANIREDA also accepts no liability of any nature whether resulting from negligence or otherwise howsoever caused arising from reliance of any Bidder upon the statements contained in this TENDER DOCUMENT. MANIREDA may, in their respective absolute discretion but without being under any obligation to do so, update, amend or supplement the information, assessment or assumptions contained in this TENDER DOCUMENT.

G. The issuance of this TENDER DOCUMENT does not imply that MANIREDA is bound to select and short-list prequalified Bids for Bid Stage (the “Bid Stage”) or to appoint the selected Bidder, as the case may be, for the Project[s] and MANIREDA reserves the right to reject all or any of the Bid or Bids without assigning any reasons whatsoever.

H. The Bidder shall bear all its costs associated with or relating to the preparation and submission of its Bid including but not limited to preparation, copying, postage, delivery fees, expenses associated with any demonstrations or presentations which may be required by the MANIREDA or any other costs incurred in connection with or relating to its Bid proposal. All such costs and expenses will remain with the Bidder and the MANIREDA shall not be liable in any manner whatsoever for the same or for any other costs or other expenses incurred by a Bidder in preparation or submission of the Bid proposal regardless of the conduct or outcome of the Bidding

process.

SECTION 1: DEFINITION & INTERPRETATION

The following words and expressions shall have the meanings hereby assigned to them:

1. **"FSPV project"** means Floating Solar PV project
2. **"Actual Energy Delivered"** means the net energy in kilo-watt hour (kWh) from 5 MW (AC) FS PV plant as measured at the Metering Point at 33kV…….. substation end.
3. **"Adjudicator"** means the person, who shall be an engineer or a firm of engineers who is appointed by the MANIREDA to act as the adjudicator to decide on or to settle any dispute or difference between the MANIREDA and the Contractor referred to it or her by the parties pursuant to RFP (Adjudicator) hereof.
4. **"Applicable Law"** means any statute, law, regulation, ordinance, notification, rule, regulation, judgment, order, decree, bylaw, approval, directive, guideline, policy, requirement or other governmental restriction or any similar form of decision of, or determination by, or any interpretation or administration as per Indian law and the State Government, by any Government Authority or instrumentality thereof, whether in effect as of the date of this Contract or thereafter.
5. **"NEEGG"** is the Net Electrical Energy Generation Guarantee in KWh. The value of NEEGG shall be given as part of the tender and bidder must give its consent to meet the NEEGG with notarized sign and stamp on Letter Head.
6. **"Bid"** shall mean the Techno Commercial and the Financial Proposal submitted by the Bidder along with all documents/credentials/attachments annexure etc., in response to this RFP, in accordance with the terms and conditions hereof.
7. **"Bidder"** shall mean Bidding MANIREDA submitting the Bid including its successors, executors and permitted assigns;
8. **"Commissioning"** means the satisfactory, continuous and uninterrupted operation of the electrical equipment/system as specified after all necessary statutory approvals, execution of required contracts for utilization of generated energy, initial tests, checks and adjustments for a period of at least 3 days to the satisfaction of the MANIREDA and necessary certificates are issued by the all concerned/ nodal agencies appointed by appropriate authority/Government.
9. **"Completion"** means that the all Facilities/Utilities/infrastructure/Electrical System /Electrical Equipment (or a specific part thereof where specific parts are specified in the Scope of Work) have been completed operationally and structurally and put in a tight and clean condition and that all work in respect of Commissioning of the Facilities or such specific part thereof has been completed as per the Scope of Work mentioned in the tender.
10. "MANIREDA" means Manipur Renewable Energy Development Agency and includes the legal successors or permitted assigns of the MANIREDA.
11. **"Contract"** or "Contract Agreement" means the totality of the Agreement signed between the MANIREDA (MANIREDA) and the Contractor to execute the entire Scope of Work
12. **"Contractor"** means the person(s) whose bid to perform the Contract has been accepted by the MANIREDA as successful bidder and undertaking to perform the works, which shall include the legal representative, successors or permitted assigns of the Contractor.
13. **"Contractor's Equipment"** means all plant, facilities, equipment, machinery, tools, apparatus, appliances or things of every kind required in or for installation, completion and maintenance of Facilities that are to be provided by the Contractor, but does not include Plant and Equipment, or other things intended to form or forming part of the Facilities.
14. **"Capacity Utilization Factor (CUF)"** shall have the same meaning as provided in CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2009 as amended from time to time.

15. **"Chartered Accountant"** shall mean a person practicing in India or a firm whereof all the partners practicing in India as a Chartered Accountant(s) within the meaning of the Chartered Accountants Act, 1949.
16. **"Completion Certificate"** shall mean the certificate to be issued by the MANIREDA or his representative when the all works have been completed as per tender to his satisfaction.
17. **"Commercial Operation Date"** (COD): with respect to the Project/Unit shall mean the date on which the project / unit is commissioned (certified by State Transcom/State Discom/State Nodal Agency for Solar) and available for commercial operation and such date as specified in a written notice given at least 10 days in advance by the EPC Contractor to MANIREDA.
18. **"Day"** means calendar day of the Gregorian calendar.
19. **"Delivery Point"** shall be the interconnection point at 33kV voltage level of …….. Substation
20. **"Defect Liability Period"** means the period of validity of the warranties given by the Contractor, during which the Contractor is responsible for defects with respect to the Facilities (or the relevant part thereof) as provided in relevant Clause.
21. **"Effective Date"** shall mean the date of issuance of Letter of Intent (LoI)/LOA/FOA/NTP/Date mentioned in contract agreement from which the time for completion shall be determined by the MANIREDA.
22. **"Facilities"** means the Plant and Equipment to be supplied and installed, as well as all the Installation Services to be carried out by the Contractor under the Contract for enabling the installation/Construction/Erection, erection, construction, testing and commissioning of the Solar Power System(s).
23. **"GCC"** means the General Conditions of Contract hereof.
24. **"Government Authority"** means Government of India, any state government or any governmental department, commission, board, body, bureau, agency, authority, undertaking, court or other judicial or administrative body or any sub-division or instrumentality thereof, central, state, or local, having jurisdiction over the Contractor, the Facility, or the performance of all or any of the services, obligations or covenants of Contractor under or pursuant to this Contract or any portion thereof.
25. **"Guarantee Test(s)"** means the Performance & Guarantee test(s) specified in the (Guarantee Test) to be carried out to ascertain whether the Facilities or a specified part thereof is able to attain the Functional Guarantees.
26. **"Installation Services"** means all those services ancillary to the supply of the Plant and Equipment for the Facilities, to be provided by the Contractor under the Contract; e.g., transportation and provision of marine or other similar insurance, inspection, expediting, Site preparation works (including the provision and use of Contractor's Equipment and the supply of all civil, structural and construction materials required), installation, Commissioning, carrying out guarantee tests, operations, maintenance, the provision of operations and maintenance manuals, training of MANIREDA's personnel etc.
27. **"Month"** means calendar month of the Gregorian calendar.
28. **"MNRE"** means Ministry of New and Renewable Energy, Government of India.
29. **"O&M"** means Operations and Maintenance.
30. **"OWNER or MANIREDA"** means Manipur Renewable Energy Development Agency
31. **"Party"** means the "MANIREDA or the Bidder" as the case may be, and "Parties" means both of them.
32. **"Plant Capacity"** is defined as 5 MW (AC) Grid-Connected Floating Solar Photovoltaic Power
33. Plant proposed at Tender for setting up of grid connected 5 MW Floating Solar PV (FSPV) plant at Thoubal Multipurpose Project Reservoir, Manipur as per the provisions in this Tender.
34. **"Project"** means Design, Engineering, Procurement & Supply, Construction, Erection, Testing, Commissioning and Comprehensive Operation & Maintenance of grid connected 5 MW Floating

Solar PV (FSPV) plant at Thoubal Multipurpose Project Reservoir, Manipur.

35. **"Project Manager"** means the person appointed by the MANIREDA in the manner provided in the RFP (Project Manager) hereof and named to perform the duties delegated by the MANIREDA.
36. **"Prudent Utility Practices"** means those practices, methods, techniques and standards, that are generally accepted for use in civil, mechanical & electric utility industries taking into account conditions in India, and commonly used in prudent electric utility engineering and operations to design, engineer, construct, test, operate and maintain equipment lawfully, safely, efficiently and economically as applicable to power stations of the size, service and type of the Project, and that generally conform to the manufacturer's operation and maintenance guidelines.
37. **"RFP document"** shall mean the bidding document issued by the MANIREDA including all attachments vide RFP No.
38. **"Site"** means the land and other places upon which the Facilities are to be installed, and such other land or places as may be specified in the Contract as forming part of the Site.
39. **"Solar Power System(s)"** means the solar photovoltaic grid interactive power system(s) to be established at the site specified in the RFP.
40. **"Subcontractor",** including vendors, means any person to whom execution of any part of the Facilities, including preparation of any design or supply of any Plant and Equipment, is sub-contracted directly or indirectly by the Contractor, and includes its legal successors or permitted assigns.
41. **"Successful Bidder"** means the eligible bidder who has been awarded the Contract and described as Contractor for the "Project".
42. **"Time for Completion"** shall be the date on or before which Completion of all Facility/Utilities/Infrastructure/Electrical System/Electrical Equipment has to be achieved to the satisfaction of the MANIREDA and such date is specified in Notice Inviting Tender (NIT).
43. **"Inter Connection Point/ Delivery/Metering Point"** 33kV ……'s substation end.
44. **"Consultant"** means the agency designated by MANIREDA to inspect/monitor/instruct to EPC contractor on behalf of MANIREDA during entire project execution tenure.
45. **Language:** The parties shall use the English language and the Contract and the other Bid documents, all correspondence and communications to be given, and all other documentation to be prepared and supplied under the Contract shall be written in English, and the Contract shall be construed and interpreted in accordance with that language.
46. **Singular and Plural**: The singular shall include the plural and the plural the singular, except where the context otherwise requires.
47. **Headings**: The headings and marginal notes in the General Conditions of Contract are included for ease of reference, and shall neither constitute a part of the Contract nor affect its interpretation.
48. **Persons**: Words importing persons or parties shall include firms, corporations and government entities.
49. **Men**: The word 'Men' in this RFP shall mean all genders i.e. male, female and others.
50. **Entire Agreement**: The Contract constitutes the entire agreement between the MANIREDA and Contractor with respect to the subject matter of Contract and supersedes all communications, negotiations and agreements (whether written or oral) of parties with respect thereto made prior to the date of Contract. The various documents forming the Contract are to be taken as mutually explanatory. Should there be any discrepancy, inconsistency, error or omission in the Contract documents, the matter may be referred to the Adjudicator and the Contractor shall carry out work in accordance with the decision of the Adjudicator.
51. **Amendment**: No amendment or other variation of the Contract shall be effective unless it is in writing, is dated, expressly refers to the Contract, and is signed by a duly authorized representative of each party hereto.

52. In case if any clause for any item/work is repeated in the Bid document/RFP/Tender Document at any place which is contradictory to each other then, most stringent/rigid/strict clause will final and applicable to EPC contractor without any further clarification.

SECTION-2. PROJECT INFORMATION

1.1 INTRODUCTION

MANIREDA proposes to develop a 5 MW floating solar photovoltaic (FPV) project in Thoubal Multipurpose Project Reservoir in Manipur to add renewable capacity to meet the state target set by MNRE under the National Solar Mission and NDC for meeting climate target. The project will also help to meet the Renewable Purchase Obligation of the state of Manipur.

The proposed FPV site is located in the village of Chadong, near the town Yaingangpokpi of Thoubal district of Manipur. The geographical coordinates of the site is 24.858719° North 94.140437° East. The altitude of the site is 840-880 m from the mean sea level. The site is suitable for establishing a 5 MW FPV power plant offers a wider and deeper channel, requiring minimal or no dredging, ensuring the buoyancy of the floating structure year-round.

The generated power will be evacuated at 132/33 kV Yaingangpokpi substation is located approximately 6.5 km away. A 33 kV transmission line shall be drawn from the site to this substation to evacuate the generated solar power from the FSPV plant.

1.2 PROJECT CAPAPCITY

TABLE 1: PROJECT CAPACITY DETAILS

CumulativeProject ACCapacity	Minimum 5MW
DC Capacity	As per project requirement
BidCapacity	Bidderhas to quotefor fullcapacity

1.3 LOCATION AND APPROACH

The detailed location of the site is as follows:

TABLE 2 : LOCATION AND APPROACH DETAILS

PARTICULARS	DESCRIPTION
Place	Chadong Village near the town Yaingangpokpi
District	Thoubal
State	Manipur
NearestAirport	Imphal (~ 35 km)
Nearest RailwayStation	Imphal(~ 30KM)

SECTION-3. INTENT OF SPECIFICATION

1.1SCOPE OF WORK

The scope of the project shall be:

1) Design, Engineering, Supply, Construction, Erection, Testing, and Commissioning of grid connected 5 MW-AC Floating Solar PV plant along with power evacuation system at final evacuation point.
2) Five (5) years Comprehensive Operation and Maintenance (O&M) of the solar PV plant from the successful completion date of Operational Acceptance Test (OAT) or commissioning, whichever is the earlier.

The scope of work covers the following activities and services in respect of all the equipment & works specified and covered under the specifications and read in conjunction with “Scope of Supply & services” elaborated elsewhere in the technical specification.

All equipment, materials and services whether explicitly stated or otherwise and that are necessary for the satisfactory operation of the Solar PV system and its integration with the existing substation / Switchyard described in the specification shall be deemed to be included in the scope of work of the Contractor and shall not be limited to the following:

1. Basic Engineering of the plant and systems.
2. Detailed design of all the equipment and equipment system(s) including civil works.
3. Providing of engineering drawings for review and approval, data, process, calculations, test procedures, Structural Design Calculations, Equipment Layout, Drawings / Data sheets of bought out items, Civil Structural / Architectural Drawings, OAT and PG test procedure (as mentioned in Technical Specification) etc.
4. Providing Operation & Maintenance/ instruction manuals, as built drawings and other information.
5. Providing training of MANIREDA’s personnel.
6. Finalization of sub-vendors, manufacturing quality plans and field quality plans.
7. Mandatory permission/ licenses/ statutory clearances from Competent Authorities for undertaking blasting related works, disposal of cutting material, etc. shall be carried out by the Bidder.
8. Complete manufacturing including conducting all type, routine, and acceptance tests; Civil, Structural and Architectural works to the extent applicable, including construction facilities and construction power distribution.
9. Packing and transportation from the manufacturer’s works to the site including Customs clearance & port clearance, port charges, (if any).
10. Receipt, storage, preservation, security and conservation of equipment at the site; Fabrication, pre- assembly, (if any), erection, testing, pre-commissioning, and commissioning and putting into satisfactory operation all the equipment including successful completion of initial operation. A separate storage shed shall be constructed by bidder, especially for indoor equipment storage.
11. Topographical survey & Geo-Technical investigation of land/waterbody and bathymetry survey of water body, as applicable and as per requirement of design of floating solar PV systems.
12. Supply of all Equipment required for complete FSPV Plant.
13. Supply of floaters, installation, anchoring, mooring, fixing of floaters for SPV panels, pathways

for the floating system, including fixing of PV Modules on Floaters.

14. Launching platforms, O&M platforms/Jetty with suitable road and water access as per requirement.
15. Construction of RCC/Pre-Engineered type Inverter room/Open Equipment platforms which includes Central Inverter/AC combiner box, Inverter Transformers along with associated LT and HT switchgear as per design. UPS and Battery Bank should be kept in separate enclosures.
16. All associated electrical and civil works required for interfacing with grid i.e. Transformers, Isolators, CTs, CBs, panels, protection system, cables, metering at 33KV level, grid compliance study as per regulation etc.
17. All equipment, materials and services that are necessary for implementation of the reactive power compensation system and any other equipment required to make the plant CEA/SERC compliant as per the grid study with satisfactory operation of the Solar PV system.
18. Evacuation of power as per requirement of STU/DISCOM of Manipur.
19. Construction of Central Monitoring and Control Station (CMCS) for 5 MW Capacity with SCADA, PPC panel and associated equipment with provision of future extensions for SCADA system, UPS and Battery bank at identified location within Solar Plant Premises. UPS and Battery Bank should be kept in separate enclosures inside CMCS.
20. Module cleaning system (Wet Method) including supply and installation of all accessories like monitoring system at CMCS and associated equipment and services at identified location to cover the complete plant.
21. SCADA system for remote monitoring and control of Inverters with all hardware & software and complete set of Weather Monitoring Station including cloud cover.
22. CCTV System for remote monitoring of the complete project including supply and installation of all accessories like monitoring system at CMCS and associated equipment and services at identified location.
23. Comprehensive Operation & Maintenance of SPV Plant along with electrical equipment, consumables, and spare parts for a period of five years from the successful completion of OAT.
24. Reliability and Functional guarantee tests (OAT and PGT) after successful commissioning of full Capacity.
25. Supply of Mandatory Spares.
26. Satisfactory completion of the contract.
27. Special tools and tackles if any required for maintenance of the plant.
28. Detailed system wise scope is elaborated in respective part of the technical specification.
29. The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices etc. given in Technical Specifications together with those stated in other Sections/Sub-sections of Bid Documents which shall be considered as a part of this volumes completely as if bound herewith. It is not the intent to specify herein all aspects of design and construction nevertheless, the equipment and civil works shall conforming all aspects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the MANIREDA, who will interpret the meaning of the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable Indian / International standards mentioned elsewhere in this specification.

30. Before submitting his bid, the bidder should inspect and examine the site and its surroundings and should satisfy himself/herself as to the nature of the ground and subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself/herself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his/her offer. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the MANIREDA.
31. Statutory compliances across the timeline of the contract as per extant regulations prevailing on the bid opening date.

A DESIGN & ENGINEERING

1. Contractor shall prepare the detailed design drawings along with relevant standards (with respective clause description), Program evaluation and review technique (PERT) Chart. Contractor shall submit two copies of the same to MANIREDA for review and approval prior to detail engineering.

2. All documents and drawings (soft copy) shall be submitted to the MANIREDA for review and approval. Every drawing shall also be submitted in '*.dwg' format. In case of design calculations done in spread sheet, editable (working) soft copy of the spread sheet shall also be submitted along with 'pdf' copies during every submission. MANIREDA shall return to the Contractor with category of approval marked thereon.

    - Category-I: Approved
    - Category-II: Approved subject to incorporation of comments. Re-submit for approval after incorporation of comments
    - Category-III: Not approved. Re-submit for approval after incorporation of comments
    - Category-IV: Kept for record/ reference
    - Category-IV (R): Re-submit for record/ reference after incorporation of comments

    (Note: Approval of document neither relieves the Vendor/ Contractor of his contractual obligations and responsibilities for correctness of design, drawings, dimensions, quality & specifications of materials, weights, quantities, assembly fits, systems/ performance requirement and conformity of supplies with Technical Specifications, Indian statutory laws as may be applicable, nor does it limit the MANIREDA/ Purchaser's rights under the contract).

3. The Contractor shall submit complete design drawings to the MANIREDA within 2 weeks after issue of LOA. The Design Drawings & Documents envisaged for submission/ approval from the MANIREDA and shall also have all the required information like drawing no., title, scheduled date of submission, actual date of submission and approval. The category of approval shall be decided mutually between Contractor and the MANIREDA at the time of finalization of drawings which shall be the basis for drawing & document approval process during project execution. The MANIREDA shall be kept updated with all proceedings and technical details during the course of design vetting of Floating unit and anchoring & mooring system.

B. ELECTRICAL SCOPE OF SUPPLY & SERVICES

1.0 BASIC ENGINEERING DESIGN PARAMETER OF FLOATING SOLAR PV PLANT

a) MINIMUM PLANT AC CAPACITY : 5 MW

b) MINIMUM DC CAPACITY : As per project requirement

c) DESIGNED SYSTEM VOLTAGE : 1500 V DC

d) POWER CONDITIONING UNIT (PCU) :

i. CAPACITY: The continuous combined rating of all PCUs shall not be less than Plant capacity at

a. Unit power factor at ambient temperature of 50 deg.

b. 0.95 power factor at ambient temperature of 45 deg.

ii. DC OVERLOADING: Maximum PCU DC overload loading shall be limited to its design PV Array Power to PCU nominal AC power ratio. Bidder needs to submit all the relevant technical document/test report from PCU manufacturer (OEM) during details engineering stage in support of declared PCU design DC overloading capacity.

e) Same rating of Inverter is recommended for the whole plant and same rating of Inverter Transformer is also preferred considering Mandatory spare management.

f) 33 kV Pooling Switchgear with all spare breaker panels, circuit breakers, relays, and all other accessories. The rooms shall have sufficient ventilation facility.

Supply and installation of metering panel along with control cable shall be in bidder's scope. ABT/SEM metering arrangement shall be as per STU/DISCOM requirement/standard.

g) Metering:

(i) Metering shall be done at both location Solar plant end and 33kV substation which is interconnection point at the Switchyard/substation at 33kV Substation end where the power is injected into the substation i.e. The delivery point / final evacuation point/interconnection point.

(ii) Automated meter reading (AMR) facility to be ensured with ABT meters. Laptop with necessary software & hardware support to be provided by EPC bidder for interfacing with ABT meters.

h) Earth Pit for DC System:

For floating Solar PV Systems, the number of earth pits shall be reviewed during detailed engineering based on actual site requirement and Bidder's earthing proposal.

i) DC and LT Power cable voltage drop criteria: From Module to Inverter Transformer shall be limited to 3% of rated voltage. For all other LT cables, Maximum Voltage drop shall be limited to 3% of rated voltage.

j) The DC Power and AC Cables shall be laid on floats in a manner that they are not submerged in water. Bidder to use suitable cable trays, cable supports etc. to achieve this. The DC power cables shall be brought to the bund and then up to inverters, using suitable arrangements. The DC cable arrangement shall be reviewed during detail

engineering and finalized as per the MANIREDA's confirmation. For complying the same, if any additional structures/arrangements requirements arise, then same shall form of this specification and shall be done by bidder.

The AC Cables shall be laid in trefoil formation using good quality trefoil clamps and other cable clamps shall also be able to sustain the harsh floating environment. Cable straps used shall be UV resistant.

Bidder can propose suitable laying scheme taking into consideration the floating aspect of the project which shall be reviewed during detailed engineering.

AC HT cable from Local pooling station to Final evacuation point, the sizing shall be done considering the project requirements (i.e. for total 5MW). Accordingly, equipment shall be selected.

k) Closed Circuit Television (CCTV) and Control and Monitoring System: CCTV system shall have full coverage for the solar blocks. For detailed specifications of CCTV system, refer relevant chapter of Technical Specifications.

l) FIRE ALARM SYSTEM: For detailed specifications of Fire alarm system, refer relevant chapter of Technical Specifications.

The detailed scope of work in accordance with this specification is elaborated below. The scope of the contractor shall be deemed to include all such items which although are not specifically mentioned in the bid documents and/or in contractor's proposal but are needed to make the system complete in all respects for its safe, reliable, efficient, and trouble-free operation and the same shall be furnished and erected unless otherwise specifically excluded as per Section Terminal Points & Exclusions.

2.0SUPPLIES &ASSOCIATED WORKS

DCSIDE
SolarPVModules
HDPEFloatersforfloatingsystem with PV module mounting systems and accessories
MooringSystemaccessoriesforFloating System
DCCablesincludingfieldconnectorsandDWCpipes
StringCombinerBox
StringInverter/Centralinverter
ACSIDE
LTSwitchgear(ACCB, ACDB)
HTSwitchgearandother necessaryequipmentatevacuation point
InverterTransformer &AuxiliaryTransformer
LTCables
HTCables
CableLaying–DC, LT&HTcables

SCADAandTimeSynchronizationEquipment
InstrumentationandCommunicationcable
EarthingSystemforFloatingbasedsystems
LightningProtectionSystem
PlantIlluminationsystem
AuxiliaryPowerSupplySystem
BatteryandBatteryCharger
UPS
PPC
Grid compliance study and supply & installation ofinterfacing equipment so as to meetstatutory requirements.
GENERALSYSTEMS
WeatherMonitoringStation
FireDetectionandprotectionsystem
ModuleCleaningsystem
ClosedCircuitTelevision(CCTV)andMonitoringSystem

3.0 Provision of SCADA HMIS/SERVER Operator Work-Station (OWS) at CMCS Room

SCADA, & other associated electrical system shall be placed at the identified location inside CMCS Room.

TABLE 5 : SCADA ROOM EQUIPMENT AND FURNITURE

Sl. no	Description	Quantity
1	Engineering cum Operator work station (EWS+OWS) (Server with Monitor)	01Set
2	Operatorworkstation(OWS)(ServerwithMonitor) OneatCMCS	02Set
3	Portable(laptopbased)EWS	01No
4	Historian(Desktop)	01No
5	LEDdisplay	01No
6	TimeSynchronizationequipment	01No
7	ControlDesk	01Set
8	ChairsforControlDesk	02No
9	LaserPrinter	01 No

C CIVIL SCOPE OF SUPPLY & SERVICES

1.0 SCOPE

The broad scope of work under this package shall include Civil, Structural Works related to but not limited to the following areas, System, Structures/ Substructures, Buildings and Facilities.

2.0 DESIGN & CONSTRUCTION OF PERMANENT FACILITIES:

TABLE 6: LIST OF PERMANENT FACILITIES

Sr. No.	Facility/Building	Quantity
1.	Siteinvestigation-Topographysurvey, Bathymetry&Geotechnicalinvestigation	As per systemdesignrequirement and specifications.
2.	FloatingSystemincludingAnchoringand Mooring for Floating Solar PV System	As required.
3.	Office, control room, store room, and staff shelter	1 no. (as per drawing)
4.	InverterRoom(s)-Pre-EngineeredBuilding (PEB) / Containerized System/Outdoor system	As required.
5.	Cable floats with necessary fittings and accessoriesincludingAnchoringandMoori ng System.	As required.
6.	CableTrenches/Trestleincludinga nyCable Tray supporting facility	As required.
7.	Toilet	As required
8.	AllEquipmentSupportingFoundati onand Structures	As per Detailed Engineering & Geotech InvestigationincludingReferencet oFlood Levels.
9.	SewagedisposalsystemsuchasSepticTan k & Soak pit for all toilets.	Asperactual.
10.	ApproachRoads & InternalRoads	As per bidder’s proposal, as per requirement
11.	Drainagesystem(Internal&Extern alalong approach road)	As per bidder’s proposal, as per requirement

12.	AnyinternalFencingandGates,e.g.for Yards (Transformer, inverter)	Asperproject requirement
13.	SiteClearing and Grading includingdismantlingofBuildingifany.	Asperthe requirement
14.	PEBSecurityCabin(Min.Size1.8MX1.8 M)	3 Nos.

Any other misc. requirement necessary for completion of commissioning & operation in line with Bidder's technical proposal / detailed Engineering.

A) Site Preparation (as required for installation of panels / equipment etc. during construction, erection, and commissioning activities).

1. Cutting, Clearing, transporting and disposal of plants, bushes, other vegetation, roots, stub, old structures etc.
2. Any temporary drainage including any dewatering, site approach & service roads.
3. All temporary work in bidder scope i.e. Fencing, Parking Shed, Road, Porta cabin and other infrastructures etc.
4. Swatch Bharat Yojana policy for cleaning and deposal of sewage.

Note –Bidders are advised to visit site location to appraise themselves with local conditions.

B) Bidder has to carry out following site Investigations before start of work.

a) Topographical survey

b) Bathymetry Survey

c) Geo-Technical investigation

d) Hydrological studies

NOTE:

A. In case, any study / investigation report / design carried out by MANIREDA, has been shared with bidder, then it is solely for the purpose of guidance of the bidder. Bidder may cross verify the data / design system on its own without any financial / time implications to MANIREDA.

D MISCELLANEOUS

1.0 CODES AND STANDARDS

All works shall be carried out as per the standards/codes (IEC, IS etc.) referred in the specification. All standards, specifications and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those codes/standards referred the former shall prevail.

Equipment complying with other internationally accepted standards such as BS, UL, DIN, VDE etc. will also be considered, if they ensure performance and constructional features equivalent or superior to standards listed in the specification. In such case the Bidder shall clearly indicate the standards adopted, furnish a copy in the English of the latest revisions in force as on date of opening of bid and shall clearly bring out salient features for comparison.

2.0 APPROVALS

The scope of the bidder includes complete design and engineering, technical coordination (including participation and arranging technical co-ordination meetings), finalization of drawings/ documents, submission of engineering drawing / documents and processing of their approvals by the MANIREDA as per relevant clauses of this document. Further, the scope shall also include submission, in proper shape & format, of all types of manuals, handbooks & documents in requisite numbers to the MANIREDA at different phases of the project as per the requirement of MANIREDA. The contractor shall have to arrange technical coordination meetings and ensure participation.

3.0 PAINTING

The bidder's scope of work includes painting of all equipment and structures. The painting shall include required application of finish paint indicated elsewhere in the Technical Specification. The quality and finish of paints shall be as per standards of BIS or approved equivalent, suitable for coastal (corrosive) conditions of site.

4.0 TESTING

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

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

5.0 CONSTRUCTION OF TEMPORARY STORAGE YARD

a) Bidder shall, at a suitable location at the site, as decided based on discussions with MANIREDA site engineer, construct temporary yards for safe storage of bidder supplied items.

b) Area of all storage yards/sheds shall be selected based on sizes of items. Bidder shall, at the time of starting their activities at site, submit drawings/ sketches/ dimensions etc to obtain approval from MANIREDA.

c) Safety and security of all the items shall be within bidder scope. Accordingly, bidder shall ensure adequate security watch and ward for these items round the clock.

6.0 CONSTRUCTION OF TEMPORARY FACILITY

The Bidder shall provide a temporary facility/ arrangement at site or otherwise for the office of MANIREDA's employee/ consultant at the time of construction of the Solar Power Plant. One (1) No. of air-conditioned Porta Cabin (20x10 ft) with facilities shall be provided by the bidder for Owner's use. The porta cabins shall be equipped with AC, Furniture, Fan, Tube light, plug sockets and other equipment for comfortable working at construction site. Prior to supply, the Bidder shall submit the Office Porta Cabin layout proposal to MANIREDA Site Engineer in Charge for approval.

Porta Cabins, with the above facilities, shall be the property of the bidder only and the bidder is free to take back from the plant after completion and after taking necessary permissions from the MANIREDA.

7.0SPARES

The Bidder shall include following spares in his scope of supply.

i. All the necessary recommended spares, commissioning spares and O&M spares.

ii. Mandatory spares as mentioned Section-10 of this specification.

8.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

All the contract personnel entering plant shall wear safety helmet, safety goggle, safety shoes (or the required foot protective equipment like gum boots) and protective clothing. In addition to the above requirement, any PPE which is required for the safe execution of job shall be provided by the Contractor and the requirement will be provided by the Engineer in charge/ authorized person of the area concerned or Safety section. The PPEs provided by the contractor to his/her personnel shall meet the requirements as per ANSI/EU/IS standards.

9.0OTHER DETAILS

The following clearances shall be arranged by bidder. However, necessary documentations/applications shall be in the name of MANIREDA.

TABLE 7: DETAILS OF STATUTORY CLEARANCES

SL.NO	ITEM	DETAILS
1	WaterRequirementduring construction	Shall bearranged bycontractor at their own arrangement and cost. MANIREDA will assist in case any permission is required for the same.
2	PowerRequirementduring construction	Power Requirement during construction shall be arranged bythe contractor – either from local DISCOM or by DG set or by both at their own expenses.
3	Forest and Environment Clearance	ShallbearrangedbyMANIREDA,wherever applicable
4	SPCB Clearance	ApplicationbyMANIREDA.Inputsforapplication& processing to be facilitated by bidder
5	CEA/CEIGClearance	Tobefacilitated bybidder
6	TreeCuttingPermission	Tobefacilitated bybidder

Bidder shall apply for necessary approvals, permits and clearances not more than 15 days from the issuance of LOA, which shall be complete in all respects, incorporating the clarifications/changes as required by the concerned authorities.

All the statutory fees for approvals till the completion of O&M period shall be in the scope of bidder (unless otherwise specifically mentioned in the document).

11.0 TRAINING OF MANIREDA'S PERSONNEL

The bidder shall provide training (free of cost) to 5-10 personnel of MANIREDA for 7 days at site for erection, testing, commissioning and O&M of the plant which must include training on Operation of Inverters, SCADA, Module Washing System from respective OEMs etc.

SECTION-4. TENDER DRAWINGS

Indicative DC and AC SLDs, Civil drawings, and other documents what MANIREDA developed for feasibility will be provided to the contractor for reference.

Various parameters for building and other equipment specified in the tender drawing are the minimum required & any increase in these parameters if required to meet the system requirement shall be made by the Bidder without any additional cost implication to MANIREDA.

SECTION-5. PROJECT SPECIFIC DATA

1.1 TECHNOLOGY

Solar Photovoltaic Power Generation on a floating platform by direct conversion of solar radiation into electricity by using “Solar Cells”, which work on the principles of photo electric effect.

1.2 1.2 SOLAR INSOLATION DATA FOR PROPOSED THOUBAL RESERVOIR SITE

TABLE 8: SITE IRRADIATION DETAILS

Months	NASA	Meteonorm (PVSyst)	PVWatt (NREL)	GlobalSolar Atlas(WB)	Average
January	4.01	4.36	4.39	4.13	4.22
February	4.78	4.65	5.22	4.72	4.84
March	5.18	5.27	5.93	5.11	5.37
April	5.17	5.47	5.51	5.14	5.32
May	4.98	4.77	5.42	4.63	4.95
June	4.32	4.33	5.1	4.09	4.46
July	3.92	4.24	4.56	3.76	4.12
August	3.96	3.79	4.17	3.83	3.94
September	4.14	4.39	4.54	3.99	4.27
October	4.14	4.43	4.21	4.02	4.20
November	4.04	4.16	4.62	4.20	4.26
December	3.67	4.34	3.97	3.86	3.96
Average	**4.36**	**4.52**	**4.80**	**4.29**	**4.49**

1.3 MODULE MOUNTING: Fixed Tilt type on Floating Structure

1.4 CORROSIVE CATEGORY (FOR PAINTS)

i. Classification of environments for Corrosive category shall be in accordance with ISO12944-2, the applicable atmospheric corrosivity categories as per requirement as mentioned above.

ii. ISO12944-5 shall be used related to paint systems in combination with guidance for the selection of different types of protective paint system.

iii. Wherever specification allows LT electrical panels, UPS, SCADA panel, Fire protection panel etc. associated with Inverter station to be placed outdoor, the enclosure of the same should be well engineered product having proper ventilation system and must be protected from harsh environment & direct sunlight/rainfall.

iv. Radiation and absorption effects of outdoor environment must be considered for temperature rise calculations. The temperature rise should not be more than working temperature of components (The derating should not limit the continuous rated operation of the project. Requirement of suitable shed/canopy shall be reviewed based on the offered solution during detailed engineering stage.

v. For metal enclosed outdoor HT switchgear, pooling switchgear on the LT side (if applicable) from string inverter to inverter transformer, suitable shed (for floating) shall be provided considering the O&M space which shall be reviewed based on the offered solution during detailed engineering stage.

vi. Painting of outdoor metallic enclosed electrical panels including HT switchgear shall be as per ISO 12944-5, corresponding to corrosive category mentioned in the above table.

vii. For outdoor inverter including containerized solution, painting corresponding to site condition shall be provided.

1.5 SEISMIC DATA & DESIGN CRITERIA

i. All structures and equipment shall be designed for seismic forces adopting the information provided in this document and in accordance with the provisions of IS:1893 (Part 1):2002 and IS:1893 (Part 4):2005.

ii. Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

1.6 WIND DATA & DESIGN CRITERIA

Location	Basicwind speed
Thoubal Multipurpose Reservoir, Manipur	AsperIS-875part-3latest

5-A: OPERATIONAL ACCEPTANCE TEST

I) TEST PROCEDURE:

1. Performance Ratio as determined through the OAT Procedure specified here shall not be less than 75% for successful completion of OAT.

2. The Operational Acceptance Test to prove the guaranteed performance parameters of the power plant shall be conducted at site by the Contractor in presence of the Owner. The Contractor's Engineer shall make the plant ready to conduct such tests. The Operational Acceptance Test shall be commenced, immediately after successful Commissioning and, there will be continuous monitoring of the performance for 30 days. Any extension of time beyond above one (1) month shall be mutually agreed upon. These tests shall be binding on both the parties to the Contract to determine compliance of the equipment with the guaranteed performance parameters. This monitoring will be performed on the site under the supervision of the Owner/ Owner's engineer.

3. The test will consist of guaranteeing the correct operation of the plant over 30 days, by the way of the efficiency rate (performance ratio) based on the reading of the energy produced and delivered to the grid and the average incident solar radiation. During this period of 30 days, any 5 (five) instances of 15 (fifteen) minutes (preferably between 10:00 AM to 4:00 PM as per mutually agreed time) shall be taken to calculate the instantaneous Performance Ratio of 15 minutes block as per the formula given below in Point No. 5. If the PR of these fives individual instances is equal to or above 75%, then Operational Acceptance Test (OAT) shall be considered successful.

4. PR shall be demonstrated against the installed DC Capacity.

5. The Performance Ratio (PR) of the PV Plant is calculated as follows (according to IEC 61724)

$$\mathbf{PerformanceRatio(PR)=Y_A/Y_R[1-\alpha*(TCellavg.-TCell)]}$$

Where;

Y_A=FinalPVsystemyield(representingthenumberofhoursthatthesystemwouldneedtooperateatits rated output power PNom to contribute the same energy to the grid as was monitored)

Or, $Y_A=E_{ac}/ P_{Nom}$

Y_R = Reference yield (representing the number of hours during which the solar radiation would need to be at STC irradiance levels in order to contribute the same incident energy as was monitored)

Or, $Y_R=I_R$Site/ I_RSTC

E_{ac}	=	ACenergyinjected into the grid duringaclearlyspecified amount of time (kWh)
P_{Nom}	=	Installednominalpeak powerofmodules(Flash testratingatSTC) (kWp)
I_RSite	=	Irradiationonthemoduleplaneofarrayduringaclearlyspecifiedamountoftime(measure dwitha Pyranometerinstalled onthearrayplane) (kWh/sq. m)
I_RSTC	=	IrradianceatSTC(kW/sq.m)
$T_{cell\ avg}$	=	Averagecell/moduletemperature(°C)
T_{cell}	=	STCcell/moduletemperature(°C)

α	=	temperaturecoefficientofpower(negativeinsign)correspondstotheinstalledmodule(% /°C)

II) MONITORING SYSTEM FOR PR VERIFICATION:

The following instrumentation will be used to determine the Solar Plant Performance:

1. Main Meter at the final evacuation point.
2. One no. calibrated pyranometer to determine irradiance on the plane of array.
3. Two nos. calibrated pyranometer to determine irradiance on horizontal plane.
4. Two nos. thermocouples to measure module temperature.
5. Shielded ventilated thermocouple.
6. An anemometer mounted on a pole mast at an appropriate height to measure wind speed.
7. Data measurement shall be witnessed in the format mutually agreed before the start of OAT by the employer and the contractor jointly for the said period.
8. The Contractor shall show the specified PR for Operational Acceptance.

III) The EPC contractor shall be allowed to conduct the Operational Acceptance Test till the test is successful as specified in this tender specification. For each unsuccessful attempt, no penalty shall be imposed.

IV) The O&M period shall start only after successful completion of OAT or 90 days from commissioning, whichever is the earlier.

5-B: WARRANTY AND COMPREHENSIVE AMC

A) WARRANTY:

Original Equipment Manufacturer (OEM) or EPC contractor shall provide warranty for the following components as follows:

TABLE 11: WARRANTY DETAILS

Sr. No.	Product/Equipment/SystemName	WarrantyinYears
1	PV Module	PerformanceWarranty:25Years
		ProductWarranty:10 Years
2	Floating System (Floater units & platforms) including anchoring & mooring with complete system	Design Life: 25 Years ProductWarranty:10Years
3	Central/StringInverters	5 Years
4	LT/HTPanels/ACCombinerBox	5 Years
5	InverterTransformers	5 Years
6	Other Items	AsperOEM'sStandard WarrantyTerms

Warranty period shall start from the date of successful completion of OAT.

B) COMPREHENSIVE AMC

1. Bidder has to take Comprehensive Annual Maintenance Contract (AMC) from Original Equipment Manufacturer (OEM) or OEM authorized service provider for a period of 5 years for the following components:

TABLE 12: COMPREHENSIVE AMC DETAILS

Equipment/System	ComprehensiveAMC
FloatingSystem(Floaterunits&platforms)including anchoring & mooring with complete system	5 Years
Central/String Inverter	5 Years
SCADA	5 Years
PowerPlantController[PPC]system	5 Years
CCTVsystem	5 Years

2. CAMC period shall start from the date of successful completion of OAT.

3. Comprehensive AMC shall include all preventive maintenance and breakdown maintenance including replacement of any component to ensure that equipment is working satisfactorily as per design/system requirement. During AMC period, the OEM or its representative are required to visit at least once a year or as per OEM recommendation cycle for periodic maintenance. During AMC period, the OEM is required to respond within one working day through telecom or

any electronic mean.

4. In case of breakdown of the system, OEM has to send their representative within 72 hours. For the minor faults not hampering the generation e.g. communication, display etc., the OEM has to get the fault rectified within 7 working days.
5. For Warranty and Comprehensive AMC, the EPC contractor shall arrange the necessary documents from respective OEM on the name of MANIREDA for entire warranty/Comprehensive AMC duration.
6. Failure from the OEM/EPC to adhere the activity and the time schedule may lead to BG encashment submitted for AMC and Warranty of Critical Equipment.

5-C: STATUTORY AND REGULATORY COMPLIANCES, GRID CONNECTIVITY

1. All construction, operation and maintenance procedures shall be carried out through appropriate relevant standards, regulations laid by DISCOMS /SERC/ GOI/ MNRE/CERC/CEA/CEI and / or any other agency as and when applicable. Further, this shall comply with the applicable labor laws. The Bidder shall make himself/herself aware of such requirements and shall not solely depend on the MANIREDA to avail full information.

2. In respect of all Labour, directly or indirectly employed in work for the performance of Contractor's part of this Agreement, bidder shall at his own expense arrange for all the safety provisions as per Indian Standards Institution and such other Acts, Rules and Regulations as applicable.

3. The scope of power evacuation system in the scope of the bidder is up to the terminal point as indicated in the tender SLD.

4. During the entire period of contract Bidder shall also comply all provisions and it's amendment(s)/Clarification(s)thereof of the following:

   a) Central Electricity Regulatory Commission (Connectivity and General Network Access to the inter-State Transmission System) Regulations, 2022.
   b) CERC 'Detailed Procedure for Connectivity and GNA' under the Central Electricity Regulatory Commission (Connectivity and General Network Access to the inter-State Transmission System) Regulations, 2022".
   c) CERC (Grant of Connectivity, Long Term Access and Medium-term Access in Interstate Transmission and related matters) Regulation 2009 (if applicable as per extant connectivity regulations/procedures).
   d) CERC's revised procedure for "Grant of Connectivity to Projects based on renewable sources to inter-state transmission system" (if applicable as per extant connectivity regulations/procedures).
   e) CEA (Technical Standards for Connectivity to Grid) Regulation,2007.
   f) CEA (Technical Standards for construction of Electrical Plants and Electrical Lines) Regulation,2010.
   g) CEA (Grid Standard) Regulation,2010.
   h) CEA (safety requirements for construction, operation and maintenance of Electrical Plants and Electrical Lines) Regulations,2011.
   i) CEA (Measures relating to Safety and Electrical Supply) Regulations,2010.
   j) CEA (Installation and Operation of Meters) Regulations 2006
   k) Indian Electricity Grid Code Regulation,2010
   l) CEA (Technical standards for communication system in Power system operations)Regulation 2020
   m) CERC (Communication System for Inter State Transmission of Electricity) Regulations 2017
   n) MOP Order dated 02.07.2020 stating measures to protect the security, integrity and reliability of the strategically important and critical Power Supply System and Network in the Country.
   o) CEA (Cyber Security in Power Sector) Guidelines, 2021.
   p) Report of the Working Group in respect of Data Submission Procedure And Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022.
   q) MNRE/CEA/MOP guidelines/OM/Advisory/Clarifications
   r) And any other applicable standards/regulations /Guidelines /clarifications/ OMs/

Advisories

6. Bidder shall facilitate MANIREDA by arranging required documents for submission of connectivity application (connectivity application shall be submitted by MANIREDA) as per CERC guidelines. Bidder shall bear the statutory charges to be paid for connectivity application.

7. Contractor has to liaison and take necessary approval, required for setting up of a solar power plant including but not limited to registration & approval of project from State and Central statutory/competent government authorities, approval from CEA/CEI, approval for connectivity, approval for construction power, approval for power evacuation from state & central statutory/ government competent authorities like DISCOMS / GOI/ MNRE/CERC,CEA,CEI and / or any other agency as and when applicable, as per requirement. Contractor shall co-ordinate with all statutory authorities and facilitate them for smooth executions and approvals.

8. Supply of hot standby redundant PLC/RTU/DCS based power plant controllers (PPC) and associated independent equipment/accessories is in the scope of the Bidder. Detailed control logic and setting of the PPC shall be in line with latest CEA (Technical Standards for Connectivity to Grid) and as per RLDC/SLDC requirement. The solar plant PPC networks shall be suitably designed, so that PPC shall directly and independently be able to control/communicate the individual solar inverter (dual or multi master) including any other reactive compensating equipment, WMS (dual master) and redundant Power Quality Meters (IEC 61000-4-30 class A) at suitable location/final outgoing portion of plant/As per the directions of SLDC. It shall also able to two way communicate with RLDC/SLDC on IEC104 protocol for its various mode of control. Bidder shall install the PQM at POI/As per the directions of RLDC and integrate with PPC at solar plant end. PPC healthiness shall be monitored by SCADA.

9. Bidder shall also submit detailed Grid compliance study (steady state/Dynamic/Power Quality) with Power Plant Controller for solar project (in PSS/E and PSCAD platform) as per CEA technical standard to grid connectivity/CTU requirement/ Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid and latest guideline of RLDC for first charging clearance. In this regard, Bidder shall submit the single inverter, aggregated and detailed RMS model of the plant in PSS/E along with PSCAD aggregated model in line with CEA Working Group report and/or applicable standard. In case any site testing is required for grid compliance as per RLDC, it shall also be conducted.

10. Payment to concerned regulatory body for system study, SLDC Charges, Connectivity charges, registration charges, CEA/CEI Inspection charges, any other statutory charges shall be re-imbursed by the MANIREDA by submission of original payment slip/Receipt from contractor. However, all Co- ordination, liaison work, Paper work etc. shall be in the scope of the EPC Contractor. MANIREDA shall re-imburse for only those statutory services/charges for which Company will have to sign/had signed agreements with relevant statutory bodies and are claimable from MANIREDA as per regulatory provisions. This is excluding DSM charges for Forecasting & Scheduling. MANIREDA will facilitate for documentation work which requires from MANIREDA for the applying of the statutory approval.

11. All necessary procedures/Statutory approval for cutting of trees should be in the scope of Successful Bidder.

12. All approvals, equipment, item and works which are not specifically mentioned in this

document but are required for completion of work including construction, commissioning, operation & maintenance of Solar Photovoltaic Power Plant in every respect and for safe and efficient construction & erection, operation and guaranteed performance are included in the scope of this bid.

13. Bidder shall provide all data and applicable study/simulation reports as per 'Procedure for Integration of solar plant those are regional entities" for submission to RLDC/SLDC/STU for first time charging clearances (as required by regulatory/statutory body). Some information/documents from the above procedure and Report of the Working Group in respect of Data Submission Procedure and Verification of Compliance to CEA Regulations on Technical Standards for Connectivity to the Grid by RE Generators July 2022/latest amendments. However, bidder shall refer the applicable documents in detailed on their own for compliance.

All equipment, materials and services whether explicitly stated or not in Technical Specifications or anywhere in the tender documents but that are necessary for the successful commissioning of Solar Plant as per latest statutoryregulations/procedures/clarifications/Advisories/OMs/Guidelines/standard issued by bodies like CERC/SERC,/CEA, RLDC/NLDC/SLDC, CTU/STU, MNRE, other Ministry etc. shall be deemed to be included in the scope of work of the Contractor and bidder shall comply the same.

SECTION-6:

TECHNICALSPECIFICATIONS A – DC SYSTEMS

A-1 : SOLAR PHOTOVOLTAIC (SPV) MODULES

1.0GENERAL

The Solar PV module comprises of PV cell(s) connected in any combination to achieve the required module power output. PV cells directly produces DC power on receipt of solar irradiation.

2.0 CRYSTALLINE SILICON MODULES (C-Si)

Dual glass PV modules offer enhanced protection from moisture, making them ideal for floating PV project environments. The glass shall be made of high transmissivity and front surface shall give high encapsulation gain.

The technical details of Solar PV Modules shall be as given below.

SIno.	Description	Details
1	TypeofSPV Module	NTypeTOPConMonocrystallineSilicon
2	PeakPowerratingof Module	580 Wp orabove
3	ModuleEfficiency	Minimum21%at StandardTest Conditions
4	Fill Factor	0.75 (Minimum)
5	Encapsulation	DualGlass/ Glassto Glass

3.0 CODES AND STANDARDS

The applicable codes and standards are as mentioned below

Codes	Description
IS14286(Part1)-2019/IEC61215 (Part1)-2016	TerrestrialPhotovoltaic(PV)Modules-Designqualification and type approval Part1- Test Requirements
IS14286(Part1/Sec-1)-2019/IEC 61215 (Part1/Sec-1)-2016	TerrestrialPhotovoltaic(PV)modules–Designqualification and type approval Part1- Test Requirements Section1-Specialrequirementsfortestingofcrystalline silicon photovoltaic (PV) modules
IS14286(Part2)-2019/IEC61215 (Part2)-2016	Terrestrial P Photovoltaic (PV) modules – Design qualificationandtypeapprovalPart2-Testprocedures
IS/IEC61730-1-2016	Photovoltaic(PV)modulesafetyqualification-Part1: Requirements for construction

IS/IEC61730-2-2016	Photovoltaic(PV)modulesafetyqualification-Part2: Requirements for Testing
IEC61701-Edition2.02011-12	Saltmistcorrosiontestingofphotovoltaic (PV)modules
IEC62804-1 :2015	Photovoltaic(PV)modules– Testmethodsforthedetectionof Potential Induced Degradation-Part1: Crystalline silicon

4.0TECHNICAL REQUIREMENTS

1. The temperature co-efficient of Power for the module should be better than - 0.35% per deg C. Each and every SPV module shall conform to standards mentioned in 2.2 above and no negative power tolerance shall be accepted. Additionally, the Module wattage band/bin offered shall not be less than 5Wp. Each inverter shall use only one type (Make and Nominal rating) of module.
2. Module shall be made up of N Type TOPCon Mono crystalline Silicon cells. The module should be PID resistant. The front glass used to make the crystalline silicon modules shall be heat strengthened low iron glass. For glass to glass framed modules, the back glass minimum thickness shall be 2.0 mm.
3. The module shall not be subjected to any point load during transportation, handling and erection and complete care has to be taken to avoid any undue loading on either side of the module.
4. The module frame shall be made of corrosion resistant materials, preferably having aluminium anodized finish.
5. Module(s) shall be provided with minimum three (03) bypass diode.
6. Junction box at the back glass of the module should be weather proof, dust proof and designed to be used with standard wiring or conduit connection. Additionally, cables coming out of the junction box shall be suitably sealed providing complete electric isolation. In case the junction box houses diode, the junction box shall be of IP 68.
7. SPV module shall perform satisfactorily with ambient temperatures between - 10°C & +60°C and shall be able to withstand mechanical load as per IEC requirement.
8. Solar PV modules used in solar power plants/ systems must be warranted for the product Workmanship for a period of minimum 10 years. Further, they shall also be warranted for their output peak output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years from the date of receipt of last batch/lot of equipment at site.
9. The bidder shall provide the sample solar PV module electrical characteristics including current-voltage (I-V) performance curves and temperature coefficients of power, voltage and current.
10. Each PV module deployed must use a Radio Frequency identification (RFID) tag for traceability. RFID shall either be placed behind name plate sticker or behind bar code label pasted on the back glass of PV module and must be able to withstand harsh environmental conditions during the module lifetime. One number RFID reader has to be supplied by the bidder which has to be compatible to read the data from the RFID Tag & download the data to Computer. All associated Software & Cables are to be provided along with the RFID reader.

The following information must be mentioned in the RFID used on each module.

i. Name of the manufacturer – PV Module
ii. Name of the Manufacturer of Solar cells
iii. Month & year of the manufacture of the module (separately for solar cells and module)

iv. Country of origin (separately for solar cells and module)
v. I-V curve for the module at STC
vi. Wattage, Im, Vm and FF for the module
vii. Unique Serial No. and Model No. of the module
viii. Date and year of obtaining IEC PV module qualification certificate
ix. Name of the test lab issuing IEC certificate
x. Other relevant information on traceability of solar cells and modules as per ISO 9001

12. All the modules in the PV plant should be arranged in a way so as to minimize the mismatch losses.
13. Each module should have two suitably sized stranded UV resistant cables and terminated with DC plug-in connector directly. The positive (+) terminal has a male connector while the negative (-) terminal has a female connector. Any different design offered shall be reviewed during detailed engineering. The connectors used for interconnecting the modules and connectors used for connecting the strings and/or to the String Combiner box, i.e. field connectors shall be of same make for better compatibility (refer Connectors chapter elsewhere for detailed Specification of Field Connectors). In case, 1500 V modules are used, the connecting cable shall be as per the relevant standard.
14. The bidder has to submit, along with the data sheet of the module, a detailed Bill of Material (BoM) elaborating on the properties, such as, thickness, material composition etc of the major components of the module which shall be same as per the type tested and approved Constructional Data Form (CDF).

5.0 NAME PLATE

All individual modules shall be provided with Name Plate label at the back of module which shall provide the information given below for identification. They shall be clearly visible and shall not be hidden by equipment wiring. Type of labels and fixing of labels shall be such that they are not likely to peel off/ fall off during the life of the panel.

i. Manufacturer's Name
ii. Model Number, Serial Number
iii. Overall Dimensions (W x L x D)
iv. Weight (kg)
v. Maximum Power (P_{MAX}), Voltage (V_{MP}), Current (I_{MP})
vi. Short Circuit Current (I_{SC}), Open Circuit Voltage (V_{OC})
vii. Main System Voltage
viii. Relevant standards, Certification lab. name
ix. Warnings, if any.

6.0 TYPE TEST

SPV modules must be tested and certified by any of the accredited certifying agencies according to above mentioned International Standards at clause 2.0 above and the type test reports shall be submitted for approval.
Note:

1. The Module Manufacturer, along with the Module datasheet, shall also provide the Details about the PV Cells used for the offered PV Modules. The information shall contain Cell Source, Type, and Electrical Parameters including efficiency, Size, Number of Bus bars and any other relevant information.
2. In case the successful bidder supplies PV Modules of different make and/or model or from different agencies, the fixing holes in the frame/ location of retaining clips, their location, diameter, centre-to- centre distance between them and all other attributes related to mounting

should be same, if applicable.

3. Bidder shall submit the following:
   i. Third-party verified PAN files for any one module, if bidder is offering three wattage bins or less. In case the bidder is offering more than three wattage bins, additional PAN files for each additional wattage bin need to be submitted.
   ii. Self-certified Electro- Luminescence (EL) Test reports of all the Crystalline Silicon based PV Modules being offered to MANIREDA.

4. In line with Office Memorandum No. 283/54/2018-Grid Solar: "Approved Models and Manufactures of Solar Photovoltaic Modules (Requirement for Compulsory Registration) Order, 2019", dated 2nd January 2019, MNRE's subsequent OM dated 10.03.2021 regarding implementation of said order, including latest OM/amendments/Clarifications etc with respect to the said order, the bidder shall source cells/modules complying with the relevant clause(s) mentioned in the order. For detailed information, bidder to refer Office Memorandum/clarifications issued by MNRE. The applicability of ALMM shall be as per latest amendments as and when issued by MNRE.

   Bidders are also required to consider the provisions of ALMM for Solar PV cells as outlined in the MNRE Office Memorandum No. 283/59/2024, dated 09-12-2024 with it's latest updates, amendments, clarifications, and other relevant directives, when submitting their bids.

7.0 INSPECTION OF PV MODULES FACTORY TESTS:

PV modules must be type tested and proven as per the applicable IEC/ IS standards mentioned in the technical specification. All the PV modules shall be tested for it's electrical parameters and the test report shall be shared with MANIREDA along with call for pre dispatch inspection. Pre-dispatch inspection will be carried out at manufacturer works by MANIREDA/ Third party testing agency.

1. SPV modules to be checked visually for following defects: (Sampling as per Special inspection level IV and AQL 2.5% as per IS 2500 (Part 1): 2000)
   i. Scratches on the frame and/or glass etc.
   ii. Excessive or uneven glue marks on glass or frame
   iii. Inconsistent cell colors, cell crack, ribbon misalignment etc.

2. Performance of SPV module at STC (Standard Test Conditions): (Sampling as per Special inspection level IV and AQL 2.5% as per IS 2500 (Part 1): 2000)
3. Hipot test: (Sampling as per Special inspection level II and AQL 1.5% as per IS 2500 (Part 1): 2000)
4. Electroluminescence Test: (Sampling as per Special inspection level II and AQL 1.5% as per IS 2500 (Part 1): 2000)
5. RFID Check: 2 Nos per lot offered
6. Wet Leakage current test: 1 No per lot offered
7. Robustness of Termination test: 1 No per lot offered
8. Mechanical Load Test: 1 No per lot offered

Note:
This is an indicative list of tests / plans. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. Visual and EL acceptance criterion to be submitted along with MQP.

A2: FLOATING SYSTEM

1.0 GENERAL

The Floating system comprises of the Floating unit, Module support structure (if applicable), platform for invertor/ transformer/ other electrical equipment, walkway and anchoring/ mooring mechanism for the Floating Solar PV system (FSPV).

Any material/ fitting/ equipment or procedure not described or left out of the specifications but considered as normal and necessary for intended services of the floating system, shall be supplied, and fitted by the vendor without any extra charge.

2.0 CODES AND STANDARDS

The floatation system must conform to the latest edition of any of the following IEC/ equivalent standards for floating system design qualification and type approval. The reports verified by third party NABL national or international accredited agency shall be submitted for approval.

CODE	DESCRIPTION	PROPERTYVALUE
ASTMD792/ ASTMD 1505	StandardTestMethodsforDensityandSpecific Gravity (Relative Density) of Plastics by Displacement/DensitybytheDensity-Gradient Technique	Density>0.9
ASTMD1693	StandardTestMethodforEnvironmentalStress- Cracking of Ethylene Plastics	EnvironmentalStress-Cracking Resistance:ZeroCrackingfor 48 Hours
ASTMD790	StandardTestMethodsforFlexuralPropertiesof Unreinforced and Reinforced Plastics and Electrical Insulating Materials	SecantFlexuralModulusat2% Strain > 750 MPa
ASTMD638	StandardTestMethodforTensileProperties of Plastics	TensileStrengthatYield>22 MPa
ASTMD695	StandardTestMethodforCompressive Properties of Rigid Plastics	CompressiveStressatYield>6 MPa
ASTMD2565	StandardPracticeforXenon-ArcExposureof Plastics Intended for Outdoor Applications	>50% of original break elongationafter3,000hours exposure(Cycle4ofASTM D2565)
UL94or IEC/ISO Equivalent	StandardforSafetyofFlammabilityofPlastic MaterialsforPartsinDevicesandAppliances Testing	ClassificationHBorbetter

The test reports of HDPE Floaters conforming to above list of code and standards shall be submitted for review and approval to MANIREDA.

3.0 TECHNICAL REQUIREMENTS OF FLOATING UNIT

3.1 The floatation units of module shall be modular and easily connected to each other. Once completely connected, the floating platform must be able to support the weight of PV module, module support structure, cables, SCBs, LA, support railing (if applicable), etc. The floater system shall also be able to support the load of installation and O&M personnel, electrical equipment as mentioned earlier in this document and module washing system etc.

3.2 The floating units shall be standardized and designed for simple onsite installation.

3.3 The floating unit for PV Module mounting shall be prefabricated and modular in design with appropriate buoyancy to support the weight of at least one solar panel/equipment (as applicable) and additional minimum weight of 60 kg per unit. For other miscellaneous floats minimum buoyancy per sq. meter shall be 80 kg.

3.4 The floating unit design shall facilitate ease of assembly /disassembling, replacement of any module and enable future expansion or scaling.

3.5 The floatation unit should be manufactured from appropriate thermoplastic (virgin material) with UV stabilizer such that the life of floatation device shall be able to sustain for a period of 25 years.

3.6 The material used in manufacturing shall withstand Environmental Stress Crack Resistance (ESCR) and have a combination of hardness and impact strength (ASTM D1693).

3.7 The material used for floatation device shall be chemically resistant to acid, lye, petrol and mineral oil and also partially resistant to benzene and non-detrimental to marine life.

3.8 To protect floating waterbody against deterioration of its water quality a material test certificate of floaters showing no appreciable change in water quality of the reservoir/water body for entire life of the project has to be submitted by the bidders during detailed engineering.

3.9 In order to increase longevity and prevent unexpected loss of buoyancy, the floating unit shall have an average material thickness of 3 mm with moisture retention of less than 5%. High load area shall have superior thickness to take the impact (Detailed design calculation to prove the adequacy of thickness at various points has to be submitted along with drawings at the time of drawing approval).

3.10 The floating unit material shall be designed to balance the thermal expansion so that PV Panel are not stretched due to effect of thermal expansion.

3.11 The complete floating system shall have at least 400 mm floating corridor along the periphery comprising of module floaters and/ or walkway floater to prevent water splash. No Equipment will be installed on periphery floaters.

3.12 The design of the floating system shall incorporate appropriately sized walking platforms for regular maintenance and inspection. The walking platform shall be continuous with minimum width of 400 mm, excluding cable-laying arrangement. Dedicated walkway to be provided to avoid movement on cables.

3.13 Between walking platforms maximum of four continuous rows of modules is allowed. Additional infrastructure required for accessing modules cables etc. during O&M shall be provided by the bidder or any other mechanized approach can be proposed by the technology solution provider to easy access to panels irrespective of rows / configuration.

3.13.1 Min 01 No. dedicated floating approach walkway for each Floating Island/Array to be provided from the end of the Arrays to Embankment to access floating blocks of solar Plant. Width of the walkway from embankment to be Floating plant shall be not less than 1500 mm with 1 M hand railing arrangement on both the sides of the walkway. The design live load of dedicated walkway floater shall be minimum 120 kg/m^2.

3.14 Bidder to take into consideration load of all electrical equipment and accessories during the design of floatation platform.

3.15 For, String Inverter/String Combiner Box (SI/SCB), as applicable to be mounted on floaters, bidder to take into consideration the load of Equipment during design of floaters and suitable supporting arrangement for mounting on Equipment floaters. In vertical rows wherever SI/SCBs are to be placed, dedicated additional walkway to be provided. The mounting of SI/SCBs should be designed in such a way that the load should be shared with multiple nos. of floats and buoyancy calculation should include minimum 2 nos. of maintenance persons also.

3.16 Floaters, connection points/ears, connectors, supports etc. should be designed considering the load of the equipment to be mounted. Physical testing of floaters, connection points/ears, supports etc. has to be carried out on equipment floats.

3.17 Floaters carrying cables should be designed to carry load of 1.5 times load of cable and other accessories with proper anchoring and mooring so as to withstand maximum load caused by wind, wave action, water level variation etc.

3.18 The bidder to populate the Array layout in the designated reservoir surface area. Also, this Array population to cast minimum shadow (Shadow loss of the PV-Array limited to maximum 1%). This proposed Array layout has to be submitted to MANIREDA along with the technical documents for verification. The Array layout to include mandatory clearances for Inverter Rooms and other utilities. The shadow analysis of the array layout to be submitted to MANIREDA for approval.

3.19 Floating system should be designed to withstand the maximum wind speed of the location.

3.20 The floating units once assembled together should form an integrated structure. The relative alignment of the floating unit subsequent to complete installation shall not misalign the solar panels. The tilt of PV Panels should not get disoriented during lateral shift of the array.

3.21 The design life of the floating units should be 25 years. The floating units shall be reprocessable and recyclable at the end of its useful life.

3.22 Vendor to supply the Mandatory spares of each component of floating unit 0.1 % of detailed BOQ quantity of floating system including mooring accessories finalized after detailed engineering.

3.23 The screw and nuts used for floater connection to have a sound locking arrangement to take care of the water flow. The positive locking arrangement to prevent any loosening of screw and nuts. This shall further prevent any loosening in the floater assembly.

3.24 Appropriate vapor escape vents should be provided for each floatation device.

3.25 The Caps of the floaters after interconnecting in assembly should be easily accessible for opening and removing of water in the event of breakage of cap due to thermal expansion or thread loss. There shall be no need to take out the floater from the assembly to remove water and replace the cap due to non-accessibility.

3.26 The PV modules shall be mounted in such a way that the clamping fixtures are easily accessible from top side in the assembled condition. There shall be no need to access from below the water for any removal/repair.

3.27 The Major screws of all HDPE bolts shall incorporate effective and durable additional fastener to prevent loosening over a period of time. This shall be way of Lock nuts, Split pins (only with solid Bolts)

3.28 Floats shall incorporate solid dummy ears at mid points on either side with thickness equal to

regular connecting ears so as to enable drilling through them to fix Metallic strip, clamps or hardware for cable and tray supports, SCBs and for Water washing pipes.

3.29 Wherever Multi-tier floater arrangement is called for to support Cables or increase/decrease heights of mounted items, OEM shall design and provide Extra length solid HDPE/LDPE bolts with nuts and lock nuts for assembling 2 or three stacks of floaters.

3.30 Since all the mooring loads will be transferred from mooring line to floater ears through spreader bar, a mechanical destructive test will be done for ear load capacity for its tensile and shear strength. The report of the same to be submitted for review to MANIREDA before start of assembly of floaters at site.

3.31 All batches of floats to clearly carry Mould stamping showing Batch No. Month, Week of year of manufacture.

3.32 Strength adequacy of the floater (body, ears etc.) and connections to anchoring locations (Spreader bars) has to be established theoretically (CFD analysis or otherwise) with verification from reputed third party NABL accredited agency/ internationally accredited agency/ reputed institutions like IITs and submitted for review and approval.

3.33 The strength adequacy of the floaters and connections to anchoring locations (Spreader bars) has to be established by Physical tests also at NABL accredited laboratory. The test shall be witnessed by MANIREDA/third party.

4.0 MODULE MOUNTING STRUCTURE (MMS) (IF APPLICABLE)

4.1. The MMS shall be so as to allow easy replacement of any module by authorized personnel.

4.2. The MMS and associated hardware / fasteners, if used are metallic in nature, shall be non-corrosive and suitable for site weather and marine conditions. The structures shall be made of anodized aluminum or SS. Any other suitable alloy material shall also be proposed subject to approval of MANIREDA.

1.3. All fasteners, nuts, bolts and other hardware shall be of Stainless steel – 304 or higher grade to suit the site conditions and to ensure a life of 25 years.

4.4. MMS shall be designed to withstand the extreme weather conditions in the area.
4.5. The modules shall be mounted at fixed tilt.
4.6. PV fixation system shall be of proven design and subjected to Mechanical test to withstand unit failure conditions under static and fatigue conditions for base wind speed. The results conforming to above test shall be submitted to MANIREDA.

4.7. The design calculations and strength verification reports for the MMS components shall be submitted for MANIREDA's approval.

5.0 ANCHORING AND MOORING SYSTEM

5.1. STANDARDS AND CODES

The Anchoring and Mooring system shall conform to the latest edition of any of the following standard'sguidelines as stipulated in table below for Anchoring and Mooring design qualification and type approval. The design reports verified by third party i.e. NABL, national or international accredited

agency shall also be required for validation purpose.

Standard/Code	Description
DNVGL-RP-C205	Environmentalconditionsandenvironmentalloads.
DNVGL-OS-E301	Position Mooring
DNVGL-OS-E302	OffshoreMooringChain
DNVGL-OS-E303	OffshoreFibreRopes
DNVGL-OS-E304	OffshoreMooringSteel Wire Ropes
ISO19901-7	Stationkeepingsystemsforfloatingoffshorestructures and mobileoffshore units
BVNR493DTR03 E	ClassificationofMooringSystemsforPermanentOffshore Units
BVNI605DTR00 E	GeotechnicalandFoundationDesign,August2014.
BVNR578 DTR00 E	RulesfortheClassificationofTensionLegPlatforms(TLP),July 2012.
DNV-RP-E303	GeotechnicalDesignandInstallationofSuctionAnchorsinClay.
ISO14713	Protectionagainstcorrosionofironandsteelstructures

5.2. TECHNICAL REQUIREMENTS OF ANCHORING & MOORING SYSTEM:

5.2.1. The anchoring and mooring system holds the floating platform in place and provides the mechanical stability it requires throughout its lifetime.

5.2.2. Water level variation and prevailing wind speed are the primary safety considerations for designing the floating solar plant. The mooring system thus needs to be designed such that it not only restricts lateral movement beyond the permissible limits of the platforms but also accommodates the water level variability.

5.2.3. The design life of the Anchoring and Mooring system shall be 25 years.

5.2.4. The floating solar PV (FSPV) power plant should be at a minimum safe distance from the edge of the land surface/embankment. In case edge of land surface has a sloped edge then this distance of array from land edge to be calculated w.r.t to the position of floating island at minimum water level condition. However, the exact positioning can be finalized at the time of detailed engineering.

5.2.5. The floating system comprising of floating unit, PV fixation system and associated anchoring system shall be designed as per base wind speed and able to withstand dynamic conditions as per IS 875-3.

5.2.6. The design of the mooring system shall permit minimal lateral movement of the plant in case of maximum wind loads (as per IS 875-3). The lateral excursion of the floating platform not to exceed 2.5 meters even at minimum water level. Anchoring design report for the project showing that the system could support the maximum wind load on site shall be submitted to MANIREDA.

5.2.7. Water variability: The mooring system should accommodate given fluctuations in water level defined elsewhere in the specification. Further, the orientation of the plant needs to be maintained; hence, any fluctuations in water level shall allow minimal movement of the FSPV plant as per mooring system design.

5.2.8. The materials used in the anchoring and mooring system shall not contaminate the water and affect the aquatic ecosystem.

5.2.9. The materials used in the anchoring and mooring system shall have a design life of 25 years.

5.2.10. The block size of the floating system depends on the array layout optimization. The same shall be finalized during detailed engineering.

5.2.11. The design of complete system, including CFD modelling, comprising of Floating unit, MMS and anchoring system, shall be verified by suitable third party NABL accredited agency/ reputed institutions like IITs and submitted for MANIREDA approval.

5.2.12. The design calculations and strength verification reports for the mooring components shall be submitted for MANIREDA's approval.

5.3. ANCHORING SYSTEM:

Anchoring of the floating Island can be through Screw Piles/ Anchor Plates/dead weights/RCC piles/ any advance anchoring system supported by design validation which will be most suited for site conditions. In case of anchoring through dead weights /RCC piles relevant chapters in civil works to be referred.

The following conditions shall be adhered to:

i. Puncturing or damage of reservoir bottom is not allowed.
ii. Anchoring & mooring system shall be such that it doesn't damage the embankment and its associated structures.

iii. Special care to be taken while installing and laying of anchors so as not to damage or disturb the reservoir floor/liner/PCC.

iv. Anchoring system shall be placed sufficiently away from the intake structures & top of embankment.

v. At some locations, cutting of road over the embankment may be required for crossing of mooring ropes, the work of cutting, filling and making the passage again in good condition is also in the scope of the bidder.

vi. In case the contractor wishes to adopt concrete pile foundation for anchoring system, Geo-tech. report shall also include the calculations, based on soil properties, for safe pile capacity under direct compression, lateral load and pull out as per IS:2911.

vii. For single pile, Lateral load capacity shall be min. of the values obtained as per IS:2911 & Brom's method corresponding to free pile head. The report shall also include recommendations about type of pile, its depth and dia. to be used.

viii. In case contractor wishes to use helical piles/ anchor plate the design, fabrication and installation shall conform to IBC (International building code). The contractor shall carry out field

trials for initial load test on pile to verify the pile design to confirm the safe load carrying capacity under direct compression, Lateral load and pull out. The min. of the two values (design value as per soil characteristics & field test results) shall be adopted.

ix. The nos. of piles to be tested under each category shall be finalized corresponding to geotechnical characteristics at site, plot area and as per the provisions of IS 2911 Part 4. However, minimum 5 nos. of piles shall be tested under each category of load.

x. The contractor shall submit detailed methodology for conducting the tests in line with IS: 2911 (Part 4)/ IBC for Engineer's approval before commencement of any test. For reference, the standard pile test procedures for compression & pull out and lateral load test to be submitted for approval. After completion of these tests the contractor shall compile the test results and submit the report in a proper format as specified in the BIS standard with recommendations/ conclusions for MANIREDA's approval. The pile work shall start only after approval of the final pile design duly verified/ confirmed with initial load test results.

xi. If Bidder choose to provide helical pile/ anchor plate after due consideration to the above criteria, then following shall be adhered to by the bidder w.r.t Corrosion Protection.

xii. To avoid the corrosion in the steel section, due to continuous impact of water and air, or due to aggressive chemical environments, suitable anti-corrosive measures need to be considered. If Steel Section is proposed for anchoring, it shall be designed considering minimum 90-micron thick galvanization in HDG.

5.4. QUALITY ASSURANCE PLAN (QAP) & INSPECTION:

5.4.1. Detailed Quality Assurance Plan (QAP) for floater and its accessories shall be submitted for approval. A typical MQP for Floaters to be followed is attached for reference.

5.4.2. The floaters and all its accessories should be inspected before dispatch as per approved QAP. The items shall only be dispatched after issue of Material Dispatch Clearance Certificate (MDCC).

5.4.3. For Assembly and anchoring & mooring works, a detailed Field Quality Plan (FQP) shall be submitted for approval. The FQP shall detail out for all the works, equipment, services, quality practices and procedures etc. in line with the requirement of the technical specifications to be followed by the Contractor at site.

5.5. WARRANTY FOR FLOATING SYSTEM AND ANCHORING & MOORING:

A warranty period of 10 years from the date of successful completion of trial run of the project shall be provided for Floater units/ Floating platforms and associated accessories. Even though the warranty period envisaged for floater units and associated accessories is only 10 years, they shall be designed for a service life of minimum of 25 years from the date of successful completion of Operational Acceptance Test (OAT) of the project, considering ambient site conditions. As such, the design shall inherently ensure that there shall be no failure owing to crack, puncture, breakage etc. in the floaters and all associated accessories which affect the integrity of the whole system, for a minimum of 25 years from the date of successful completion of OAT.

The warranty of floating system as well as Anchoring & mooring system shall be provided by OEM only.

5.6. COMPREHENSIVE O&M OFFLOATING SYSTEMAND ITSASSOCIATED ANCHORING & MOORING:

The EPC Contractor has to do Operation & maintenance of installed system for period specified in

Project Information. EPC Contractor has to depute sufficient no. of persons at site during O & M period as per project size requirement. Bidder to submit O & M manual for complete system which must include following (but not limited to):

I. Periodic maintenance schedule for checking the floater condition, sign of crack/ damage, tightening of mooring ropes and any other maintenance needed to maintain healthiness of floating island. This includes replacement of faulty floaters used in the system.

II. Bidder shall maintain a minimum stock of each component of floating system and its associated anchoring & mooring as O & M spare at site during complete O & M Period for maintenance of the system, as per OEM recommendation. Bidder to replenish the spares if consumed and maintain minimum stock at any time during O&M period. The minimum requirement is only indicative and any additional quantity as deemed required shall be maintained at site by the bidder.

III. Schedule and methodology of checking of Anchoring and mooring components periodically for its wear and tear.

IV. Schedule of preventive maintenance and checks.

6.0 COMPREHENSIVE ANNUAL MAINTENANCE CONTRACT (AMC)

Bidder has to furnish AMC on yearly basis from the date of completion of O & M of the floating system for period specified in Project Information. Comprehensive AMC shall include all preventive maintenance and breakdown maintenance including replacement of any component to ensure that equipment is working satisfactorily as per design/system requirement. During AMC period, the OEM is required to respond within one working day through telecom or any electronic means. This AMC to include the following:

I. Attending to and resolving any breakdown/fault of the floatation platform.

II. Mandatory 1 half yearly visit (once in six months) to assess the floating platform for any failure or any sign which may lead to subsequent failure. Vendor to send the assessment report to MANIREDA customer through email.

In case of severe breakdown of the system, OEM has to send their representative within 72 hours. For the minor faults not hampering the generation, the OEM has to get the fault rectified within 7 working days. Failure from the OEM to adhere the activity and the time schedule may lead to BG encashment.

7.0 PROVENESS CRITERIA

I. Bidder shall take necessary approval from MANIREDA before finalisation of the floater supplier.
II. The bidder/his sub-vendor(s) is required to meet the Proveness criteria and/or qualification requirement for Floating, Anchoring and Mooring systems as per the criteria stipulated below:

7.1 SOLAR PV FLOATING SYSTEM

Supplier of Solar PV Floating system shall have manufactured and supplied Solar PV floaters of minimum capacity of 5MW at single location. The supplied floating system should have been successfully commissioned and working satisfactorily for minimum 6 months as on LOA date.

7.2 ANCHORING AND MOORING SYSTEM FOR FLOATING SPV BLOCKS

The Installer of Anchoring and Mooring System shall have designed and installed anchoring and

mooring system for a minimum of 2.5MW floating Solar PV blocks at single location. The supplied anchoring and mooring system should have been successfully installed and working satisfactorily for minimum 6 months as on LOA date.

A3: DC CABLES

1.0The DC Cables in a solar PV plant is used in the following areas.

a) Interconnecting SPV modules
b) From SPV Modules up to SCB/String Inverter
c) From SCB up to the Inverter.

2.0 DC CABLES (Interconnecting SPV MODULES and from SPV Modules to SI/SCB)

1. Each module, shall have two UV resistant cables and terminated with DC plug-in connector directly. The positive (+) terminal shall have a male connector while the negative (-) terminal a female connector. All the modules in the PV plant shall be arranged in a way so as to minimize the mismatch losses.

2. Cables used for inter-connecting SPV modules as well as Modules to SCB's shall conform to the requirements of EN 50618:2014/IS17293:2020 applicable for DC cable for photovoltaic system. The connectors used for interconnecting the modules and connectors used for connecting the strings and/or to the String Combiner Box, i.e. field connectors to be mated shall be of same make and model otherwise they shall be tested for Inter-compatibility as per detailed Specification of Field Connectors given elsewhere in this specification).

3. These cables shall also meet the fire resistance requirement as per the above standard and shall be electron beam cured.

4. All cables except module cable used for (+) ve and (–)ve shall have distinct color identification.

5. In addition to manufacturer's identification on cables as per EN50618/IS 17293, following marking shall also be provided over outer sheath.
   i. Cable size, voltage grade and code designation “PV”
   ii. Word 'HALOGAN FREE LOW SMOKE’
   iii. Sequential marking of length of the cable

6. The distance between two consecutive printing, identification or embossing shall not be more than 550 mm. The Printing shall be progressive, automatic, in line and marking shall be legible and indelible.

7. Type test, routine, acceptance tests requirements for these cables shall be as per EN50618:2014/IS 17293:2020. All test charges shall be deemed to be included in the cable price. Sampling for acceptance tests will be as per IS 7098.

8. A maximum of 8 Cables (4 Circuits) shall be laid in one HDPE Pipe for DC Cable from Module to string combiner box (if applicable). The fill factor of the pipe should not be more than 40%.

9. However, in case of necessity to lay more than 8 cables (4 circuits) in one pipe, the same shall be allowed during detailed engineering and as per the derating factors recommended by the cable manufacturer. Fill factor criterion is still to be maintained.

10. Bidder to ensure that there is no gap and proper packing at the junction of two pipes, in which DC cable is laid, using proper method and accessories, like bell mouth.

11. Bidder can propose DC Cables (Interconnecting SPV Modules and from SPV Modules to SCB) with Nylon 12 sheath/other suitable material between Insulation and outer sheath of the DC Cable. Such cables can be laid without DWC/HDPE pipes. Such cable should be type

tested. The proposal to accept such cable and such laying methodology shall be reviewed during detailed engineering.

3.0 DC CABLES (STRING COMBINER BOX TO INVERTER)

1. Cables used between SCBs and Inverters shall be of 3.3kV (E) grade. These Power cables shall have compacted Aluminum/copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), Armored/ Unarmored, FRLS PVC outer sheathed conforming to IS: 7098 (Part-II). These cables shall confirm to the requirements of the standards & codes specified in the relevant chapter.

2. For other details refer chapter –LT Cables

3. Bidder can propose DC Power Cables (SCB to Inverter) with armor of HDPE/other suitable material instead of Steel or Aluminum Armor. Such cable should be type tested. The proposal to accept such cable shall be reviewed during detailed engineering.

4. Cable laying arrangement shall be done as mentioned in the other chapters (3-B: Electrical Scope and Supply &Services) and other relevant chapters of this specification.

4.0 DC CABLES SIZING CRITERIA

As per relevant clause in Chapter AC Cables.

5.0 CABLE DRUM

For details refer clause 9.0 of Chapter -AC Cables

A-4 STRING COMBINER BOX (IN CASE OF CENTRAL INVERTER)

1.0 GENERAL

String Combiner box (SCB) is used in multi-string photovoltaic systems to combine the individual strings electrically and connect them to the Inverters. It shall have protection devices to protect the PV modules from current/voltage surges. Nos. of input to each SCB shall be decided during detail engineering based on approved SLD and the temperature rise calculations.

Vendor to note that DC system 1500-Volt rating only is acceptable. Accordingly, component/assembly shall comply with 1500 V rating as applicable.

Voltage rating of the selected component shall be 1500V (Min.) as per system requirement during detail engineering. SCB offered for 1500V Application shall have already been type tested and in satisfactory operation in Solar plant with 1500 V DC system. SCBs are not applicable in case of string inverters configuration.

2.0 CODES AND STANDARDS

SNO.	CODES	DESCRIPTION
1	UL94V	FireResistant/flammabilityforEnclosure
2	UL746C	UVResistantforEnclosure
3	IEC62262/EN50102	MechanicalImpactresistanceforenclosure
4	IS2147/IEC60529	DegreesofProtectionprovidedbyenclosures(IPcode)
5	IEC61643-12	SurgeProtection
6	IEC62208	Enclosureforlowvoltageswitchgearandcontrolgear assemblies

Vendor shall submit the suitable Test Certificate/Report from accredited lab(s) indicating compliance of mentioned codes and standard if asked for the offered component or assembly.

3.0 GENERAL REQUIREMENT

SCB shall be equipped (but not limited to) with the following.

a) DC Disconnector /Breaker to disconnect the PV strings from the Inverter for maintenance purpose as per specification mentioned in this chapter.
b) All component in the SCB shall be suitable for operation within temperature range of 0-65 Deg C.
c) Fuse in each SCB input (both positive and negative) shall be provided to prevent the reverse short circuit current flow. However, in case of negative string fuse is not required as per recommendation of inverter manufacturer, string cable shall preferably be terminated with field connector with SCB.
d) Surge Protection Devices for protection against surge currents and voltages as per specification given in separate clause. Other associated items like cable glands, lugs, vents and items required for the protection and completeness of the system shall be provided
e) The common collection bus bars should be made up of zinc/tin coated copper and shall be suitably sized to limit temperature rise within safe operating limits.
f) Vendor shall ensure adequate clearance with suitable insulated separator between positive bus and negative bus if it is in same enclosure. Positive and Negative section shall be orientated

horizontally (Landscape orientation) on the either side of separator. Separate compartment for negative section and positive section for termination of positive and negative string input shall be preferred.

g) String monitoring cards, for measuring Currents, temperatures and Voltages.

4.0 DC SURGE PROTECTION DEVICES (SPD) for PV Solar Application:

DC output SPD shall consist of three Metal Oxide Varistors (MOV) type surge arrestors which shall be connected from positive and negative bus to earth. The discharge capability of the SPD shall be at least 12.5kA at 8/20 micro second wave as per IEC 61643-12 and shall be rated for MCOV 1500 Volt DC. During fault and failure of MOV, the SPD shall safely disconnect 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 able to extinguish the arc. SPD shall have local visual indication and potential free contact for remote indication.

5.0 STRING FUSES

In order to provide protection to all cables and modules, string fuses shall be provided with strings. String fuses shall be of gPV category and dedicated to solar applications and conform to IEC 60269- 6 or UL-2579 standards and fuse base shall comply with IEC 60269-1. String fuses should be so designed that it should protect the modules from reverse current overload. Fuses or Isolation Link shall be mounted in pull out type fuse holders. Fuse holders shall be suitable for DIN rail mounting. PCB mounted fuses are not acceptable. Fuse rating for single and combined input (limited to two) shall be calculated and finalized as per the current rating (Isc) of the PV module installed and the same be as per relevant standards and not less than 1.5 times of the input current which shall be suitable for 1500 Volt for crystalline module. In case of negative grounded system, requirement of string fuses as well as inverter input fuses on negative side shall be decided based on the recommendation of Inverter (PCU) manufacturer. There should be minimum 10 mm gap between two fuses (fuse holders).

6.0 SCB ENCLOSURE AND ASSEMBLY

SCB shall satisfy the following requirement.

i. The enclosure shall be made of UV Protected, Halogen Free, and Fire-retardant GRP/FRP/Polycarbonate material with self-extinguishing property.

ii. Degree of protection for enclosure shall be at least IP 67. All the part shall be corrosion resistant and enclosure surface shall be free from crazing, blistering, wrinkling, color blots/striations. There should not be any mending or repair of surface.

iii. The mechanical impact resistance of enclosure shall be IK 07 or better.

iv. The size of the enclosure and general arrangement of the component shall be designed in such a way that the average temperature of enclosure shall not exceed 62 degree C and operating temperature of the components used in the enclosure shall not exceed 72 deg C or OEM recommended temperature limit at ambient temperature of 50 deg C for rated load conditions along with spare. The components mounted inside the SCB shall have higher temperature withstand capability and operation/performance of should not be affected due to derating by temperature.

v. Complete assembled SCB shall be subject to heat run type test to be witnessed by owner after manufacturing. The heat run test to be carried out at 1.25 times the rated current i.e. 1.25 x (Imp

of PV Modules) x (no. of string inputs + spare). In case it is found that the temperature rise is beyond the acceptable limits, bidder shall redesign the assembly and perform the test free of cost to verify that temperature rise is within acceptable limit.

vi. In each SCB 5 % spare terminals along with cable glands and fuse rounded off to next higher integer shall be provided to connect the PV strings.

vii. All terminals blocks shall be rated for min 1500V and rated continuously to carry maximum expected current.

viii. All internal wiring shall be carried out with stranded copper wires with voltage rating mentioned elsewhere in the specification. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on wires and shall not fall off when the wire is disconnected from terminal blocks.

ix. If metallic hinge is being used with enclosure cover, it shall be made of SS304 and shall be rust proof. Enclosure shall be provided with captive screws so that it screw don't fall off when cover is opened. Screw shall be made of corrosion free material. Suitable non-conducting protection cover shall be provided for any metallic hinge/screw/fastener to avoid contact with live part of the assembly.

x. Mounting plate inside the SCB for mounting/fixing of devices shall be made of FRP/GRP or equivalent non-conducting material.

7.0 DC On-load Isolator

Solar PV On-load Isolator shall be suitable for 1500Vdc operational voltage having minimum Insulation voltage of 1500 V dc, in true 2 pole or 3 pole construction with 500Vdc per pole breaking. Any multipolar device achieving this configuration with shorting link (with less than 500Vdc per pole), will not be acceptable. The Isolators shall be type tested to carry the nominal current at rated Voltage till ambient Temperature of 60 Deg C without any de-ration, inside the String Junction box. The Switching part shall necessarily contain reinforced break with an integrated magnetic arc-extinguishing system for the PV arc. The PV isolator need to positive break indication given through a position indication window. The PV Isolator terminals need to be silver plated, and shall comply with IEC 60947-3 and tested for PV application. These shall withstand any PV current and should have no critical current.

8.0TYPE TEST

Vendor shall submit the following Type Test/ Product Certification from any National/International accredited lab for approval.

a. Temperature rise test on complete assembled Box as per acceptable limit mentioned in relevant clause.
b. Type test for enclosure as per code and standard mentioned in relevant clause.
c. Thermal ageing at 70 Deg C for 96 hours as per IEC 60068-2
d. HV Test

9.0 DC PLUG-IN CONNECTORS FOR FIELD CABLING

9.1 GENERAL REQUIREMENT

Field connectors are electrical connectors/coupler used for connecting solar panels and also strings of panels to String combiners box. Cable connector to be used for connecting SPV modules and String Combiner boxes shall be in accordance with IEC 62852: 2014.

Connector shall be of plug and socket design to be plugged together by hand but can be separated again using a tool only. Contractor shall ensure that field connectors to be mated shall always be of same make and model or shall be tested Inter-compatible as per IEC 62852: 2014 for offered make(s).

Mating of connectors of different makes/model shall not be acceptable if not tested for inter-compatibility by any accredited lab.

Bidder can propose Y-connector type DC Field Connector for paralleling two DC strings from PV Module to SCB. However, bidder to provide suitably sized fuse in positive side of Y-connector.

9.2 TECHNICAL REQUIREMENTS

RatedCurrent,IEC (85°C)	Min1.5 timesofStringcurrent (Isc)
RatedVoltage	Min1500 Volts
Connector Design	Snap-InlockingType
ProtectionDegree	IP68(Mated)
Ambient Temperature	(-)40degC to (+) 85degC
Protection/SafetyClass	ClassII
Contact material	Cu
Contactsurface material	Silver/Tin
Contactresistanceforplug connecter	<0.5 milli-ohms
Strippinglength	10 MM
Inflammabilityclass	UL94-V0
InsulatingMaterial	PPE / PPO/Polyamide
Pollution degree	3
Certification	UL/TUV/CSA/EACor Equivalent
RatedCurrent,IEC (85°C)	Min1.5 timesofStringcurrent (Isc)
RatedVoltage	Min 1500 Volts

9.3 TYPE TEST FOR DC plug-in connectors

a. Protection Degree (IP)
b. Operating Temperature
c. Inflammability
d. Pollution Degree
e. Voltage Withstand (Rated Voltage/Test Voltage)
f. Salt mist, cyclic (sodium chloride solution) as per IEC 60068-2-52

A-5 POWER CONDITIONING UNIT

1.0 GENERAL

The Power Conditioning Unit (PCU) is Solar Inverter designed to convert solar PV DC power to 3-phase AC power and fed into utility grid. The PCU shall consist of solid-state electronic switch along with all associated control & protection, filtering, measuring instruments and data logging devices. The PCU shall have suitable maximum power point tracker (MPPT) for operating the input PV Array at its maximum power point. The PCU output shall always follow the grid voltage & frequency by sensing the grid voltage and phase and the PCU shall always remain synchronized with the grid. The PCU shall use only self-commutated device which shall be adequately rated. The continuous combined rating of all PCUs shall be as per 3-B: Electrical Scope and Supply &Services.

2.0 CODES AND STANDARDS

IEC-61683	Energy efficiencyrequirements
IEC61000	Emission/Immunityrequirement
IEEE519	Recommended practices and requirements for harmonic control in electrical power systems
IEC60068	Environmentaltesting
IEC62116	Testingprocedure— Islandingpreventionmeasuresforpowerconditioners used in grid-connectedphotovoltaic (PV) power generation systems
IEC62109-1&2	Safetyofpowerconvertersforuseinphotovoltaic power systems.
EN50530	Overallefficiencyof gridconnectedphotovoltaicinverters.
IEEE1547/IEC 61727/BDEW	StandardforinterfacingsolarPVplantwithutilitygrid.
IEC60529	Ingressprotectiontest
GridConnectivity	Relevant CEA regulations and Indian grid code as amended and revised from time to time

3.0 GENERAL REQUIREMENTS (Applicable both for Central and String Inverter)

3.01 PCU shall meet the following technical parameter

1.	MaximumInputvoltageDC	1500V
2.	Nominaloutputvoltagefrequency	50Hz
3.	Continuousoperatingfrequencyrange	47.5Hzto52 Hz
4.	ACVoltageRange	±10%ofratedACvoltage
5.	Euroefficiency	Minimum97%(asperIEC61683)
6.	NumberofMPPT	SingleMPPTorMulti-MPPT
7.	SurgeProtectionDevice (SPD)	Type-I&IIDCside Type-IIACside
8.	Euroefficiency	Minimum97%(asperIEC61683)
9.	Operatingpowerfactorrange	0.8Leadto0.8Lag(adjustable)
10.	NightSVG(QatNight)	Required.
11.	Currentharmonics	AsperCEAregulationrequirement
12.	CurrentTHDvalue	<3%atnominalpower
13.	DCInjection	<0.5%atratedcurrent
14.	Operatingambienttemperature	0to60°C
15.	Humidity	95%non-condensing
16.	MaximumNoiselevel	75dBA(forindoorapplication)
17.	Flicker	AsperCEAregulationrequirement
18.	Remotestartandstopfacilityfrom SCADA	Required.
19.	Activepowerlimitcontrol,reactivepower, and power factor control features.	Required. Possible both from PPC and SCADA.
20.	PCUdesignedDCfaultcurrentlevel	MaximumshortcircuitcurrentofPVarray connectedtoPCUand durationcontinuous.
21.	PCUdesignedACfaultcurrentlevel	Maximumshortcircuit current of LVside of Inverter Duty transformer and duration onesec.
22.	(i) AC & DC overcurrent protection. (ii) Synchronization loss protection. (iii) Over temperature protection. (iv) DC & AC under and over voltage protection. (v) Under & over frequency protection. (vi) Cooling system failure protection (vii) PV array ground fault monitoring & detection (viii) PV array insulation monitoring (ix) LVRT protection (x) Anti-islanding protection (xi) Grid monitoring	Required.

3.02 The PCU shall comply with the Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments.

3.03 The PCU shall be capable of supplying reactive power as per grid requirement during solar and non-solar hours. PCU shall have Static Var Generation (SVG) function.

3.04 The PCU shall have protection against any sustained fault in the feeder line and against lightning discharge in the feeder line.

3.05 The Contractor shall ensure by carrying out all necessary studies that the PCU will not excite any resonant conditions in the system that may result in the islanded operation of PV plant and loss of generation. In case there is excitation of any resonant condition in the system during PV plant operation that may result in the islanding/tripping of the PV plant and affect the power transfer, it shall be the responsibility of contractor to rectify the design and carryout required modification in the equipment of his supply.

3.06 The PCU must be self-managing and stable in operation

3.07 In case of grid failure, the PCU shall be re-synchronized with grid after revival of power supply. Bidder to furnish the time taken by PCU to be re-synchronized after restoration of grid supply during detailed engineering.

3.08 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.

3.09 PCU shall have necessary limiters in build in the controller so as to ensure the safe operation of the PCU within the designed operational parameters.

3.10 PCU shall have thermal overloading protection to prevent failure of switching devices (ie, IGBT) and other components of Inverter. PCU controller shall automatically regulate/limit the power output to reduce the PCU cabinet and switching devices temperature. Bidder to submit the PCU power vs ambient temperature curve during detailed engineering stage. PCU shall be able to provide inverter inside cabinet (in soft analog value) to SCADA system for remote monitoring, storing and report generation purpose.

3.11 PCU shall be provided with the mobile user interface facility for monitoring of inverter by plant O&M personnel for better O&M and highest yield from the PV plant. In case PCU does not have this facility, then bidder can provide the same facility through plant SCADA system.

3.12 PCU shall have AC and DC side monitoring capability reporting to SCADA system (measured analog and digital value measured within PCU). Any special software if required for this purpose shall be provided for local and remote monitoring and report generation

3.13 All-important alarm and trip signals shall be configured in the PCU and their corresponding Modbus address shall be provided for SCADA configuration. Signal shall necessarily be included such as LVRT in action and trip operated, HVRT trip, islanding protection operated, over current operated, Inverter cabinet temperature high alarm and all other important signals. Details shall be finalized during details engineering stage.

3.14 DC Overloading: Maximum PCU DC overload loading shall be limited to its design PV Array Power to PCU nominal AC power ratio. Bidder needs to submit all the relevant technical document/test report from PCU manufacturer (OEM) during details engineering stage in support of declared PCU design DC overloading capacity.

3.15 EARTHING OF INVERTERS: The PCU shall be earthed as per manufacturer recommendation. During detail engineering the Bidder needs to submit the details earthing arrangement of PCU and system earth pit requirement during detail engineering stage. The detail specification for

panel earthing for safety has been mentioned elsewhere in this specification.

3.16 OPERATING MODES OF PCU

a. **Low Power Mode:** The PCU shall be able to wake-up automatically when PV array open circuit voltage value is equal/more than preset value in the PCU program. Once its start generation the PCU shall automatically enter maximum power mode.

b. **Maximum Power Point Tracking (MPPT):** In order to maximize the energy collection from solar PV array, the PCU shall have inbuilt MPPT controller and same shall be able operate the PV array at its maximum power point by adjusting output voltage of PV array system according to atmospheric condition. PCU MPPT controller shall ensure that it operate the PV array system at its global maximum power point under all operating conditions of PV array including cloudy atmospheric condition.

c. **Sleep Mode:** PCU shall automatically go into sleep mode when the output voltage of PV array and/or output power of the inverter falls below a specified limit. During sleep mode the inverter shall disconnect from grid. Inverter shall continuously monitor the output of the PV array and automatically start when the DC voltage rises above a pre-defined level.

   The above clause is applicable for unity power factor operation/no reactive power support to grid. In case reactive power is required to be supplied to grid, in that case the PCU shall remain connected to grid and supply reactive power as per grid requirement. Inverter shall continuously monitor the output of the PV array and automatically start active power generation when the DC voltage rises above a pre- defined level.

d. **Standby Mode:** In standby mode the PCU DC & AC contactor are open, inverter is powered on condition and waiting for start command.

3.17 In case auxiliary supply of PCU is met internally, then it should have sufficient power backup to meet the LVRT requirement.

3.18 Bidder to submit third-party verified OND files of the inverter during detail engineering.

3.19 Bidder may consider sufficient modularization of Inverter to ensure that potential solar generation is minimally impacted due to breakdown/shutdown of a particular Inverter.

4.0 CENTRAL INVERTER

a) PCU must have provision to be isolated from grid through Air Circuit Breaker/MCCB. The ACB/MCCB as required can be provided as a part of PCU/its Modules or separately based on standard design and configuration of PCU manufacturer. The ACB and MCCB shall be able to withstand the maximum fault current for minimum one sec duration. ACB/MCCB shall be able to isolate PCU from AC grid under all fault current condition. Any alternate provision other than ACB/MCCB which is recommended by OEM and meeting the requirement, shall be considered on case-to-case basis during detailed engineering stage.

b) Suitable rated fuse shall be provided (at inverter end) in incoming DC cable from each String Combiner box (SCB). One set spare terminal with fuse (as applicable) and holder shall be provided for the future use. In addition, the PCU shall have suitable rated DC motorized isolator/MCCB or contactor for isolation of PV array from inverter.

c) String Monitoring facility: - PCU shall be provided with current monitoring transducer at incoming DC cables from each String Combiner box (SCB) for PV array zone monitoring purpose. The

current transducers used for this purpose shall have accuracy of 1.0 class or better.

d) The PCU should be designed for parallel operation through galvanic isolation. Solid state electronic devices shall be protected to ensure smooth functioning as well as ensure long life of the inverter. Parallel operated PCU system are also accepted subjected to recommendation of PCU manufacturer. In such case, PCU design shall also ensure that no abnormal interaction shall take place among the PCU unit during any grid operating condition which may result in outages.

e) PCU shall have suitable communication card (Modbus TCP/IP) for networking and SCADA integration and same shall support dual master communication. PCU shall include all important measured & internal calculated analog values and alarm & trip signals for remote monitoring, storing and report generation purpose in SCADA system. Details list of above such parameters shall be provided along with their Modbus address during detail engineering stage.

f) In case of modular design of PCU is offered, the Contractor shall ensure that no abnormal interaction shall take place among the various PCU modules during any grid operating condition which may result in outages. The PCU controller offered by the Contactor shall be such as to ensure stability, reliability, and a good dynamic performance. The Bidder shall indicate the control scheme adopted for modular PCU and its merits and the test which will check its performance.

g) Bidder may offer liquid cooling system subject to MANIREDA approval. In case Liquid cooled inverters are offered, Bidder to ensure that coolant is used in closed cycle. Complete inverter along with cooling system shall be of proven design.

h) The Inverter shall have suitable arrangement for negative grounding of solar PV array system and the ground current shall be limited to safe limit. Ground current shall be measured continuously, and alarm shall be generated in case ground current reaches to predefined set value. Inverter shall trip in case ground current more than safe operating limit.

i) Inverter shall have emergency stop push button for tripping of inverter with complete DC & AC electric isolation.

4.1 INDOOR CENTRAL INVERTER

a) The PCU enclosure protection class shall be IP 20 or better protection.
b) COOLING AND VENTILATION: -
c) To prevent the maximum permissible temperature the maximum permissible temperature in the inverter room from being exceeded because of internal heat emission of inverters and other auxiliaries in the inverter room, the inverter room in the PV plant shall be adequately ventilated. The Ventilation plant capacity and air quality of inverter room shall be as per inverter and other auxiliary's system manufacturer's recommendations. Filter banks at the air inlet of the inverter room shall be provided to prevent dust ingress. Bidder shall furnish peak power consumption of cooling system (cooling fans, pumps etc.) of the PCU along with the data sheet.
d) Ventilation shall be designed in such a way that the temperature rise of the inverter rooms does not exceed the maximum designed temperature of Inverters and other auxiliary equipment's placed inside the inverter room. Accordingly, the air velocity through the filter shall be suitably chosen to remove the heat from the inverter room. All exhaust and fresh air fans shall be provided with thermostat control.

4.2 OUTDOOR CENTRAL INVERTER

a) Outdoor PCU enclosure must be suitable to withstand the harsh environmental conditions for complete life of plant.

b) The PCU enclosure protection class shall IP 54 or better protection. For outdoor solution (Other than containerized), the electronic card compartment shall have IP 65 or better protection.

c) Bidder to submit temperature endurance test report of complete assembly during detail engineering stage.

d) For Outdoor PCU (without containerized solution) the complete assembly should be placed inside a shed made of structural steel section preferably tubular/hollow section and color coated metal sheets for roof with BMT 0.5 mm and at least 60cm projection in all side. For containerized solution separate shed is not required, however, the container shall have projection of at least 60cm wherever an opening in the inverter door exposes the inverter component to outside environment. Structural steel and paints for shed shall be as per ISO 12944-5.

e) Outdoor inverter (including containerized solution) platform shall be raised Min 1250 mm from NGL. Cable bending radius and other relevant factors to be considered during platform design. This shall be reviewed during detailed engineering.

5.0 STRING INVERTER

a) The string inverter enclosure protection class shall be IP 65 or better protection.

b) The string inverter should be placed inside a canopy shed with at least 15 cm in all direction, if installed in open. Alternatively, the Bidder can also install the inverter on the column post of the module mounting structure, below the modules. In such case, the canopy is not required, and the column and foundation shall be designed accordingly.

c) String inverter shall have suitable communication port (TCP-IP/PLC) for SCADA integration. All necessary hardware, software and accessories used for communication with SCADA (including smart logger Data logger) at both the ends shall be provided by the bidder. String Inverters system shall support dual master communication.

d) String inverter shall have string monitoring (MPPT level) capability and reporting to SCADA system. Any special software if required for this purpose shall be provided for local and remote monitoring and report generation.

e) Anti-PID device along with all hardware and communication cable/device shall be provided in case negative grounding of PV string provision is not available in string inverter.

f) DC fuse requirement for PV string at string inverter end shall be as per string manufacturer/system requirement and same shall be finalized during detail engineering stage.

g) Provision for AC and DC electrical isolation device (such as MCB/MCCB/Isolator) inside string shall be as per string inverter manufacturer practice.

h) Local Display unit for viewing important parameters, configuration and troubleshooting purpose shall be provided as per string inverter manufacture practice. In case standard design of string inverter does not include display, then string inverter shall be provided with required software along with accessories (2 sets for complete plant) for interface with inverter or facility for mobile viewing and configuration with laptop.

i) LT Junction box, switchboard, and switchgear requirement for string inverter system as per chapter B-1 (LT Switchgear).

6.0 TYPE TESTING (Applicable both for Central and String Inverter)

a) During detailed engineering, the contractor shall submit all the type test reports including temperature rise test and surge withstand test carried out within last ten years from the date of LOA. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

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

SECTION-6 : TECHNICAL SPECIFICATIONS

B – AC SYSTEMS

B-1 LT SWITCHGEAR

1.0 CODES AND STANDARDS

The design, materials, and method of LT switchgear shall conform to the applicable IEC standard. All equipment shall be installed, and all work shall be carried out in accordance with relevant IEC standards. Where an applicable IEC standard is not available, IS/ any applicable international standard shall be referred to as best practice. All standards, specifications and codes of practice shall be the latest editions including all applicable official amendments and revisions.

As a minimum requirement, the following standards shall be complied with:

IS	Details
IEC60947/IS13947	Low-voltageswitchgearandcontrolgear
IS 2705	CurrentTransformers
IS 3043	Codeofpracticefor earthing.
IS 3072	Codeofpracticeforinstallationandmaintenance of Switchgear
IS 3156	Voltage Transformers
IS 3202	Codeofpracticeforclimateproofingof electricalequipment.
IS 3231	Electricalrelaysforpower system protection.
IS13703 /IEC60269	HRCCartridgefuses
IS10118 (4 parts)	Codeofpracticeforselection,installationandmaintenanceof switchgearandcontrolgear.
IEC60255	ElectricalRelays

2.0 TECHNICAL PARAMETERS

A.POWERSUPPLY(ACSYSTEM)		
(i)	Voltage	415V+-10%,3Phase,4wire,Neutral SolidlyEarthed
(ii)	Frequency	50Hz +/-5%
(iii)	Minimumsystemfault level	Aspersystemfaultcurrent(for1 sec)
(iv)	Shorttimeratingforbusbars,ckt.breakers, current transformersandswgr. Assembly.	Aspersystemfaultcurrent(for1 sec)
(v)	Maximum ambient air Temperature	50deg. C

BUS BARS		
(vi)	Continuouscurrentratingat50ºCambient:	As PerRequirement
(vii)	TemperatureRiseallowedabove ambient	40°Cforplainjoints55°CforSilver platedjoints
B. MCCB		
(i)	Ratedvoltage	415V
(ii)	RatedInsulationLevel	690V
(iii)	Rated ultimateand service SC breaking capacity(Asper systemrequirement)	Aspersystemfaultcurrent(for1 sec)
(iv)	Ratedmakingcapacity	2.1timesofsystemfaultcurrent
(v)	Utilization category	A
C.DIGITALMFM		
(i)	Accuracyclass	0.5 or better
(ii)	MFMshallbeprovidedat LTsuitablecommunicationportfor integrationwithSCADAsystem.	
D.CURRENTTRANSFORMERS		
(i)	Type	Cast Resin Bar Primary
(ii)	Voltage class and frequency	650V, 50HZ
(iii)	CT Secondary Current	1:00 AM
(iv)	Class of insulation	E or better
(v)	Accuracy class & burden	
	a) For Protection	5P20, 5VA
	b) For Metering	Class 0.5, 5VA (min)
(vi)	Instrument Security Factor for metering CT	5
E.VOLTAGETRANSFORMERS		
(i)	Type	Cast Resin
(ii)	Voltage Ratio	415 / 110V for line PT
		415/√3 / 110/√3V for Bus PT
(iii)	Methodof Construction	VeeVee
(iv)	AccuracyClass	0.5

(v)	RatedVoltage factor	1.1 continuous, 1.5 for30sec.
(vi)	Class ofinsulation	E orbetter
(vii)	One-minutepower frequencywithstand voltage	2.5 KV
F.HRC FUSES		
(i)	Voltageclassandfrequency	650 Volts
(ii)	Rupturingcapacity	80kA(RMS)forACcircuits
G. CONTACTORS		
(i)	Type	Airbreak electro magnetic
(ii)	UtilisingCategory	AC3 of IS/IEC 60947 for non-reversibleAC4ofIS/IEC60947for reversible drives
H.SWGR.CUBICLECONSTRUCTIONALREQUIREMENTS		
(i)	Colourfinish	
	Exterior	RAL9002(Mainbody) AsperManufacturerstandard. Thepaintthicknessshallnotbeless than 50 microns
	Cableentry	
(ii)	Power Cables	Bottom
	Control Cables	Bottom

The quantities/Nos. of the Feeders /MCCB shall be so as to meet the system requirements. 5% spare with minimum 01 No. to be provided on each board/switchgear having more than 5 MCCB. However, no spare Air circuit breaker panels are required.

3.0 DETAILS OF DISTRIBUTION BOARDS

Applicable for Auxiliary Power Supply system and String Inverter distribution board of rating up to & including 400A.

1. Switchboards in CMCS shall be of metal enclosed, indoor, floor-mounted, free-standing type. Distribution boards of small size can be of wall/channel mounted type. For inverter stations, if outdoor distribution boards/LT pooling switchgear is proposed, the same shall be of suitable IP class and shall be kept under shed.
2. All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material.

3. All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that they do not permanently bulge/ bend by the weight of maintenance personnel working on it.
4. The switchboards shall be of bolted design. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cut outs shall be true in shape and devoid of sharp edges.
5. All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS/IEC 60947. All cutouts shall be provided with EPDM / Neoprene gaskets.
6. All switchboards shall be of uniform height not exceeding 2450 mm.
7. Switchboards shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates.
8. All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. Replacement /Maintenance of individual equipment/ component shall be possible without switching off or isolating the other equipment/components.

9. Each switchboard shall be provided with undrilled, removable type gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall be provided with gasket to ensure enclosure protection.
10. The minimum clearance in air between phases and between phases and earth for the entire busbars shall be 25mm. For all other components, the clearance between "two live parts", "a live part and an earthed part", shall be at least ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for busbars the clearances specified above should be maintained even when the busbars are sleeved or insulated. All connections from the busbars up to switch / fuses/MCCB shall be fully insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits. All busbars and jumper connections shall be of high conductivity aluminum alloy / copper of adequate size.
11. All switchboards shall be provided with three phase and neutral busbars. Entire busbar system shall be insulated with PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.
12. The cross-section of the busbars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars.
13. All busbars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength sheet molded compound or equivalent type polyester fiber glass molded insulator. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The busbar insulators shall be supported on the main structure.
14. All busbar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver-plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the busbar. All copper to aluminum joints shall be provided with suitable bimetallic washers.
15. All busbars shall be color coded as per IS: 375.
16. Wherever the busbars are painted with black Matt paint, the same should be suitable for temperature encountered in the switchboard under normal operating conditions.
17. The Bidder shall furnish calculations establishing the adequacy of bus bar sizes for specified

current ratings.

18. Panel space heaters shall be provided and the supply for this shall be tapped from incomer, before the isolating switch/circuit breaker. Incoming circuit to space-heater shall have an isolating switch, HRC fuse and neutral link of suitable rating. Panel illumination and plug-socket shall also be tapped from the space heater supply.
19. A galvanized steel / Copper / Aluminum earth bus shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar. Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus.
20. The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth without exceeding the allowable temperature rise.
21. All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting.
22. All metallic cases of relays, instruments and other panel-mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. All the equipment mounted on the door shall be earthed through flexible wire/braids. Insulation color code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors, soldering is not acceptable. Looping of earth connections, which would result in loss of earth connections to other devices, when a device is removed, is not acceptable. However, looping of earth connections between equipment to provide alternative paths to earth bus is acceptable.
23. VT and CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.
24. All hinged doors having potential carrying equipment mounted on it shall be earthed by flexible wire/ braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges/ hinge pins of proven design may also acceptable. The Contractor shall establish earth continuity at site also.
25. All switchboards shall be supplied completely wired internally upto the terminals, ready to receive external cables.
26. All auxiliary wiring shall be carried out with 650V grade, single core stranded copper conductor, colour coded, PVC insulated wires. Conductor size shall be 1.5 mm2 (min.) for control circuit wiring and 2.5 mm2 (min) for CT and space heater circuits.
27. Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped.
28. All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.
29. All internal wiring terminations shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible. Screw-less (spring loaded) / cage clamp type terminal shall also be provided with lugs.
30. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.
31. Cable termination arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminium conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc., shall be provided by the contractor, to suit the final cable sizes.
32. All power cable terminals shall be of stud type and the power cable lugs shall be solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.
33. All Switchgears, MCCs, Distribution Boards, Fuse boards, all feeders, local push-button stations etc. shall be provided with prominent, engraved identification plates.

34. All name plates shall be of non-rusting metal or 3-ply Lamicoid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Employer's approval.
35. Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.
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36. The gaskets, wherever specified, shall be of good quality EPDM / neoprene with good ageing, compression, and oil resistance characteristics suitable for panel applications.
37. The bidder shall, ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per Indian standards / specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.
38. ON/OFF status and protection trip status of incomers and bus coupler (if applicable as per SLD) be provided for SCADA system.
39. Suitable changeover and interlocking arrangement shall be provided for incomers and bus coupler (if applicable as per SLD).
40. It shall be the responsibility of the contractor to fully coordinate the overload and short circuit breakers/fuses with the upstream and downstream circuit breakers / fuses, to provide satisfactory discrimination. Further the various equipment supplied shall meet the requirements of type ii class of co-ordination as per IS: 8544.
41. All sheet steel work shall be pre-treated, in tanks, in accordance with is: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "class-c" as specified in is: 6005. The phosphate surfaces shall be rinsed and passivated. After passivation, electrostatic powder coating shall be used. Powder should meet requirements of is 13871 (powder costing specification). Finishing paint shade for complete panels excluding end covers shall be as per manufacturer’s standard, unless required otherwise by the employer. The paint thickness shall not be less than 50 microns.

4.0 MCCB

1. MCCB shall be fixed type module, air break type, having trip free mechanism with quick make and quick break type contacts. MCCB shall have current limiting feature. MCCB of identical ratings shall be physically and electrically interchangeable. MCCB shall be provided with 1 NO and 1NC auxiliary contacts.
2. MCCB shall have inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit also. The protection settings shall have suitable range to achieve the required time & current settings. LED indications shall also be provided for faults, MCCB status (on/off etc).
3. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit rating. Extended cable terminal arrangement for higher size cable may also be offered. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door can not be opened unless the MCCB is in OFF position. Means shall be provided for defeating this interlock at any time. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked. The MCCBs being offered shall have common/interchangeable accessories for all ratings like aux. switch, shunt trip, alarm switch etc. The MCCBs shall have the current discrimination up to full short circuit capacity and shall be selected as per manufacturer’s discrimination table.

5.0 FUSES

1. All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted.

Fuses for AC circuits shall be rated for 80kA rms (prospective) breaking capacity at 415V AC and for DC circuits, 20kA rms breaking capacity at 240V DC.
Fuse shall have visible operation indicators. Insulating barriers shall be provided between individual power fuses.

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

6.0 LT SWITCHGEAR FOR STRING INVERTER

In addition to the above clauses (relevant), the following shall also be applicable for switchgear ratings more than 400A

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

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

   SWITCHGEAR / FEEDER COMPARTMENT: All equipment associated with an feeder of rating above 400A shall be housed in a separate compartment of the vertical section. ACB shall be provided for feeders of rating 1000A and above. The design of the vertical section for such an arrangement shall ensure ease of termination of power cables of size & quantity as per system requirement. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. Insulating sheet at rear of the compartment is also acceptable. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure.

   CABLE COMPARTMENT/CABLE ALLEY: A full-height vertical cable alley of minimum 250mm width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations located in cable alley of capacity more than 400 A shall be designed to meet the Form IVb and for less than 400A A shall be designed to meet the Form 3b (as per IEC 61439) for safety purpose. Wherever cable alleys are not provided for distribution boards, segregated cable boxes for individual feeders shall be provided at the rear for direct termination of cables. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley. Cable alley door shall be hinged.

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

2. All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 4X as per IS/IEC 60947 (for indoor panels). All cutouts shall be provided with EPDM / Neoprene gaskets. However, the control / relay compartments shall have degree of protection not less than IP 5X. If outdoor LT switchgear is proposed at inverter stations, the same shall be of suitable IP class and shall be kept under shed.

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

3. Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. EPDM / Neoprene gasket shall be provided between the panel sections to avoid ingress of dust into panels.
4. The minimum clearance in air between phases and between phases and earth for the entire busbars. and bus-link connections at circuit-breaker shall be 25mm. All busbars and jumper connections shall be of high conductivity aluminum alloy / copper of adequate size.
5. After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.
6. All switchgear (circuit-breaker) panels shall be of single-front type. The covers shall be provided with "DANGER" labels. All panel doors shall open by 90 deg or more.
7. All circuit-breaker modules shall be of fully draw out type having distinct 'Service' and 'Test' positions. Suitable arrangement with cradle / rollers, guides along with tool / lever operated racking in / out mechanism shall be provided for smooth and effortless movement of the chassis.
8. All switchboards shall be provided with three phase and neutral busbars. Two separate sets of vertical busbars shall be provided in each panel of double front DBs. Interleaving arrangement for busbars shall be adopted for switchboards with a rating of more than 1600A. Entire busbar system shall be insulated with PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.
9. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door cannot be opened unless the MCCB is in OFF position. Means shall be provided for defeating this interlock at any time. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked.
10. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear switchgear also.
11. Temperature raise test of LT switchgear of rating more than 400A:- The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current.
12. The carriage and breaker frame shall get earthed while being inserted in the panel and positive earthing of the breaker frame shall be maintained in all positions, i.e. SERVICE & ISOLATED, as well as throughout the intermediate travel.
13. Electrically controlled circuit breaker boards shall be provided with DC control supply.

7.0 CIRCUIT BREAKERS

1. Circuit breakers shall be three pole, air break, horizontal draw out type, and shall have fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameters of continuous current rating and fault making / breaking capacity only after provision of cooling fans or special device shall not be acceptable.

2. Circuit breakers along with its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker.
3. There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "Test" position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLLY WITHDRAWN" position. Circuit Breaker rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa shall be possible only in the compartment door closed condition.
4. Separate limit switches, each having required numbers of contacts shall be provided in both "SERVICE" and "TEST" position of the breaker. All contacts shall be rated for making, continuously carrying, and breaking 10 Amp at 240 V AC and 1 Amp (Inductive) at 240 V DC respectively.
5. Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE ", "TEST" AND "SPRING CHARGED" positions.
6. Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half a cycle of rated frequency.
7. Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed-circuit breaker shall preferably not trip the circuit breaker. In case the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exists between the fixed and draw out contact at the time of breaker trip so that no arcing takes place even with the breaker carrying its full rated current.
8. Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position.
9. Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.
10. Breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.
11. Circuit breakers shall be provided with coded key / electrical interlocking devices, as per requirements.
12. Circuit breaker shall be provided with anti-pumping feature and trip free feature, even if mechanical anti-pumping feature is provided.
13. Mechanical tripping shall be possible by means of front mounted Red "trip" push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.
14. Complete shrouding / segregation shall be provided between incoming and outgoing bus links of breakers. In case of bus coupler breaker panels the busbar connection to and from the breaker terminals shall be segregated such that each connection can be approached and maintained independently with the other bus section live. Dummy panels if required to achieve the above feature shall be included in the Bidder's scope of supply.
15. Circuit breaker open/close shall be possible from SCADA and open/close status and all other important signal status shall be provided for SCADA monitoring.
16. Power operated mechanism shall be provided with a Universal motor suitable for operation on DC Control supply. In case of DC supply motor should satisfactorily operate with voltage variation between 85% to 110% nominal control supply voltage. Motor insulation shall be class "E" or better.
17. The motor shall be such that it requires not more than 30 Seconds for fully charging the closing spring at minimum available control voltage.
18. Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.
19. The mechanism shall be such that as long as power is available to the motor, a continuous

sequence of closing and opening operations shall be possible. After failure of power supply at least one open- close-open operation shall be possible.

20. Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
21. All circuit breakers shall be provided with closing and trip coils. The closing coil shall operate correctly at all values of voltage between 85% to 110% nominal control supply voltage. The trip coil shall operate satisfactorily at all values of voltage between 70% to 110% nominal control supply voltage.
22. Provision for mechanical closing of the breaker only in "Test" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds.
23. The ACB Panel door shall not be possible to open in breaker closed condition. Further, the racking mechanism shall be accessible only after opening the breaker panel door.
24. Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit-breaker module in a cubicle at each location. The trolley shall be such that the top most breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. The telescopic trolley shall be such that all type, size and rating of breaker can be withdrawn /inserted of particular switchgear.
25. Electrical Parameter of Circuit Breaker

1	Type	Airbreakspringchargedstoredenergytype
2	Operatingduty	O-3MIN-CO-3MIN-OC
3	Symmetricalinterrupting	Aspersystemfaultcurrent(foronesec)
4	Shortcircuit rating	2.1timesofSystemfaultcurrent(peak)
5	ShortCircuitBreakingcurrent	
	a)ACComponent	Aspersystemfaultcurrent(foronesec)
	b)DCComponent	Asper IS:13947
6	Short time withstand	Aspersystemfaultcurrent

8.0 AC JUNCTION BOXES (FOR USE WITH STRING INVERTERS)

1. Separate AC Junction box shall be used for string inverters AC output connection. Protection class for AC junction box shall be IP 54 or better protection. All components of junction box shall be suitable for rated output voltage (with + 10% variation) of string inverter, grid frequency of 50 Hz +/- 5%, ambient temperature 50 deg. C and system fault current for 1 sec.
2. Each input of AC junction box shall have protection with suitably rated MCCBs.
3. AC junction box shall be of metal enclosed type. All frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. The minimum clearance in air between phases and between phases and earth shall be at least twenty five (25) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers.
4. All power cable terminals shall be of stud type and the power cable lugs shall be of tinned

copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.

5. EPDM / Neoprene gasket shall be used to prevent ingress of dust into panels.
6. All non-current carrying metal work of the junction box shall be effectively connected to the system earth bus.
7. Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns.

9.0 TEMPERATURE-RISE (FOR LT SWITCHGEAR OF CAPACITY MORE THAN 400A)

The temperature rise of the horizontal and vertical busbars and main bus links including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material.
Temperature rise for the busbars shall be carried out at 90% of the rated current.

10.0 DERATING OF COMPONENTS

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

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

B-2 HT SWITCHGEAR

1.0 CODES AND STANDARDS

All standards, specification and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of Techno commercial bid. In case of conflict between this specification and those (IS Codes, Standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.

SINo	IS code	Nameof Equipment
1	IS:722	AC electricitymeters.
2	IS:996	SinglephasesmallACanduniversalelectricalmotors.
3	IS: 1248	DirectActingindicatinganalogueelectricalmeasuringinstrumentsand Accessories.
4	IS/IEC:60947	Degreeofprotectionprovided byenclosuresforlowvoltageswitchgear and controlgear.
5	IS: 2544	Porcelainpostinsulatorsforsystemswithnominalvoltages greaterthan 1000 Volts.
6	IS: 2705	Currenttransformers.
7	IS: 3156	Voltage Transformers
8	IS: 6005	Codeof practiceforphosphatingof ironand steel.
9	IS: 5082	Specificationforwroughtaluminiumandaluminiumalloybars, rods, tubes andselectionsforelectricalpurposes.
10	IEC:61850	CommunicationStandardforNumerical relays
11	IEC:61131-3	AutomationStandardforNumericalrelays
12	IS: 9046	ACcontactorsfor voltagesabove1000 voltsandupto andincluding11000 Volts.
13	IS:13703	Lowvoltagefuses
14	IS: 9385	HVfuses
15	IS: 9431	Specificationforindoor postinsulatorsoforganic materialforsystemwith nominalvoltagesgreater than1000voltsuptoandincluding300 kV
16	IS: 9921	A.C.disconnectors(isolators)andEarthingswitchesforvoltages above 1000 V
17	IS: 11353	Guideforuniform systemof markingandidentification ofconductors and apparatus terminals.
18	IS: 13118	SpecificationforhighvoltageACcircuit breakers.
19	IEC:60099-4	Metaloxidesurgearrestorwithoutgap forAC system
20	IS/IEC: 62271-100	Highvoltagealternatingcurrentcircuit breakers.
21	IS/IEC: 62271-200	Highvoltagemetalenclosedswitchgearandcontrol gear.
22	IEC:60947-7-1	Terminalblocksforcopper conductors

23	IS:513 (2008)	ColdRolledLowCarbonSteelSheetsand Strips

1.0 TECHNICAL PARAMETERS

A. SYSTEMPARAMETERS		
a)	NominalSystemvoltage	33kV
b)	HighestSystemvoltage	36kV
c)	RatedFrequency	50Hz
d)	Numberofphases/ poles	Three
e)	Systemneutral earthing	SolidlyEarthed
f)	One-minutepower frequencywithstandvoltage	
	-forTypetests	70kV
	-forRoutinetests	70kV
g)	1.2/50microsecond Impulsewithstandvoltage	170kV (peak)
h)	Minimumsystemfault level	AsperSystemFaultcurrent
i)	Shorttimeratingforbusbars,circuitbreakers,current transformers and switchgear assembly.	
j)	Dynamic withstand rating	2.55timesofsystem fault current
k)	Space heaters	240VACsinglephasewith neutral solidly earthed
l)	Maximum ambient air temperature	50deg.C
m)	Internal Arc testing	Aspersystemfaultcurrent (for Min 1 sec)
B. BUS BARS		
a)	Continuouscurrentratingat50C ambient:	As PerRequirement
b)	TemperRiseallowedabove ambient	AsperIEC62271-1,2017
C.SWGR.CUBICLECONSTRUCTIONALREQUIREMENTS		
a)	Colourfinish	
b)	Exterior	DuringEngineeringstage
	Cableentry	
	Power Cables	Bottom
	Control Cables	Bottom
c)	Earthing conductor	Galvanizedsteel strip
d)	ServiceContinuityofswgrs (LSC2B-PM)	asperIS/IEC62271-200
D. CIRCUIT BREAKERS		
a	Thecircuitbreakerscurrentratingshall beselectedfromtheload currentatanambientof 50ºC.	
b	Shortcircuitbreaker Current	
	a)A.C.component	AsperrelevantClauseinthis specification
	b)D.C.component	AsperIS:13118or IEC-62271
c	ShortCircuitmakingcurrent	2.55timesofsystemfaultcurrent(peak)
d	OperatingDuty	O-3min-CO-3min-CO
e	Totalbreaktime	Not morethan 4 cycles
f	Totalmaketime	Not morethan 5 cycles
g	Operating Mechanism	Motor wound spring charged stored energy type as per IEC-62271

E.CURRENTTRANSFORMER		
a)	SecondaryCurrent	1A
b)	Class ofInsulation	Class E orbetter
c)	Ratedoutput of each	Adequatefortherelaysanddevicesconnected,butnotless thanfive(5) VA.
d)	Accuracyclass	
	Protection	5P20/PSas per requirement
	Measurement	0.2sclassorbetter asperrequirement
e)	Instrument Security Factor for Measurement CTs	5
f)	CT Ratio	CT ratio shall be finalized during details engineering stage. MinimumCTprimarysidecurrentshallbe110%ofrated current.
F.VOLTAGE TRANSFORMERS		
	Rated Voltage Factor	1.2continuousforallVTs,and1.9for8Hoursforstar connectedVTs.
	Class ofinsulation	Class E orbetter
c)	Otherparameters	0.2SClass orbetter asper requirement. VA requirement shall be based on application/ requirement. Additionalopendeltacorewithdampingresistorshallbe providedinallVT'stopreventdamageon accountofFerro-Resonance conditions
d)	At pooling switchgear, Bus VTs panels and line VTs in outgoing feeders shall be provided. All other switchgear location, at outgoing feeder cable charge indication shall be provided based on voltage sensing or use of voltage transformer.	
G.DIGITALMFM		
a)	AccuracyClass	0.2Sorbetter

3.0 SWITCHGEAR PANEL

1. The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction complying with clause No. 3.102 of IEC 62271-200, comprising of a row of free-standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main busbars and auxiliary control devices. The adjacent panels shall be completely separated by steel / Aluzinc sheets except in bus bar compartments where insulated barriers shall be provided to segregate adjacent panels. The Service Class Continuity of Switchgears shall be LSC 2B-PM (as per IS/ IEC 622771-200). However, manufacturer's standard switchgear designs without inter panel barriers in busbar compartment may also be considered.
2. The circuit breakers and bus VTs shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position. For complete withdrawal from the panel, the truck shall rollout on the floor or shall roll out on telescopic rails. In case the later arrangement is

offered, suitable trolley shall be provided by the Bidder for withdrawal and insertion of the truck from and into the panel. Testing of the breaker shall be possible in isolated position by keeping the control plug connected.

3. The trucks shall have distinct SERVICE and ISOLATED positions. It shall be possible to close the breaker compartment door in isolated position also, so that the switchgear retains its specified degree of protection. Circuit Breaker rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa shall be possible only in the compartment door closed condition. While switchboard designs with doors for breaker compartments would be preferred, standard designs of reputed switchgear manufacturers where the truck front serves as the compartment cover may also be considered provided the breaker compartment is completely sealed from all other compartments and retains the IP-4X degree of protection in the Isolated position. In case the latter arrangement is offered, the Bidder shall explain how this sealing is achieved and shall include blanking covers one for each size of panel per switchboard in his total Techno commercial bid price.
4. The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck in any position SERVICE, ISOLATED or removed, and all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets.
5. The control / relay compartments shall have degree of protection not less then IP 5X in accordance with IS/IEC 60947. However, remaining compartments can have a degree of protection of IP 4X. All louvers, if provided, shall have very fine brass or GI mesh screen. Tight fitting gourmet / gaskets are to be provided at all openings in relay compartment. Numerical Relays shall be fully Flush mounted on the switchgear panels at a suitable height.
6. The Switchgear shall have an internal Arc Classification of IAC FLR corresponding to system fault current. The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panels shall be specially designed to withstand these. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of protection of panels under normal working conditions. To demonstrate that the pressure relief device operates satisfactorily the Contractor shall submit a type test report in line with IEC 62271-200 Annex – A for each high voltage chamber. Wherever louvers are provided, the construction of louvers should be such that the IAC requirements are satisfied. Further, viewing glass windows shall have the same strength as the enclosure against Internal Arc.
7. Enclosure shall be constructed with rolled steel / Aluzinc sections. The doors and covers shall be constructed from cold rolled steel sheets of 2.0 mm or higher thickness. Gland plates shall be 2.5 mm thick made out of hot rolled or cold rolled steel sheets and for non-magnetic material it shall be 3.0 mm.
8. The height of switches, pushbuttons and other hand operated devices shall not exceed 1800mm and shall not be less than 700mm.
9. Necessary guide channels shall be provided in the breaker compartments for proper alignment of plug and socket contacts when truck is being moved to SERVICE position. A crank or lever arrangement shall preferably be provided for smooth and positive movement of truck between Service and Isolated positions.
10. Safety shutters complying with IEC 62271-200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall, however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. In case, insulating shutters are provided, these shall meet the requirements of IEC 62271-200 and necessary tests as per IEC 62271-200 Clause 5.103.3.3 shall be carried out. A clearly visible warning label "Isolate elsewhere before earthing" shall be provided on the shutters of incoming and tie connections which could be energized from other end.
11. Switchgear construction shall have a bushing or other sealing arrangement between the circuit breaker compartment and the busbar / cable compartments, so that there is no air communication

around the isolating contacts in the shutter area with the truck in service position.

12. The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors. Standard and proven designs of switchgear manufacturers (other than above) shall be reviewed during detailed engineering stage. Busbar and cabling compartments provided on the rear side shall have separate bolted covers with self-retaining bolts for easy maintenance and safety. Breaker compartment doors shall be provided with single-shot latch type handle and shall have locking facility. Suitable interlock shall be provided, which will ensure that breaker is OFF before opening the back doors. Suitable interlock shall be provided to prevent opening of any compartment doors which has any of the MV equipment, in case the supply is ON
13. In the Service position, the truck shall be so secured that it is not displaced by short circuit forces. Busbars, jumpers and other components of the switchgear shall also be properly supported to withstand all possible short circuit forces corresponding to the short circuit rating specified.
14. Suitable base frames made out of steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and levelled when the flooring is being done, welding of base frame to the insert plates as per approved installation drawings shall be in Bidder's scope.
15. Alternatively, Outdoor HT switchgear can be offered for ICOG configuration. The outdoor switchgear shall have minimum IP 55 or better protection with painting and shed requirement as mentioned in Appendix-1 of Part-A, Sub section-1. The bidder shall submit the relevant details of the switchgear including the datasheets, drawings and applicable type test reports during the detailed engineering for Employers approval. Internal Arc requirement for metal enclosed outdoor HT switchgear shall be same as indoor type switchgear. The main pooling/final pooling switchgear shall be indoor only.

4.0 CIRCUIT BREAKERS

1. The circuit breakers shall be of Vacuum type.
2. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism.
3. Circuit breaker shall be restrike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti-pumping features. An arrangement of two breakers in parallel to meet a specified current rating shall not be acceptable.
4. During closing, main poles shall not rebound objectionably and mechanism shall not require adjustments. Necessary dampers shall be provided to withstand the impact at the end of opening stroke.
5. Plug and socket isolating Contacts for main power circuit shall be silver plated, of self-aligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material. Plug and socket contacts for auxiliary circuits shall also be silver plated, sturdy and of self-aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.
6. All working part of the mechanism shall be of corrosion resisting material. Bearings which require greasing shall be equipped with pressure type grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately secured and locked to prevent loosening or change in adjustment due to repeated operation of the breaker and the mechanism.
7. The operating mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and shall not lead to closing or tripping of circuit breaker. Failure of any auxiliary spring shall also not cause damage to the circuit breaker or endanger the operator.
8. Mechanical indicators shall be provided on the breaker trucks to indicate OPEN / CLOSED conditions of the circuit breaker and CHARGED / DISCHARGED conditions of the closing spring. An operation counter shall also be provided. These shall be visible without opening the breaker compartment door.
9. The rated control supply voltage shall be as mentioned elsewhere under Technical parameters. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply

voltage between 85% to 110% rated DC voltage. The shunt trip coil shall operate satisfactorily under all operating conditions of the circuit breaker upto its rated short circuit breaking current at all values of control supply voltage between 70% to 110% of rated DC voltage. The trip coil shall be so designed that it does not get energized when its healthiness is monitored by two indicating lamps (Red) and one trip coil supervision relay.

10. The time taken for charging of closing spring shall not exceed 30 seconds. The spring charging shall take place automatically preferably after a closing operation. Breaker operation shall be independent of the spring charging motor which shall only charge the closing spring. Opening spring shall get charged automatically during closing operation. As long as power supply is available to the charging motor a continuous sequence of closing and opening operations shall be possible. One open-close- open operation of the circuit breaker shall be possible after failure of power supply to the motor. Spring charging motors shall be capable of starting and charging the closing spring twice in quick succession without exceeding acceptable winding temperature when the control supply voltage is anywhere between 85% to 110% rated DC voltage. The initial temperature shall be as prevalent in the switchgear panel during full load operation with 50 deg. C ambient air temperature. The motor shall be provided with short circuit protection.
11. Motor windings shall be provided with class E insulation or better. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in a hot, humid and tropical climate. 4.12 Circuit breaker shall be provided with inter pole barriers of insulating materials. The use of inflammable materials like Hylam shall not be acceptable.

5.0 CONTROLS AND INTERLOCKS

1. Rotary type Control switches shall be provided in each switchgear panel. The circuit breaker will normally be controlled from remote control panels through closing and shunt trip coils. The control switch and local control console of the relay flush mounted on the switchgear would normally be used only for testing of circuit breaker in isolated position, and for tripping it in an emergency. The closing and opening of the breaker shall also be possible from the laptop through front serial port of the relay to facilitate commissioning activities.
2. The basic control scheme shall be developed in the numerical relay using programmable (soft) logics. Tripping of breaker shall be done either through numerical relay or Master Trip Relay.
3. Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency.
4. Each panel shall have two separate limit switches, one for the Service position and the other for isolated position.
5. Auxiliary Contacts of breaker may be mounted in the fixed portion or in the withdrawable truck as per the standard practice of the manufacturer and shall be directly operated by the breaker operating mechanism.
6. Auxiliary contacts mounted in the fixed portion shall not be operable by the operating mechanism, once the truck is withdrawn from the service position, but remain in the position corresponding to breaker open position. Auxiliary contacts mounted on the truck portion and dedicated for Employer's use shall be wired out in series with a contact denoting breaker service position. With truck withdrawn, the auxiliary contacts shall be operable by hand for testing. There shall be at least 2 NO and 2 NC breaker/contactor original Auxiliary contacts made available for the of the Employer's use.
7. The contacts of all limit switches and all breaker auxiliary contacts located on truck portion and fixed portion shall be silver plated, rated to make, carry and break 1.0A 240V DC (Inductive) / 10A 240V AC. Contacts of control plug and socket shall be capable of carrying the above current continuously.
8. Movement of truck between SERVICE and ISOLATED positions shall be mechanically prevented when the breaker is closed. An attempt to withdraw a closed breaker shall not trip it.
9. Closing of the breaker shall be possible only when truck is either in TEST/ISOLATED or in-SERVICE position and shall not be possible when truck is in between. Further, closing shall be possible only when the auxiliary circuits to breaker truck have been connected up, and closing

spring is fully charged.

10. It shall be possible to easily insert breaker of one typical rating into any one of the panels meant for same rating but at the same time shall be prevented from inserting it into panels meant for a different type or rating.
11. Indications shall be provided in the relay console flush mounted on the panel front as brought out in the specification elsewhere. It shall be possible to easily make out whether the truck in SERVICE OR ISOLATED POSITION even when the compartment door is closed.
12. Reverse blocking and Inter tripping shall be implemented in switchgear boards level. Detailed scheme for the same shall be finalized during detailed engineering stage.
13. All required interlock shall be provided for safe operation of switchgears. Capacitive voltage detection or other alternative suitable arrangement (VT shall not be used) shall be used for outgoing feeder backdoor (cable chamber) open interlock.

6.0 NUMERICAL RELAYS AND NETWORKING

1. Circuit breaker feeders (with protection function as per requirement) shall be provided with communicable numerical relays (IED, i.e. Intelligent Electronic Device) complying with IEC-61850, having protection, control, and monitoring features. These relays shall be networked and suitably interfaced with the Solar SCADA system for dynamic SLD display, status monitoring, measurements, event / alarm displays, reports, etc. The relays shall be flush mounted on panel front with connections from the inside. These numerical relays shall be of types as proven for the application and shall be subject to Employer's approval. Numerical relays shall have appropriate setting ranges, accuracy, resetting ratio and other characteristics to provide required sensitivity. All equipment shall have necessary protections.
2. The numerical relay shall be capable of measuring and storing values of a wide range of quantities, events, faults and disturbance recordings. The alarm / status of each of protection function and trip operation shall be communicated to Solar SCADA. The numerical relays shall have built in feature / hardware interface to provide such inputs to Solar SCADA / for analog / digital values.
3. All relays shall be rated for control supply voltage as mentioned elsewhere under parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Contacts for breaker close and trip commands shall be so rated as to be used directly used in the closing and tripping circuits of breaker without the need of any interposing / master trip relays. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage.
4. One-minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms).
5. Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.
6. Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.
7. All numerical relays shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per the requirement of control schematics. The quantities of such input / outputs shall be finalized during detailed engineering.
8. All the numerical relays shall have communications on two ports, local front port communication to laptop and rear port on IEC 61850 to communicate with the interface equipment for connectivity with the Solar SCADA. Laptop provided with PCU/SCADA shall be used to facilitate numerical relay configuration, DR and event/fault records downloading from relay locally. Latest version of hardware and Software for interfacing the numerical relays with laptop shall be provided. At least two sets of communication cable for Laptop to relay communication shall be provided.
9. All the numerical relays shall have adequate processor memory for implementing the programmable scheme logic required for the realization of the protection / control schemes, in addition to the built in protection algorithms. Numerical relays shall have inrush detection feature for blocking of user selectable protection functions.

10. Numerical relays shall have feature of current measurement. Relay shall be able to provide the same in soft to solar SCADA system.
11. Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.
12. Master trip (86) and non-86 trips shall be software configurable to output contacts.
13. Numerical relays used at main pooling switchgear shall have provision of both current and voltage inputs. Number of CT inputs for numerical relays at all switchgear panels shall be as per actual protections requirement but not less than 4 sets, 3 nos. for phase fault & 1 no. for earth fault. Relays shall be suitable for CT secondary current of 1A. All 33kV feeders shall be provided with non- directional EF and OC protection. Numerical relays used at main pooling switchgear shall have voltage protection and measurement feature.
14. Relay setting shall be based on time grading principle with minimum 100mSec shall be the grading margin. Least time setting at inverter transformer feeders and shall be increased towards the evacuation point (towards grid). Relay time setting shall be minimum 100 ms. However, relay current and time setting including time grading margin shall be as per Bidder offered system (with minimum as per above) considering smooth plant operation and proper protection integration/coordination with grid. Bidder can use same relay time setting for tie feeder panels between two switchgears. Relay setting of solar plant feeders shall be done in coordination with 33kV main pooling switch (grid side) relay setting. Any special/other protections, control interlocks etc as per requirement shall be provided by the Bidder. Details shall be finalized during detailed engineering stage.
15. For relay setting calculation grid side shall be taken upstream and inverter side shall be taken downstream. For any switchgear outgoing feeder shall be towards grid and incoming feeders shall be towards inverter to be considered.
16. All CT & VT terminals on the relays shall be of fixed type suitable for connection of ring-type lugs to avoid any hazard due to loose connection leading to CT open-circuit. In no circumstances Plug In type connectors shall be used for CT / VT connections.
17. All numerical relay shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote.
18. Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures and a separate output contact for indication of any failure.
19. Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC / ANSI programmable characteristics.
20. Design of the relay must be immune to any kind of electromagnetic interference. Vendor shall submit all related type test reports for the offered model along with the offer.
21. All cards / hardware of numerical relays shall be suitable for operation in Harsh Environmental conditions with respect to high temperature, humidity & dust.
22. Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature.
23. All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.
24. Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc.
25. Numerical relays shall have feature for Time synchronization through the SCADA System / networking. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system.
26. Ethernet switches shall be suitable to accept both AC & DC supplies with range of 70 % to 120 % of rated voltage.
27. Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.
28. All numerical protection relay configuration and setting shall be done as per approved setting and configuration at switchgear manufacturer work by relay OEM or his authorized representative. All

numerical relay testing and logic/interlock checking during commissioning stage at site shall be done under the supervision of Relay OEM or his authorized representative.

7.0 OTHER PROTECTIONS AND CONTROL FUNCTIONS IN THE RELAYS

1. Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker trip circuit both in pre-trip and post trip conditions.
2. Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer function for protection function shall be as required. Timer functions shall be programmable for on/off delays.
3. The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis.
4. The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.
5. At least 200 time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault.
6. Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be shall be available on the user interface.
7. The alarm/status of each individual protection function and trip operation shall be communicated to solar SCADA.
8. Sequence of events shall have 1 ms resolution at device level.
9. Measurement accuracy shall be 1 % for RMS Current and voltage.

8.0 BUSBARS AND INSULATORS

1. All Busbar and jumper connections shall be of high conductivity aluminium alloy. They shall be adequately supported on insulators as per manufacturer's standard proven design to withstand electrical and mechanical stresses due to specified short circuit currents.
2. Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage.
3. Contact surfaces at all joints shall be silver plated or properly cleaned and nonoxide grease applied to ensure an efficient and trouble free connection. All bolted joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance. Bimetallic connectors or any other technically proven method shall be used for aluminium to copper connections.
4. Busbar insulators shall be of arc and track resistant, high strength, nonhygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100pico coulomb at rated voltage x 1.1 / 3 . Use of insulators and barriers of in-flammable material such as Hylam shall not be accepted.
5. Successful Bidder shall furnish calculation establishing adequacy of busbar sizes for the specified continuous and short time current ratings.
6. All busbars shall be color coded.
7. The temperature of the busbar and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of IEC 62271-1,2017, duly considering the specified ambient temperature (50 deg. C).

9.0 EARTHING AND EARTHING DEVICES

1. A copper / galvanized steel earthing bus shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.
2. A copper / galvanized steel earthing bus shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.
3. The earth bus shall have sufficient cross section to carry the momentary short-circuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise.
4. Suitable arrangement shall be provided at each end of the earth bus for bolting to Employer's earthing conductors. All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.
5. All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical continuity of the whole switchgear enclosure frame work and the truck shall be maintained even after painting.
6. The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. SERVICE and ISOLATED as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.
7. All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. Looping of earth connections which would result in loss of earth connection to other devices, when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.
8. VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.
9. Separate earthing trucks shall be provided by the Contractor for maintenance work. These trucks shall be suitable for earthing the switchgear busbars as well as outgoing / incoming cables or busducts. The trucks shall have a interlock to prevent earthing of any live connection.
10. As an alternative to separate earthing trucks the Bidder may also offer built-in earthing facilities for the busbars and outgoing / incoming connections, in case such facilities are available in their standard proven switchgear design. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have facility for padlocking in the earthed condition.
11. Interlocks shall be provided to prevent:
    i. Closing of the earthing switch if the associated circuit breaker truck is in Service position.
    ii. Insertion of the breaker truck to Service position if earthing switch is in closed position.
    iii. Closing of the earth switch on a live connection.
    iv. Energizing an earthed Section: Complete details of arrangement offered shall be provided during detailed engineering, describing the safety features and interlocks.
12. The earthing device (truck / switch) shall have the short circuit withstand capability equal to that of associated switchgear panel.

All hinged doors shall be earthed through flexible earthing braid.

10.0 PAINTING (INDOOR SWITCHGEAR)

All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be

done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder coating specification). Finishing paint shade for complete panels excluding end covers shall be as per bidder standard for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall be 50 microns or more as per the ambient conditions of installation area. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

11.0 INSTRUMENT TRANSFORMERS

1. All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.
2. All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly. The current transformer shall further have the dynamic and short time ratings at least equal to those specified for the associated switchgear and shall safely withstand the thermal and mechanical stress produced by maximum fault currents specified when mounted inside the switchgear for circuit breaker modules.
3. The parameters of instrument transformers specified in this specification are tentative and shall be finalized by the Employer in due course duly considering the actual burden of various relays an other devices finally selected. In case the Bidder finds that the specified ratings are not adequate for the relays and other devices offered by him, he shall offer instrument transformer of adequate ratings and shall bring out this fact clearly in his Techno commercial bid.
4. All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block.
5. Current transformers may be multi or single core and shall be located in the cable termination compartment. All voltage transformers shall be single phase type. The bus VTs shall be housed in a separate panel on a truck so as to be fully withdrawable.
6. All voltage transformers shall have suitable current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted on the withdrawable portion. Replacement of the primary fuses shall be possible with VT truck in isolated position. The secondary fuses shall be mounted on the fixed portion and the fuse replacement shall be possible without drawing out the VT truck from service position.
7. All voltage transformers shall be designed and manufactured for 0.8 Tesla operating point on B-H curve. VT shall be fully insulated type (i.e. double pole construction and neutral side fully insulated to rated BIL). VT shall be manufactured without any joint in secondary winding.

12.0 SURGE ARRESTOR

The surge arrestors shall be provided as per tender indicative AC SLD/ as per system requirement and shall be of metal oxide, gapless type generally in accordance with IEC 60099-4 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment. Surge arrestor selected shall be suitable for un-earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear.

13.0 CONTROL SUPPLY AND SPACE HEATER SUPPLY

1. Each switchboard shall be provided at least two (02) Nos of DC feeders for the control supply.
2. In case two DC sources are provided, then suitable rated blocking diodes in both circuit has to be

provided. Alternately Bidder can provide source selection switch.

3. One suitable rated 240V single phase AC supply feeder per switchboard / Switchboard section for space heater supply. Bidder shall provide necessary switch and fuse to receive, isolate and distribute to each panel.
4. Each sub circuit shall have separate fuses. Fuse size shall be determined so as to achieve selective clearance between main circuit and sub circuit in case of fault. Potential circuits for protection and metering shall also be protected by separate fuse.
5. All fuses shall be of link type conforming to IS: 13703 / 9385 mounted on suitable fuse bases. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage. All accessible live connection to fuse bases shall be adequately shrouded.
6. All DC circuits shall be fused on both poles. Single phase AC circuits shall have fuses on line and link on neutral.
7. DC and AC supply monitoring relay shall be provided, and alarm shall be generated in SCADA system in case of failure of supply.

14.0 SPACE HEATER

1. Each switchgear panel shall be equipped with thermostatically controlled space heater(s), suitably located in breaker and cable compartments to prevent condensation within the enclosure. The space heater shall be connected to 240V single phase AC auxiliary supply available in the switchgear, through switches and fuses provided separately for each panel.
2. A 240V single phase 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF switch for connection of hand lamp.

15.0 TERMINAL BLOCKS

1. Terminal blocks shall be 650V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals, the screw shall be captive, preferably with screw locking design.
2. Terminal blocks for CT and VT secondary leads shall be of stud type, made up of unbreakable polyamide 6.6 grade. They shall be provided with links to facilitate testing, isolation star / delta formation and earthing. Terminal blocks for CT secondary shall have the short-circuiting facility. The terminals for remote ammeter connection etc. shall also be disconnecting type only. All metal parts shall be of non-ferrous material. Screws shall be captive.

3. At least 10% spare terminals for external connections shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available in each panel.
4. There shall be minimum clearances of 250 mm between the terminal blocks and the cable gland plate and 150 mm between two rows of terminal blocks.
5. All panel wring for external connections shall terminate on separate terminal blocks which shall be suitable for connecting two (2) stranded copper conductors of 2.5 sq. mm on each side, or alternatively, the terminal blocks shall have the possibility of double shorting space to facilitate looping.

16.0 SWITCHGEAR WIRING

1. All Switchgear panels shall be supplied completely wired internally upto the terminal block ready to receive Employer's external cabling. All inter cubicle wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided / done by the Contractor.
2. All internal wiring shall be carried out with 650 V grade, single core, 1.5 sq. mm. stranded copper

wires having minimum of seven strands per conductor and color coded, PVC insulation. CT circuits shall be wired with 2.5 sq. mm. wires which otherwise are similar to the above. Extra flexible wires shall be used for wiring between fixed and moving parts such as hinged doors.

3. All wiring shall be properly supported neatly arranged, readily accessible and securely connected to equipment, terminals and terminal blocks. Wiring troughs or gutters be used for this purpose.
4. Internal wire terminals shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor. Insulation sleeves shall be provided over the exposed parts of lugs.
5. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.
6. Interconnection to adjacent panels shall be brought out to a separate set of terminal blocks located near the slots or holes, meant for the interconnecting wires.
7. Arrangement shall permit neat layout and easy interconnections to adjacent panels at site and wires for this purpose shall be provided by Contractor looped and bunched properly inside the panels.
8. Contractor shall be fully responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.
9. The Contractor shall provide the necessary clamps wiring troughs etc. for all wiring inside the switchgear enclosed including the Employer's power and control cables.

17.0 POWER CABLE TERMINATION

1. Cable termination compartment shall receive the stranded Aluminium conductor, XLPE insulated, shielded, armored / unarmored, PVC jacketed, single core / three core, unearthed / earthed grade power cable(s).
2. A minimum clearance of about 600 mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnection of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTs, gland plates etc. and the electrical clearances available shall be submitted for Employer's approval during detail engineering.

3. Cable termination compartment shall have provision for termination of power cables of sizes as indicated during detailed engineering with removable undrilled gland plates. For all single core cables gland plates shall be of nonmagnetic material. Cable entry shall be from bottom. Any change will be intimated later.

18.0 NAME PLATES AND LABELS

1. Each switch board shall have a name plate for its identification. All enclosure mounted equipment shall be provided with individual engraved name plates for clear equipment identification. All panels shall be identified on front as well as backside by large, engraved name plates giving the distinct feeder description along with panel numbers. Back side name plates shall be fixed in panel frame and not on the rear removable cover.
2. Name plate shall be of non-rusting metal or 3-ply lamicoid with white engraved letterings, on black background or as per manufacturer's proven standards. Inscriptions and lettering shall be subjected to Employer's approval.
3. Suitable stencilled paint mark shall be provided for identification of all equipment, located inside the enclosure, as well as for door mounted equipment, from the back side in addition to plastic sticker labels, if provided. These labels shall be located directly by the side of the respective equipment, shall be clearly visible and shall not be hidden by equipment wiring. Labels shall have device number as mentioned in wiring drawings. Type of labels and fixing of labels shall be such that they are not likely to peel off / fall off during prolonged use.

19.0 MODULE DESCRIPTION (Typical)

SlNo	Panel Type	Application	Applicability
1	DB	TransformerFeeder	TransformerFeeder
2	DC	IncomerFeeder	IncomerFeeder
3	DD	BusCoupler Feeder	BusCouplerPanelfor MV Boards
4	DE-IC	TieFeeder	TieIncomer Panel
5	DE-OG	TieFeeder	TieOutgoingPanel
6	G	BusPT	BusPTPanel
7	ICOG	StandaloneTransformer feeder	Standalone panel with bothincoming&outgoing cables

20.0 TESTS

20.1 TYPE TESTS

All equipment to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the following type tests carried out not earlier ten years from LOA date. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

A)	Reports of the following type tests carried out on circuit breaker / circuit breakerpanels,of each voltage class and current rating shall be submitted.
i)	Short circuit duty test on circuit breaker, mounted inside the panel offered alongwith CTs, bushing and separators

ii)	Shorttimewithstandtestoncircuitbreaker,mountedinsidepaneloffered togetherwith CTs, bushings and separators.
iii)	Powerfrequencywithstandtestonbreakermountedinsidepanel.
iv)	Lightningimpulsewithstandtestonbreakermountedinsidepanel.
v)	Temperature rise test on breaker and panel together. For this test, the test set up shall include three panels with breakers, the test breaker and panel being placed in the center.
	The adjacent panels shall also be loaded to their rated current capacity. Alternatively, the test panel may be suitably insulated at the sides, which will be adjoining to other panels in actual site configuration
vi)	Internal Arc Test as per IEC 62271-200
vii)	Measurement of resistance of main circuit.
viii)	Mechanical operation test.
B)	Short circuit withstand test of earthing device (truck / switch).
C)	Testing to observe compliance to degree of protection, shall be checked for each switch board enclosure and busbar chambers during routine inspection shall be as under. IP -4X: It shall not be possible to insert a one (1) mm. dia steel wire into the enclosure from any direction, without using force. IP-5X: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.

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

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

D) Type test reports for the following tests on the model of the Numerical relays, Ethernet switches shall be submitted for employer's review

Sl. No.	TEST ITEMS	Standard
i)	Dimensions of structure and visual inspection	IEC 60297-3-101
ii)	Functional requirements:	Relevant
	– Steady-state simulation	
	– Dynamic simulation	IEC 60255-100
iii)	Product safety requirements	IEC 60255-27
	(including the dielectric tests and thermal short time rating)	
iv)	EMC requirements:	IEC 60255-26

	– Emission	
	– Immunity	
v)	Energizing quantities:	
	– Burden	N/A
	– Change of auxiliary energizing quantity	IEC 60255-11
vi)	Contact performance	N/A
vii)	Communication requirements	IEC 61850
viii)	Climatic environmental requirements:	IEC 60068-2-14,
		IEC 60068-2-1,
	– Cold	IEC 60068-2-2,
	– Dry heat	IEC 60068-2-78,
	– Change of temperature	IEC 60068-2-30,
	– Damp heat	IEC 60255-27
ix)	Mechanical requirements: – Shock	IEC 60255-21-1,
	– Vibration	IEC 60255-21-2,
	– Bump	IEC 60255-21-3
	– Seismic	
x)	Enclosure protection	IEC 60529,
		IEC 60255-27

Two (2) protected soft copies on CD-ROM of the approved test results shall be furnished with the equipment. These shall include complete reports and results of the routine tests and type tests (if the latter is carried out) on equipment. If the type tests are not conducted, the CDs shall contain copies of the results of type tests carried out on identical equipment earlier.

20.2 ROUTINE TESTS

All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price
An indicative list of tests / checks is mentioned as QA chapter on HT switchgear. However, the manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

20.3 COMMISSIONING CHECKS / TESTS

After installation of panels, power and Control wiring and connections, Contractor shall perform commissioning checks as listed below to verify proper operation of switchgear / panels and correctness of all equipment in all respects. In addition, the Contractor shall carry out all other checks and tests recommended by the manufacturers.

A. General

(a) Check name plate details according to specification.
(b) Check for physical damage
(c) Check tightness of all bolts, clamps and connecting terminals
(d) Check earth connections.
(e) Check cleanliness of insulators and bushings
(f) Check heaters are provided

(g) H.V. test on complete switchboard with CT & breaker in position.
(h) Check all moving parts are properly lubricated.
(i) Check for alignment of busbars with the insulators to ensure alignment and fitness of insulators.
(j) Check for interchange ability of breakers.
(k) Check continuity and IR value of space heater.
(l) Check earth continuity for the complete switchgear board

B. Circuit Breakers

(a) Check alignment of trucks for free movement.
(b) Check correct operation of shutters.
(c) Check slow closing operation (if provided)
d) Check control wiring for correctness of connections, continuity and IR values.
(e) Manual operation of breakers completely assembled.
(f) Power closing / opening operation, manually and electrically at extreme condition of control supply voltage.
(g) Closing and tripping time.
(h) Trip free and anti-pumping operation.
(i) IR values, resistance and minimum pick up voltage of coils.
(j) Simultaneous closing of all the three phases.
(k) Check electrical and mechanical interlocks provided.
(l) Checks on spring charging motor, correct operation of limit switches and time of charging
(m) All functional checks.

C. Current Transformers

(a) IR value between windings and winding terminals to body.
(b) Polarity tests.
(c) Ratio identification checking of all ratios on all cores by primary injection of current.
(d) Magnetisation characteristics & secondary winding resistance.
(e) Spare CT cores, if any to be shorted and earthed.

D. Voltage Transformers

(a) Insulation resistance test.
(b) Ratio test on all cores.
(c) Polarity test.
(d) Line connections as per connection diagram.

E. Cubicle Wiring

(a) Check all switch developments.
(b) It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked.
(c) All the wires shall be checked for IR value.
(d) Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component / equipment.
(e) Check terminations and connections.
(f) Wire ducting

B-3(A) INVERTER TRANSFORMER

1.0 TECHNICAL REQUIRMENTS (OIL FILLED TRANSFORMER)

Sl. No.	TRANSFORMER	INVERTERTRANSFORMER
i)	VARating& Quantity	Aspersystemrequirement
ii)	VoltageRatio (KV)	Aspersystemrequirement
iii)	Duty,Service &Application	ContinuousSolarInverterapplicationandconverter duty (Outdoor)
iv)	Winding	ASpersystem requirement
v)	Frequency	50 Hz
vi)	Nos. ofPhase	THREE
vii)	VectorGroup& Neutralearthing	Aspersystemrequirement
viii)	Cooling	ONAN/KNAN
ix)	TapChanger	Aspersystemrequirement OCTC +/- 5% (min.)
x)	Impedanceat75degC PrincipalTap Othertaps	AspersystemrequirementandSLD*&asper Inverter manufacturer recommendation.
xi)	PermissibleTemperatureriseoveranambientof50degC(irrespectiveof tap)	
	a.Top oil	50degC
	b.EachIndividual winding	55degC
xii)	SC withstand time(thermal)	2 sec.
xiii)	FaultLevel&Bushing CT	Aspersystemrequirement
xiv)	Termination	Aspersystemrequirement
xv)	Bushingrating,Insulationclass (Winding & bushing)	AsperrelevantIS/IEC (However,InverterTransformerLVsidewinding& bushing insulation class shall be of at least 3.6 kV) Creepage distance: 31 mm/kV
xvi)	Noiselevel	AS PER NEMA TR-1
xvii)	Loading Capability	Continuous operation at rated MVA on any tap with voltage variation of +/-10%, also transformer shall be capable of being loaded in accordance with IS: 6600/ IEC60076-7. As minimum requirement, Transformers shall be designed with 110% continuous thermal overloading capability. The same shall be tested during Temp Rise Type test.
xviii)	Flux density	Not to exceed 1.7 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds. Bidder shall furnish over fluxing char. up to 150%
xix)	Air Clearance	As per CBIP
xx)	Foundation	All the foundation shall be designed as per highest rating Transformer in case different capacity

		transformer are offered.
xxi)	Nitrogen Injection Fire Protection System (NIFPS)	All Inverter transformers with oil quantity more than 2000 litres, shall be equipped with NIFPS.

NOTE (COMMON FOR OIL FILLED AND DRY TYPE TRANSFORMER):

1. Inverter Transformer shall have copper/Aluminium Shield winding between LV & HV windings. Each LV winding must be capable of handling non-sinusoidal voltage with voltage gradient as per relevant applicable standards and Inverter manufacturer recommendation. Also, each shield winding shall be taken out to tank with two separate connection from shield to bushing with proper support with 2 nos. 3.6 kV shield bushings and same shall be brought down along with support insulator from tank & copper flat up to the bottom of the tank for independent grounding.
2. If Inverter transformer is provided indoor, it shall be necessarily dry type.
3. Harmonic Factor as per Inverter manufacturer recommendation must be considered while designing the transformer. The extra no load loss due to voltage harmonics and load and stray load loss due to current harmonics (as applicable) and must be taken into consideration in transformer design. In addition, the dc bias component of 0.5% of rated Inverter output current is to be accounted for its effect on the transformer design.
4. The adverse effect on life of transformer due to cloud intermittency and solar generation loading cycle must be compensated through suitable design (as applicable).
5. The thermal design of Inverter Transformer needs to consider the temperature dependent performance of the Inverter. It is to in accordance with Inverter output and under worst condition it should not limit Inverter output.
6. The multi-winding transformer needs to be designed for long term operating conditions with asymmetrical load on LV side i.e., in case three winding design, the transformer needs to operate reliable with only one Inverter supplying power to only one LV winding.
7. For multi winding transformer, it is recommended to have close coupling and equal impedances on each of LV winding to HV winding and to have high enough impedance (8% min. based on one LV winding rating) between two LV windings in order to decouple these windings.
8. In case of inverter transformer, it shall be proven and of successfully type tested design
9. Contacts from Inverter transformer fittings/protection devices shall be wired for tripping of Inverter transformer Circuit Breaker. Detailed scheme regarding same shall be finalized during detailed engineering.
10. Single Line Diagram (SLD) will be finalized during detailed engineering however kVA rating of inverter transformer shall not be less than combined kVA capacity of respective Inverters connected to it.
11. Contractor shall ensure that all the Outdoor Transformers are provided with Sheds, as protection against rain/moisture ingress, after due consideration of Lifting Height of the Transformer. Bus Ducts, as applicable, shall also be covered under the shed.

1.2. CODES AND STANDARDS

Transformers	IS:2026,IS:6600, IEC:60076
Bushings	IS:2099,IEC:60137,IS3347,IS 12676
Insulatingoil	IEC61099/IS16081
Bushing CTs	IS:2705,IEC60185
Indian ElectricityAct2003, BEEGuideline&CEA notifications	

1.3. GENERAL CONSTRUCTION

Transformer shall be constructed in accordance to IS: 2026 and IS: 3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect and shall be in scope of supplier.

The other important construction particulars shall be as below.

1. The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane.
2. A double float type Buchholz relay conforming to IS: 3637 shall be provided.
3. Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
4. All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at site
5. The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel breather (in transparent enclosure). Silica gel shall be isolated from atmosphere by an oil seal. Transformer shall have adequate capacity Conservator tank to accommodate oil preservation system and volumetric expansion of total transformer oil.
6. Transformer shall have Oil Temperature Indicator and Winding temperature Indicator with accuracy class of +/-2 deg.
7. Radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/valve at the bottom and air release plug at the top.
8. M. Box shall be of sheet steel, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Also Marshalling Box, shall be at least 450 mm above ground level. Wiring scheme (TB details) shall be engraved in a stainless-steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.

1.4. WINDINGS

1. The Bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.
2. The conductors shall be of electrolytic grade copper/electrolytic grade Aluminium free from scales & burrs.
3. All windings of the transformers shall have uniform insulation.
4. Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratios.

1.5. CORE

1. The core shall be constructed from non-ageing, cold rolled, super grain-oriented silicon steel laminations equivalent to M4 grade steels or better.
2. Core isolation level shall be 2 kV (rms.) for 1 minute in air.
3. Adequate lifting lugs will be provided to enable the core & windings to be lifted.

1.6. TRANSFORMER OIL

1. No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's

premises and shall have following parameters.

S.No	Property	Permissiblevalues
1	KinematicViscosity, mm2/s	≤12at 40°C ≤1800.0at(-)30°C
2	Flash Point	≥140 °C
3	Pour Point	≤(-)40°C
4	Appearance	Clear,freefromsedimentand suspended matter
5	Densitykg/dm3 at 20 °C	≤ 0.895
6	InterfacialTensionN/mat25C	≥0.04
7	Neutralisationvalue,mgKOH/g	≤ 0.01
8	Corrosivesulphur	Non coorsive
9	Watercontent mg/kg	≤ 30 in bulk supply ≤40 in drum supply
10	Anti-oxidantsadditives	Not detectable
11	OxidationStability -Neutralizationvalue,mgKOH/g	≤1.2 ≤ 0.8
	-Sludge, % by mass	
12	Breakdown voltage As delivered, kV After treatment, kV	≥30 ≥70
13	Dissipation factor, at 90 C And 40 Hz to 60 Hz	≤ 0.005
14	PCA content	≤ 1%
15	Impulse withstand Level, kVp	≥ 145
16	Gassing tendency at 50 Hz after 120 min, mm3/min	≤ 5

2. Subsequently oil samples shall be drawn at:

S.no	Parameters	Beforefillingin main tank & tested for	Prior to energization forfollowing properties &acceptance norms:	Applicability
i)	BDV	60 kV (min)	60 kV (min)	Applicableforall Transformers.
ii)	Moisture content	10ppm (max.)	10ppm (max.)	

3. For ester filled oil, relevant IS/IEC shall be followed for relevant oil parameters for type/routine test. The oil supplied with transformers shall be new and previously unused and must conform to IS/IEC while tested at supplier's premises and shall fulfil all oil parameters. Type test are to be performed by the supplier at NABL accredited Govt approved independent laboratory before supplying the oil and submit for its approval by MANIREDA.

1.7. BUSHINGS

1. Bushing below 52 kV shall be oil communicating type with porcelain insulator.
2. LV Bushing below 3.6 kV used within transformer cable box, epoxy type bushing confirming to IS 2099/IEC 60137 also allowed as alternate to porcelain type
3. No arcing horns to be provided on the bushings.
4. Inverter Transformer LV bushing palms shall be silver/tin plated.

1.8. BUSHING CTS

1. Shall be of adequate rating for protection (differential and others if any) as required, WTI etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.
2. All CT terminals shall be provided as fixed type terminals on the M. Box to avoid any hazard due to loose connection leading to CT opening. In no circumstances Plug In type connectors shall be used for CT.

1.9. VALVES

1. All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies.
2. Sampling & drain valves should have zero leakage rate.

1.10. GASKETS

1. Gasket shall be fitted with weather proof, hot oil resistant, nitrile rubber-based gasket.
2. If gasket is compressible, metallic stops shall be provided to prevent over compression.
3. The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

1.11. PAINTING

PARTSNAME	TYPEOFPAINT	NO.OF COATS	TOTAL DFT
Insideoftankand accessories (except M Box)	Oil&heatresistantfullyglossy white	Onecoat	Atleast 30 micron
External surface of transformer and accessoriesincluding M Box (except radiators)	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceious iron oxide) as intermediatepaintfollowedby polyurethane finish paint (As per manufacturer standard)	Onecoateach	Atleast 100 micron
ExternalRadiator surface	Anticorrosive primary paint followedbyhighqualityfull glossyouterfinish paint (As per manufacturer standard)	Twocoatseach	Atleast 100 micron
Internal Radiator surface	Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil	---	---
Internal surface of M Box	Chemical resistant epoxy zinc phosphate primer followed by chemical and heat resistant epoxy enamel white paint	Two coats each	Not less than 100 micron

1.12. NEUTRAL EARTHING ARRANGEMENT

Neutral earthing shall be done as per system requirement and SLD. In case of solidly earthed neutral of Transformers, it shall be brought through insulated support from tank to the ground level at a convenient point with 2 nos. copper flat, for connection to ground network (as applicable). Neutral of

Transformer if not used should be taken out through bushing and covered by insulating cap.

1.13. CABLE BOXES & DISCONNECTING CHAMBER (DISCONNECTING CHAMBER APPLICABLE 3.3 KV AND ABOVE & FOR INVERTER TRANSFORMER BOTH SIDE)

1. HV Cable boxes shall be of phase segregated air insulated type & shall be of sufficient size to accommodate Employer's cable & termination. Phase segregation shall be achieved by insulating barriers (for 3.3 kV and above side)
2. Cable boxes shall have bus bars / suitable terminal connectors of adequate size & bolt holes to receive cable lugs. The degree of protection of cable boxes shall be IP 55.
3. A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box
4. The support from base for the cable box (for 3.3 kV and above side) shall be of galvanized iron
5. The contractor shall provide earthing terminals on the cable box, to suit Employer's GI flat.
6. The minimum length provided for terminating 33 kV, 11KV & 3.3 KV XLPE cable shall be 1000 mm (for 33 kV) 650 mm (for 3.3 kV and 11 kV) from cable gland plate to the cable lug) for the cable boxes, for 433V side suitable length shall be provided (shall be discussed during detail engineering). The final cable size, number & length of terminating XLPE cable shall be furnished during detailed engineering.
7. Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).
8. Cable boxes shall have removable top cover (for transformer above 100 KVA) & ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.

1.14. FITTINGS

Following fittings shall be provided with Transformers covered under this sub section. The fittings listed below are only indicative and other fittings, which generally are required for satisfactory operation of the transformers are deemed to be included.

a)	-ConservatorformaintankshallbeprovidedwithMOGwithlowoillevelalarmcontact,drainvalve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.
b)	- Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement.
c)	- Itshallbeprovidedwithminimumtwonumbersof spring-operatedPRD(withtripcontacts)with suitable discharge arrangement for oil shall be provided.
d)	OTI & WTI shall be 150 mm dial type with alarm and trip contacts withmax. reading pointer &resetting device (maximum height 1500 mm above ground level). ForInverterTransformers,WTIshallbeprovided atleastforallLV windings.
e)	Top&bottomfiltervalveswiththreadedmaleadapters,bottomsamplingvalve,drainvalve/sludge removal valve at the bottom most point of the tank.
f)	Airreleaseplug,bushingwithmetalparts&gaskets,terminalconnectorsonbushings(as applicable).
g)	Prismatic/toughenedglassoilgaugefortransformers.
h)	Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Coolingequipment.
i)	Coverliftingeyes, transformerliftinglugs,jackingpads,towingholesand coreandwindinglifting lugs, inspection cover, Bilingual R&D Plate, Terminal marking plates, two nos. earthing terminals etc.
j)	Bolts&nuts(exposedtoatmosphere)shallbe galvanizedsteel/SS.
k)	RainhoodstobeprovidedonBuchholz,MOG&PRD.Entrypointsofwiresshallbesuitablysealed.

2.0 DRY TYPE INVERTER TRANSFORMER

Sr. No.	PARAMETERS	INVERTERTRANSFORMER
i)	Type	Epoxycast resin/resinencapsulated
ii)	Duty,Service &Application	ContinuousSolarInverterapplicationandconverter duty (Indoor)
iii)	MVA&Voltage ratio	Aspersystemrequirementand SLD.
iv)	Vectorgroup	
v)	Termination&BushingCT	
vi)	FaultLevel&Earthing	
vii)	Tapchangertype&range	AspersystemrequirementandSLD. OCTC +/-5% (min.)
viii)	Impedance	AspersystemrequirementandSLD&asperInverter manufacturer recommendation.
ix)	Numberof phases	Three (3)
x)	Typeofcooling	AN Transformershallbeprovidedwithsuitableventilation systemtoensurethetemperatureriselimitsundermost severe condition while in service however all tests and performance guarantee shall correspond to air natural (AN)cooling.
xi)	Bushingrating,Insulationclass (Winding & bushing)	AsperrelevantIS/IEC (However,InverterTransformerLVsidewinding& bushing insulation class shall be of at least 3.6 kV)
xii)	MaximumTemperatureriseofwinding over 50 deg. C ambient. (byresistancemethod)withAirNatural (AN) cooling.	90 deg.C. (class F) 115deg.C.(classH)
xiii)	SC withstand time(thermal)	2 sec
xiv)	NoiseLevel	Nottoexceed valuesspecified inNEMA TR-1.
xv)	PDLevel(max.Allowable)	10 pc
xvi)	LoadingCapability	ContinuousoperationatratedKVAonanytapwith voltage variation of +/-10% corresponding to the voltage of the tap as well as in accordance with IEC60076-12/IS: 6600.
vii)	Flux Density	Not to exceed 1.9 Wb/sq.m. at any tap position with +/- 10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due combined voltage and frequency fluctuations: 110% for continuous rating. 125% for at least one minute. 140% for at least five seconds.

2.1 CODES AND STANDARDS

Drytypetransformers	IS:11171,IEC60076-11
IndianElectricityAct2003 and IndianElectricityRules, BEEnotification&CEAguidelines	

2.2 DESIGN AND CONSTRUCTIONAL FEATURES

1. The core shall be constructed from high grade non-ageing cold rolled grain oriented silicon steel laminations of M4 grade or better quality. The insulation of core to clamp-plates shall be able to withstand a power frequency voltage of 2 kV (rms) for one (1) minute.
2. The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23.In case it is placed outdoor, IP for enclosure shall be minimum IP-42 or higher. Enclosure shall be of a tested quality sheet steel of minimum thickness 2mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting. Suitable bi-directional skids with pre-drilled holes shall be provided integral with the enclosure or bi-directional rollers shall be provided with suitable locking arrangement.
3. Winding conductor shall be electrolytic grade Copper/ Aluminum. Windings shall be of class F insulation or better. All windings are to be uniformly insulated.
4. Transformer HV bushings and LV bushings can be either solid porcelain or epoxy type. Bushing shall be suitable for satisfactory operation in the high ambient temperature inside Bus Duct enclosure (if applicable). LV flange area shall be of non-magnetic material.
5. Bushing CTs shall be provided in the LV neutral side of adequate rating for REF protection, WTI, etc (as applicable).

   6. For Marshalling Box the sheet steel used shall be at least 1.6 mm thick cold rolled. The box shall be tank mounted type. The degree of protection shall be IP-54 in accordance with IS-13947. Wiring Scheme shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.
7. Transformer shall be provided with suitable ventilation system to ensure the temperature rise limits under most severe condition while in service however all tests and performance shall correspond to air natural cooling.

2.3 PAINTING

The inside of enclosure and accessories (except M. Box) shall be painted with two coats of fully glossy white colour with total DFT of 25 to 60 microns. The external paint colour of transformer & accessories can be as per manufacturer standard. The external surface of transformer & accessories shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of polyurethane finish paint with total DFT of 80 to 150 microns. The internal surface of M.Box shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of chemical & thermal resistant epoxy enamel white paint with total DFT of 80 to 150 microns.

2.4 FITTING

Winding temperatur e indicator (WTI)	ShallbePlatinumresistancetypetemperaturedetectorin each limb. Single Indicating meter may be provided for display of temperature of all limbs.AccuracyclassofIndicatingmetershallbe+/-1%orbetteranditshall have least count of 0.1 oC or better. 1 no. 4-20 mA signal shall be provided for remote monitoring of winding Temperature.
RTD/Thermistors	1 No. PT-RTD shall be embedded in each limb with alarm and trip contacts forremoteannunciation.Additional1No.thermistor/RTDshallbeembedded in each limb.

Fittings which are generally required for satisfactory operation of the transformers are deemed to beincluded, in the scope of supply of the Contractor.

3.0 TESTS AND INSPECTION

In case the bidder/contractor has conducted type test(s) within last ten years, then bidder may submit the type test reports to the owner for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

In case the Bidder is not able to submit report of the type test(s) conducted within last ten years from the date LOA by MANIREDA, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract at no additional cost to the Employer and submit the reports for approval.

SHORT CIRCUIT TEST:

In case short circuit test has not been conducted or the test report not meeting the specification requirement for the offered transformer manufacturer, Bidder /Sub-vendor shall establish" Ability to withstand the dynamic effects of short circuit "for the offered transformer as per latest IEC 60076-5.The ability to withstand the dynamic effects of short circuit can be established either by performing actual short circuit test or by method of calculation with reference to short circuit tested reference transformer as per IEC- 60076-5/Annexure-A&B. Bidder shall choose any one the two options mentioned below;

Option-1:Performing actual short circuit test as Type Test. In order to meet project schedule, Bidder/Sub vendor shall take suitable steps quite in advance to ensure successful conduction of short circuit test within three months' time from date of LOA failing which the offered make of the transformer shall not be considered.

Option-2: By theoretical evaluation of the ability to withstand dynamic effect of short circuit based on 'Calculation and Design and Manufacture Consideration'. In this regard the guidelines given in Annexure-A with applicable tables of the IEC 60076-5 is to be followed. The reference transformer chosen shall be of same application, winding configuration, conductor current density and as per Annexure-B of latest IEC-60076-5. Necessary Design document and reference test reports related to theoretical comparative evaluation must be submitted by Manufacturer/Bidder as required by Employer in this case.

S.N.	ROUTINETESTS	
1.	Allroutinetestshallbecarriedoutinaccordance withIEC60076.	√
2.	MeasurementofVoltage Ratio&phasedisplacement(asperIEC60076-1)	√
3.	Measurementofwindingresistanceonallthetaps(asperIEC60076-1)	√
4.	VectorgroupandPolarityCheck (asperIEC60076-1)	√
5.	MagneticBalanceandMagnetisingCurrentTest	√
6.	Measurementofno loadcurrentwith 415V,50 Hz AC supply	√
7.	Measurementofnoload lossesandcurrent at90%,100% &110% ofratedvoltage (as per IEC 60076-1)	√
8.	Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps	√
9.	IR measurement (As per IEC 60076-1)	√
10.	Measurement of capacitance & tan delta to determine capacitance between winding & earth.	√
11.	Separate Source Voltage Withstand Test /Applied voltage test (as per IEC 60076-3)	√

12.	Induced overvoltage test/Induced voltage withstand (IVW) test as per IEC60076 part 3	√
13.	Repeat no load current/loss & IR after completion of all electrical test	√
14.	Oil leakage test on completely assembled transformer along with radiators (as per relevant clause of this sub section)	√
15.	Jacking test followed by D.P. test	√
16.	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	√
17.	IR measurement on wiring of Marshalling Box.	√
S. N.	TYPE TESTS # (To be carried out on one transformer of each rating)	
1.	Lightning impulse (Full and chopped wave) test on windings (as per IEC 60076-3) (Not applicable for LV)	√
2.	Short circuit test (special test) as per IEC 60076-5 (if applicable).	√
3.	Temperature Rise test at a tap corresponding to maximum losses as per IEC 60076. Gas Chromatography shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599).	√
4.	Measurement of harmonics of no load current (special test)	√
5.	Measurement of acoustic noise level as per NEMA TR-1 (special test)	√
6.	Tank Vacuum & Pressure Test (as per CBIP norms)	√

(#) NOTE: -

I. All the type and special tests shall be conducted after performing Short Circuit Test. If Tank Vacuum & Pressure Test is to be carried out then it shall be conducted before SC test.
II. ii) Inverter Transformer LV winding Di-electric tests (except for lightning impulse test for LV winding) shall be carried out corresponding to levels (as per IEC 60076) for 3.6 kV class.
III. iii) All Type tests should be done as per Employer's approved procedure.

3.1 LEAKAGE TEST ON ASSEMBLED OIL FILLED TRANSFORMER (ROUTINE TEST)

All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur. Bidder can perform this test at site depending upon urgency subject to MANIREDA approval. Suitable Fire Fighting arrangements for Oil filled Transformers shall be provided if applicable as per Tariff Advisory Committee (TAC)/statutory requirements. In case Nitrogen based fire protection system is used, CBIP manual shall be followed for compliance. Firewall & soak pit as applicable (as per statuary requirement/TAC/IS 10028 / IS 1646) shall be provided of minimum 230 mm thickness of RCC wall or 355 mm thick fire resisting brick wall subject to MANIREDA approval. However, for all oil filled outdoor a pit shall be provided all around at a distance of 1.0 meter (min.) from transformer outer edge, a sump pit shall be provided for each pit. Transformer efficiency shall be as per Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electrical Lines) regulation, 2010.

3.2 ROUTINE / TYPE TESTS (DRY TYPE TRANSFORMERS)

Transformer shall be short circuit tested after conducting the routine tests. Rest of the type tests shall be conducted after successful short circuit testing.
All routine tests in accordance with IS: 11171 / IEC 60076-11 shall be carried out on each transformer.

And All Type tests should be done as per Employer's approved procedure.

Routine/TypeTests(DryTypeTransformers)			
a)	MeasurementofwindingResistanceforeachtapposition.		Routine
b)	Measurementofvoltage ratioateachtapsposition.		Routine
c)	Vectorgroupandpolarity check		Routine
d)	Measurementofimpedancevoltage/shortcircuitimpedance&loadlossat principaltapandextreme taps		Routine
e)	Measurementofnoloadlossesandmagnetisingcurrentatratedfrequencyand 90%,100%and110%rated voltage.		Routine
f)	Measurementofinsulation resistance		Routine
g)	Measurementofcapacitanceandtandelta		Routine
h)	DielectricTests		
	1)	PF/SeparatesourceACwithstandvoltage test.	Routine
	2)	Choppedwavelightningimpulsevoltagetestonwindings(asp er IEC60076-3)(NotapplicableforLV)	Type
	3)	Inducedovervoltagewithstand test	Routine
i)	Partialdischargemeasurement		Routine
j)	Measurementofironloss&IR(repeatafterinducedvoltage test)		Routine
k)	ShortCircuittestas per IEC(ifapplicable)		Type
l)	NoiseLevel Measurement		Type
o)	Temperaturerisetestas per IEC(HV&LV winding)		Type

B-3(B) AUXILIARY TRANSFORMER

1.0 TECHNICAL REQUIRMENTS (OIL FILLED TRANSFORMER)

Sr.No.	DESCRIPTION	AUXILIARYTRANSFORMER(AT)
i)	VARating& Quantity	Aspersystem requirementand/orSLD*
ii)	VoltageRatio (KV)	Aspersystem requirementand /orSLD*
iii)	Duty,Service &Application	Continuousapplication(Outdoor)
iv)	Winding	TWO
v)	Frequency	50 Hz
vi)	Nos. ofPhase	THREE
vii)	VectorGroup&Neutralearthing	Aspersystem requirementand/orSLD*
viii)	Cooling	ONAN
ix)	TapChanger	Aspersystem requirementand/orSLD*
x)	Impedanceat75degC	
	a)PrincipalTap	Aspersystem requirementand/orSLD*.
	b)OtherTaps	
xi)	PermissibleTemperature riseoveran ambientof50degC(irrespectiveoftap)	
	a)TopOil	35 deg.C
	b) Winding	40 deg.C
xii)	SC withstand time(thermal)	2 sec.
xiii)	Faultlevel&BushingCT	Aspersystemrequirementand SLD*
xiv)	Termination	Aspersystemrequirement/cablebox
xv)	Bushingrating,Insulationclass (Winding & bushing)	AsperrelevantIS/IECCreepagedistance:31 mm/kV
xvi)	Noiselevel	AS PER NEMA TR-1
xvii)	Loading Capability	Continuous operation at rated MVA on any tap with voltage variation of +/-10%, also transformer shall be capable of being loaded in accordance with IS: 6600.
xviii)	Flux density	Not to exceed 1.7 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds. Bidder shall furnish over fluxing char. up to 150%
xix)	Air Clearance	As per CBIP

NOTE (COMMON FOR OIL FILLED AND DRY TYPE TRANSFORMER):

1. Auxiliary transformers shall be suitable for 3 phase, 4 wire system with additional LVN bushing for equipment earthing.
2. Auxiliary Transformer can be either Oil Natural/Synthetic Ester oil) filled or Dry Type (refer relevant specification).
3. In case Ester Oil filled Transformers are offered, then 50% quantity shall be Natural ester filled and balance 50% quantity shall be of Synthetic Ester oil filled.

2.0 CODES AND STANDARDS

Transformers	IS:2026, IS:6600
Bushings	IS:2099,IS3347
Insulatingoil	IS16659/IS16081

Bushing CTs	IS:2705

2.1 GENERAL CONSTRUCTION

Transformer shall be constructed in accordance to IS: 2026 and IS: 3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect and shall be in scope of supplier.

The other important construction particulars shall be as below.

1. The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane.
2. A double float type Buchholz relay conforming to IS: 3637 shall be provided.
3. Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
4. All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at site
5. The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel breather (in transparent enclosure). Silica gel shall be isolated from atmosphere by an oil seal.
6. Transformer shall have adequate capacity Conservator tank to accommodate oil preservation system and volumetric expansion of total transformer oil.
7. Transformer shall have Oil Temperature Indicator and Winding temperature Indicator (WTI applicable for transformer above 50 KVA) with accuracy class of +/-2 deg.
8. For Transformers above 100KVA, radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/valve at the bottom and air release plug at the top.
9. M. Box shall be of sheet steel, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Also Marshalling Box, shall be at least 450 mm above ground level (for transformer above 100 KVA). For transformer above 100 KVA, wiring scheme (TB details) shall be engraved in a stainless-steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.
10. In case Natural Ester oil (IS 16659) filled transformer, the Transformer should be hermetically sealed and corrugated tank design. It should fit with monitoring equipment like DGPT etc. for accessing the healthiness of Natural ester oil. As transformer becomes hermetically sealed, fitting, valves and accessories shall be decided during detail engineering but all other part of tender specification related to design of transformer active part and testing requirement shall remain same. HV/LV Bushing shall be fitted vertically on tank cover and all necessary measures to be taken to make the transformer leakage proof. Suitable nitrogen capping system shall be provided for preserving Natural ester oil for O&M.

2.2 WINDINGS

a) The bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.
b) The conductors shall be of electrolytic grade copper free from scales & burrs.
c) All windings of the transformers shall have uniform insulation.

d) Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.

2.3 CORE

a) The core shall be constructed from non-ageing, cold rolled, super grain-oriented silicon steel laminations equivalent to M4 grade steels or better.
b) Core isolation level shall be 2 kV (rms.) for 1 minute in air.
c) Adequate lifting lugs will be provided to enable the core & windings to be lifted.

2.4 INSULATING MINERAL OIL

1. No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.

S. No.	Property	Permissible Value
1.	KinematicViscosity,mm2 /s	≤12 at 40 °C ≤1800.0 at(-)30°C
2.	FlashPoint,°C	≥ 140°C
3.	Pourpoint, °C	≤(-)40°C
4.	Appearance	Clear,freefromsedimentand suspended matter
5.	Densitykg/dm3 at 20°C	≤0.895
6.	InterfacialTensionN/mat25°C	≥0.04
7.	Neutralisationvalue,mgKOH/g	≤0.01
8.	Corrosivesulphur	Non Corrosive
9.	Watercontent mg/kg	≤30inbulksupply ≤40indrumsupply
10.	Anti-oxidantsadditives	Not detectable
11.	OxidationStability -Neutralizationvalue, mgKOH/g-Sludge,%bymass	≤1.2 ≤0.8
12.	Breakdownvoltage As delivered, kV Aftertreatment,kV	≥30 ≥70
13.	Dissipationfactor,at90°C And 40 Hz to 60 Hz	≤0.005
14.	PCA content	≤1%
15.	ImpulsewithstandLevel, kVp	≥145
16.	Gassingtendencyat 50Hzafter 120min, mm3 /min	≤5

2. Subsequently oil samples shall be drawn at:

Sr. No.	Parameters	Before filling in main tank & tested for	Prior to energization for following properties & acceptance norms:	Applicability
i)	BDV	60 kV (min)	60 kV (min)	Applicable for all transformers
ii)	Moisture Content	10 ppm (max.)	10 ppm (max.)	

3. For ester filled oil, relevant IS/IEC shall be followed for relevant oil parameters for type/routine test.

2.5 BUSHINGS

a) Bushing below 52 kV shall be oil communicating type with porcelain insulator.
b) No arcing horns to be provided on the bushings.

2.6 BUSHING CTS

Shall be of adequate rating for protection as required, WTI (WTI CT applicable for transformer above 50 KVA) etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.
All CT terminals shall be provided as fixed type terminals on the M. Box to avoid any hazard due to loose connection leading to CT opening. In no circumstances Plug In type connectors shall be used for CT

2.7 VALVES

All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies.
Sampling & drain valves should have zero leakage rate.

2.8 GASKETS

a) Gasket shall be fitted with weather proof, hot oil resistant, rubberized cork gasket.
b) If gasket is compressible, metallic stops shall be provided to prevent over compression.
c) The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

2.9 PAINTING

PARTSNAME	TYPEOFPAINT	NO.OF COATS	TOTAL DFT
Insideoftank and accessories (exceptMBox)	Oil&heatresistant fullyglossywhite	Onecoat	Atleast30 microns
External surface of transformer and accessories including M Box (except radiators)	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceious iron oxide) as intermediatepaintfollowedbypolyurethane finish paint (As per manufacturer standard)	Onecoateach	Atleast100 micron
ExternalRadiator surface	Anticorrosiveprimarypaint followedby highqualityfullglossyouterfinishpaint (As per manufacturer standard)	Two coats each	Atleast100 micron
InternalRadiator surface	Hot oil proof, lowviscosityvarnishand subsequentflushingwithtransformer oil	---	---
Internalsurface of M Box	Chemical resistant epoxy zinc phosphateprimerfollowedbychemical and heat resistant epoxy enamel white paint	Two coats each	Notlessthan 100 microns

2.10 NEUTRAL EARTHING ARRANGEMENT

Neutral earthing shall be done as per system requirement and SLD. In case of solidly earthed neutral of Transformers, it shall be brought through insulated support from tank to the ground level at a convenient point with 2 nos. copper flat, for connection to ground network (as applicable). Neutral of Transformer if not used should be taken out through bushing and covered by insulating cap.

2.11 CABLE BOXES & DISCONNECTING CHAMBER (DISCONNECTING CHAMBER APPLICABLE 3.3 KV AND ABOVE)

a) HV Cable boxes shall be of phase segregated air insulated type & shall be of sufficient size to accommodate Employer's cable & termination. Phase segregation shall be achieved by insulating barriers (for 3.3 kV and above side).
b) Cable boxes shall have bus bars / suitable terminal connectors of adequate size & bolt holes to receive cable lugs. The degree of protection of cable boxes shall be IP 55.
c) A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box
d) The support from base for the cable box (for 3.3 kV and above side) shall be of galvanized iron
e) The contractor shall provide earthing terminals on the cable box, to suit Employer's GI flat.
f) The minimum length provided for terminating 33 kV, 11KV & 3.3 KV XLPE cable shall be 1000 mm (for 33 kV) 650 mm (for 3.3 kV and 11 kV) from cable gland plate to the cable lug) for the cable boxes, for 433V side suitable length shall be provided (shall be discussed during detail engineering). The final cable size, number & length of terminating XLPE cable shall be furnished during detailed engineering.
g) Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).
h) Cable boxes shall have removable top cover (for transformer above 100 KVA) & ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.

2.12 FITTINGS

Following fittings shall be provided with Transformers covered under this sub section.

a)	-Conservatorformaintank(transformerabove100KVAshallbeprovidedwithMOGwithlowoil level alarm contact), drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.
b)	- Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement (Gas collecting arrangement applicable for transformer above 100 KVA).
c)	-For Auxiliarytransformers below 2MVA, diaphragmtypeexplosion ventshall beprovided.
d)	OTI & WTI shall be 150 mm dial type with alarm (WTI only for transformer above 50 kVA) and tripcontactswithmax.readingpointer&resettingdevice(maximumheight1500mmabovegroun d level).
e)	Fortransformerabove100 KVA: Top&bottomfiltervalveswiththreadedmaleadapters,bottomsamplingvalve,anddrain valve/sludge removal valve at the bottom most point of the tank. ForTransformer upto100 KVA: common drain cum sampling cum bottom filter cum sludge removal valve and top filter valve can be provided.
f)	Airreleaseplug,bushingwithmetalparts&gaskets,terminalconnectorsonbushings(as applicable).
g)	Prismatic/toughenedglassoilgaugefortransformers.

h)	Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Coolingequipment.
i)	Cover lifting eyes, transformer lifting lugs, jacking pads(jacking pad applicable for transformer above100KVA),towingholesandcoreandwindingliftinglugs,inspectioncover,BilingualR&D Plate, Terminal marking plates, two nos. earthing terminals etc.
j)	Bolts&nuts(exposedtoatmosphere)shallbe galvanizedsteel/SS.
k)	RainhoodstobeprovidedonBuchholz,MOG&PRD.EntrypointsofwiresshallbesuitablysealedE.

2.13 TESTS AND INSPECTION

S.N.	ROUTINE TESTS	
1.	Allroutinetestshallbecarriedoutinaccordance withIEC60076.	√
2.	MeasurementofVoltage Ratio&phasedisplacement(asperIEC60076-1)	√
3.	Measurementofwindingresistanceonallthetaps(asperIEC60076-1)	√
4.	VectorgroupandPolarityCheck (asperIEC60076-1)	√
5.	MagneticBalanceandMagnetisingCurrentTest	√
6.	Measurementofno-loadcurrentwith 415V,50 Hz AC supply	√
7.	Measurementofno-loadlossesandcurrentat90%,100%&110%ofratedvoltage (asper IEC60076-1)	√
8.	LoadLoss&ShortCircuitImpedanceMeasurementonprincipal&ExtremeTaps	√
9.	IRmeasurement(AsperIEC60076-1)	√
10.	SeparateSourceVoltage Withstand Test/Appliedvoltagetest (asperIEC 60076-3)	√
11.	Inducedovervoltagetest/Inducedvoltagewithstand(IVW)testasperIEC60 076part3	√
12.	Repeatnoloadcurrent/loss&IRaftercompletion ofallelectricaltest	
13.	Oilleakagetestoncompletely assembledtransformeralongwithradiators(asper relevant clause of this sub section)	√
14.	MarshallingBox/Cablebox:Itshallnotbepossibletoinsertathinsheetofpaperunder gaskets and through enclosure joints.	√
15.	IRmeasurementonwiringofMarshallingBox.	√
S.No.	**TYPETESTS#**	
1.	TemperatureRisetestatatapcorrespondingtomaximumlossesasper IS2026.	√
2.	TankVacuum&PressureTest(asperCBIPnorms)	√

2.14LEAKAGE TEST ON ASSEMBLED OIL FILLED TRANSFORMER (ROUTINE TEST)

All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur. Bidder can perform this test at site depending upon urgency subject to MANIREDA approval.

2.15FIRE FIGHTING

Fire Fighting arrangements for Transformers shall be provided if applicable as per Tariff Advisory Committee (TAC)/statutory requirements. Firewall & soak pit as applicable (as per statuary requirement/TAC/IS 10028 / IS 1646) shall be provided of minimum 230 mm thickness of RCC wall or 355 mm thick fire resisting brick wall subject to MANIREDA approval. However, for all outdoor transformer at a distance of 1.0 m (min.) from transformer outer edge. A sump pit shall be provided for each pit.

Transformer efficiency shall be as per Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electrical Lines) regulation, 2010.

3.0 DRY TYPE AUXILIARY TRANSFORMERS:

Dry Type Transformer shall be constructed in accordance to IS: 2026, IS: 11171 or equivalent to any other international standard, Indian Electricity Act 2003, BEE Guideline & CEA notifications. Transformer rating and all related technical parameters including tap changer (if applicable) shall be as per system requirement/SLD and relevant standards. Transformer shall be suitable for continuous indoor duty application. Transformer shall be complete & functional in all respect. The other important construction particulars shall be as below.

a) The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23. The enclosure shall be provided with suitable hardware (as required).
b) The conductors shall be of electrolytic grade copper free from scales & burrs.
c) Dry Type Transformer windings shall be of class F insulation or better. Cooling shall be AN.
d) The core shall be constructed from non-ageing, cold rolled, grain-oriented silicon steel laminations (M4 or better).

The fittings/accessories including protection/monitoring device (temperature scanner) generally required for satisfactory operation of the transformer, are to be provided.

B-4 AC CABLES

1.0CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS:7098(Part -I)	CrosslinkedpolyethyleneinsulatedPVCsheathedcablesforworkingvoltagesuptoandincluding 1100V.
IS:7098(Part -II)	CrosslinkedpolyethyleneinsulatedPVCsheathedcablefor(Part-II)workingvoltage from 3.3 KVupto&including33 KV
IS:1554 - I	PVCinsulated (heavyduty) electric cablesforworkingvoltagesuptoandincluding1100V.
IS:3961	Recommendedcurrentratingsforcables
IS:3975	Lowcarbongalvanisedsteelwires,formedwires andtapesforarmouringofcables.
IS:5831	PVCinsulationandsheathofelectricalcables.
IS:8130	Conductorsforinsulatedelectricalcables andflexible cords.
IS: 10810	Methodsoftestsfor cables.
ASTM-D-2843	Standard test method for density of smoke from the burning or decomposition ofplastics.
ASTM-D-2863	Standardmethodformeasuringtheminimumoxygenconcentrationtosupport candle like combustion of plastics.
IEC-754(Part-I)	Testsongases evolvedduringcombustion ofelectriccables.
IEC-332Part-3:	Testsonelectriccablesunderfireconditions.Testsonbunchedwiresorcables (Category-B).
IEEE-383	Standardfortypetestof Class IEElectric Cables
IS:4905	Methodsforrandomsampling.
IS: 10418	Specificationfordrumsforelectriccables.

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

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

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

2.2. Cable lengths shall be considered in such ways that straight through cable joints are avoided.

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

2.4. If cables are to be laid over ground (eg on RCC/concrete pedestals etc), the cables shall be UV- resistant supported by test reports.

2.5 CONDUCTOR

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

2.6 INSULATION

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

circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

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

2.7 ARMOUR

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

Calculatednominaldia.ofcableunderarmour	SizeandTypeofarmour
Upto 13 mm	1.4mmdia GS wire
Above13 &upto25mm	0.8mm thick GSformed wire/ 1.6mm diaGS wire
Above25 &upto 40 mm	0.8mmthick GS formedwire/ 2.0mmdiaGS wire
Above40 &upto55mm	1.4mm thick GSformed wire/2.5mmdiaGS wire
Above55 &upto 70 mm	1.4mmthick GS formedwire/ 3.15mmdiaGS wire
Above70mm	1.4mmthick GS formedwire/ 4.0mm diaGS wire

2. The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264-ohm mm2 per meter at 20 deg C. The sizes of aluminum armoring shall be same as indicated above for galvanized steel.
3. The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wire / formed wire.

2.8 OUTERSHEATH

1. Outer sheath shall be of PVC as per IS: 5831 & black in colour for power cables. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.
2. Oxygen index of min. 29 (as per IS 10810 Part-58). Acid gas emission of max. 20% (as per IEC-754-I). Smoke density rating shall not be more than 60 % (as per ASTMD-2843).
3. In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.
    - Cable size and voltage grade - To be embossed
    - Word 'FRLS' at every 5 metre - To be embossed
    - Screen Fault current _ _ _KA for _ _ _ Sec. (Value of current & time shall be indicated) (If applicable)
    - Sequential marking of length of the cable in metres at every one metre -To be embossed / printed
4. The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.
5. All cables shall meet the fire resistance requirement as per IEEE - 383 with cable installations made in accordance with 'Flammability Test' and as per Category-B of IEC 332 Part -3.
6. Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum, over the declared value in the technical data sheets.
7. Repaired cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

3.0CABLE SELECTION & SIZING

Cables shall be sized based on the following considerations:

1. Rated current of the equipment
2. The Maximum Overall Voltage Drop: As per relevant clause in other chapters.
3. Short circuit withstand capability
4. Fault current- As per system fault current.
5. Time-As per protection time grading requirement subject to the minimum value mentioned at Cable sizing criteria of relevant chapter.

4.0DERATING FACTORS

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

1. Variation in ambient temperature for cables laid in air
2. Grouping of cables
3. Variation in ground temperature and soil thermal resistivity for buried cables.

5.0HT POWER CABLES

1. For single-core armored cables, the armouring may constitute the metallic part of insulation screening
2. In case of single core cables where there are both metallic screening and armouring, there shall be extruded inner sheath between them.
3. Distinct extruded PVC inner sheath of black colour as per IS:5831 shall be provided for the cables as follows:
   a. For all multicore cables.
   b. For single core armoured cables, where armouring is not being used as metallic screen.
4. Cores of the cables of upto 3 cores shall be identified by colouring of insulation or by providing coloured tapes helically over the cores with Red, Yellow & Blue colours.
5. The cross-sectional area of the metallic screen strip/tape shall be considered in design calculations.
6. The eccentricity shall be calculated as

Eccentricity	Ovality
tmax -tmin ---------- 100*t max*	dmax-dmin - ---------- 100*d max*
Wheret-max/t-minis themaximum/minimum thicknessof insulationand d-max/d-minis the maximum/minimumdiameterofthecore	

7. The eccentricity of the core shall not exceed 10% and ovality not to exceed 2%
8. Cables shall conform to IS: 7098 Part - II. These cables shall have mutli-stranded, compacted circular, aluminium conductors, XLPE insulated, metallic screened suitable for carrying the system earth fault current, PVC outer sheathed. The conductor screen and insulation screen shall both be

of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for cables shall be “dry curing / gas curing”.

9. The metallic screen of each core shall consist of copper tape with minimum overlap of 20%. However for single core armoured cables, the armouring shall constitute the metallic part of the screening.
10. The standard length for HT power cables shall be 1000 meter for all single core cables and 750 meters for 3 core cables. The length per drum shall be subjected to a maximum tolerance of +/- 5% of the standard drum length. The Employer shall have the option of rejecting cable drum with shorter lengths. One drum length of each cable size can be of non standard length (not less than 250 meter) so as to match the ordered quantity. For each size, the variance of total quantity, adding all the supplied drum lengths, from the ordered quantity, shall not exceed +/-2% and the payment shall be made based on the actual cable length supplied within this limit.

6.0LT POWER CABLES

1. LT Power & control cables shall be of minimum 1100 volts grade XLPE /PVC insulated conforming to IS 1554 / IS 7098 (Part-I) for utilization voltages less than equal to 415 V.
2. For cable connecting central inverter and inverter transformer, no. of runs and interconnecting trench, bus bar terminations, lugs shall be provided in such a manner so that no overheating of contacts & terminals encountered. Sufficient space for cabling & termination shall be kept.
3. The sizing of the cable will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let-out energy of the fuse. For breaker-controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.
4. Single core cables shall have no Inner sheath as per IS: 7098 Part-I
5. All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated.
6. 1.1 KV grade XLPE power cables shall have compacted aluminium/ copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), armoured/ unarmoured, PVC outer-sheathed conforming to IS:7098. (Part-I). Cables which are directly buried shall be armoured.
7. 1.1KV grade PVC power cables shall have aluminium/copper conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) armoured/ unarmoured, PVC outer-sheathed conforming to IS:1554 (Part-I).

7.0 LT CONTROL CABLES

1. Conductor of control cables shall be made of stranded, plain annealed copper.
2. Outer sheath shall be of PVC as per IS: 5831 & grey in colour for control cables.
3. Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:
    - core - Red, Black, Yellow or Blue
    - core- Red & Black
    - core-Red, Yellow & Blue
    - core-Red, Yellow, Blue and Black
4. For control cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The

numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.

5. Cable selection & sizing:

Control cables shall be sized based on the following considerations:

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

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

No.ofcores in cable	Min.No. ofspare cores
2C, 3C	NIL
5C	1
7C-12C	2
14C & above	3

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

8.0 TESTS

1. Indicative list of tests/checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of power and control cables enclosed at relevant section.
2. All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price. All cables to be supplied shall be of type tested design.
3. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
4. However, if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of LOA, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.

Sl	TypeTest	Remarks
	Conductor	
1.	Resistancetest	
	ForArmourWires/FormedWires	
2.	MeasurementofDimensions	
3.	TensileTest	
4.	Resistancetest	
5.	Wrappingtest	
6.	Torsiontest	ForGSroundwiresonly
7.	Elongationtest	ForGSwireonly
8(a)	Mass&uniformityofZincCoatingtests	ForGSwires/formedwiresonly.
8(b)	Adhesiontest	ForGSwires/formedwiresonly
	ForXLPEinsulation&PVCSheath	
9.	Testforthickness	
10.	Tensilestrengthandelongationtestbeforeageingand afterageing	
11.	Ageinginairoven	
12.	Shrinkagetest	
13	Hotsettest	ForXLPEinsulationonly
14	Waterabsorptiontest	ForXLPEinsulationonly
15.	Lossofmasstest	ForPVCoutersheathonly.
16.	Hotdeformationtest	ForPVCoutersheathonly.
17.	Heatshocktest	ForPVCoutersheathonly
18.	Thermalstabilitytest	ForPVCoutersheathonly
19.	Oxygenindextest	ForPVCoutersheath only
20.	Smokedensitytest	ForPVCoutersheathonly
21.	Acidgasgenerationtest	ForPVCoutersheathonly
22	FlammabilitytestasperIEC-332Part-3(Category-B)	Forcompletedcableonly
23	Insulationresistancetest(VolumeResistivitymethod)	
25.*	Partialdischargetest	For HT cables only
26.*	Bending test	
27.*	Dielectricpowerfactortest	
	a)Asafunctionofvoltage	
	b)Asafunctionoftemperature	
28.*	Heatingcycletest	
29.*	Impulsewithstandtest	
25.*	Partialdischargetest	
26.*	Bending test	
27.*	Dielectricpowerfactortest	

*Not applicable for 3.3/3.3kV grade cables.

9.0 CABLE DRUMS

1. Cables shall be supplied in wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. However, For Single core cables upto 6 Sq. mm size, supplier can do alternative packaging of whole Drum/Spool to eliminate

ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

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

B-5 CABLE INSTALLATION METHODOLOGY

1.0 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513Coldrolledlowcarbonsteelsheetsand strips.
IS:802CodeofpracticefortheuseofStructuralSteelinOverheadTransmissionLineTowers.
IS:1079HotRolledcarbonsteelsheet&strips
IS:1239Mildsteeltubes,tubularsandotherwroughtsteelfittings
IS:1255Codeofpracticeforinstallationandmaintenanceofpowercablesuptoandincluding33K V rating
IS:1367Part-13TechnicalsupplyconditionsforthreadedSteelfasteners.(Hotdipgalvanizedcoatingsonthreaded fasteners).
IS:2147Degreeof protectionprovided byenclosures forlow voltageswitchgear andcontrolgear
IS:2309CodeofPractice fortheprotectionofbuildingand alliedstructuresagainstlightning.
IS:2629Recommendedpractice forhotdipgalvanizingofiron&steel
IS:2633Method fortestinguniformityof coatingon zinc coated articles.
IS:3043Codeofpracticefor Earthing
IS:3063Fastenerssinglecoilrectangularsectionspringwashers.
IS:6745Methods fordeterminationofmass ofzinccoatingon zinc coatediron &steel articles.
IS:8308Compressiontypetubularin-lineconnectorsforaluminiumconductorsofinsulated cables
IS:8309Compressiontypetubularterminalendsforaluminiumconductorsofinsulatedcables.
IS:9537Conduitsforelectricalinstallation.
IS:9595Metal- arcweldingofcarbon andcarbon manganesesteels-recommendations.
IS:13573Jointsandterminationsforpolymericcablesforworkingvoltagesfrom6.6kvuptoand including33kv performancerequirements andtypetests.
BS:476Firetestson buildingmaterials and structures
IEEE:80 IEEE guidefor safetyinACsubstationgrounding
IEEE:142Groundingof Industrial&commercialpowersystems
DIN46267(Part-II) Non-tension proofcompressionjoints forAluminium conductors.
DIN46329Cablelugs forcompressionconnections,ring type,forAluminiumconductors
VDE0278Testsoncableterminationsandstraightthroughjoints
BS:6121SpecificationformechanicalCable glandsforelastomersandplasticinsulatedcables.
IndianElectricityAct.
IndianElectricityRules.
IEEE:80 IEEE guidefor safetyinACsubstationgrounding

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

2.0 DESIGN AND CONSTRUCTIONAL FEATURE

2.1 INTER PLANT CABLING

Interplant cabling for main routes shall be laid in Cable trenches/cable trays/buried/duct banks. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. All buried cables shall be of armoured type. Bidder can propose over ground cabling methodology (e.g. on RCC/concrete pedestals etc.). In such cases, the cables shall be UV-resistant supported by test reports.

2.2CABLE SIZING CONDITIONS

All cables shall be suitably derated as per the laying conditions for carrying the required load current and fault current. For derating, the ambient temperature for directly buried cables shall be taken as 40° C and 50° C for cables laid in air.

All XLPE cables shall be rated at 90° C conductor temperature for AC Voltage drop calculation and 80° C for DC Voltage calculation. However, for Voltage drop calculation in DC Cable, actual conductor temperature as per loading can be used.

2.3 TRENCHES

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

2.4GENERAL

1. The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.
2. Sizing criteria, derating factors for the cables shall be met as per respective chapters. However, for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.
3. Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:
   i. Meet all safety requirements
   ii. Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc

3.0EQUIPMENT DESCRIPTION

3.1 CABLE TRAYS, FITTINGS & ACCESSORIES

1. Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.
2. Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from

flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

3. Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.
4. Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

3.2 SUPPORT SYSTEM FOR CABLE TRAYS

Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make". Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

1. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
2. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fittings and accessories shall be prefabricated factory galvanized.
3. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer &aluminium paint shall be applied
4. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.
5. Support system shall be able to withstand
    i. weight of the cable trays
    ii. weight of the cables (75 Kg/Meter run of each cable tray)
    iii. Concentrated load of 75 Kg between every support span.
    iv. Factor of safety of minimum 1.5 shall be considered.

3.3PIPES, FITTINGS & ACCESSORIES

1. Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria
2. GI Pipes shall be of medium duty as per IS:1239
3. Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.
4. Hume pipes shall be NP3 type as per IS 458

3.4 JUNCTION BOXES

1. Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanized as

per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

2. Terminal blocks shall be 1100V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded copper conductors of size upto 2.5 sq mm each. All internal wiring shall be of minimum 1.5 sq. mm cu. Conductor PVC wire.

3.5 TERMINATIONS & STRAIGHT THROUGH JOINTS

1. Termination and jointing kits for 33kV, 11kV, 6.6 kV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 33kV, 11kV and 6.6 kV grade joints and terminations shall be type tested as per IS:13573. 3.3kV grade joints and terminations shall be type tested as per VDE0278. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solderless crimping type cable lugs & ferrule as per DIN standard.
2. Straight through joint and termination shall be capable of withstanding the fault level for the system.
3. 1.1 KV grade Straight Through Joint shall be of proven design.

3.6 CABLE GLANDS

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS:6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.

3.7 CABLE LUGS/FERRULES

Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipment. Cable lugs and ferrule shall conform to relevant standard

3.8 TREFOIL CLAMPS

Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.

3.9 CABLE CLAMPS & STRAPS

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

3.10 RECEPTACLES

Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped galvanized or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break,AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable mA sensitivity.

3.11GALVANIZING

1. Galvanizing of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots.
2. The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

3.12WELDING

The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595.

4.0INSTALLATION

4.1CABLE TRAY AND SUPPORT SYSTEM INSTALLATION

1. Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.
2. Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with relevant standard.
3. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.
4. The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval.
5. All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.
6. In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete

at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

4.2CONDUITS/PIPES/DUCTS INSTALLATION

1. The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/ roof/ wall/ cable tunnel/ cable trenches made for conduit installation shall be sealed and made water proof by the Contractor either with any proven fire sealing system rated for one hour or Modular multi-diameter cable sealing system consisting of frames, blocks, Compression wedge and its accessories. The Cable sealing system should have been tested for fire insulation for min. 1 hr as per BS 476 and shall also provide water sealing. System shall be anti- rodent and anti- termite.
2. GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.
3. Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.
4. Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise.

Conduit/pipesize(dia)	Spacing
Upto 40 mm	1M
50 mm	2 M
65-85mm	2.5M
100mmand above	3M

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

4.3JUNCTION BOXES INSTALLATION

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

4.4CABLE INSTALLATION

1. Cable installation shall be carried out as per IS:1255 and other applicable standards.
2. For Cable unloading, pulling etc following guidelines shall be followed in general :
3. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on

cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

4. While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.
5. Cables shall be laid on cable trays strictly in line with cable schedule
6. Power and control cables shall be laid on separate tiers in line with approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two meters. All multi core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with self-locking type nylon cable straps with de- interlocking facilities. For horizontal trays arrangements, multi core power cables and control cables shall be secured at every five-meter interval. For vertical tray arrangement, individual multi core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five-meter interval and at every bend.
7. Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.
8. Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.
9. No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.
10. In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
11. Wherever few cables are branching out from main trunk route troughs shall be used.
12. Wind loading shall be considered for designing support as well Cable trays wherever required.
13. Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.
14. The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

4.5SEPARATION

1. At least 300mm clearance shall be provided between:
    - HT power & LT power cables,
    - LT power & LT control/instrumentation cables,
2. At least 600mm clearance shall be provided between

- HT power and LT control/ instrumentation cables

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

No.ofcores in cable	No. ofsparecores
2C,3C	NIL
5C	1
7C-10C	2
14Cand above	3

4.6 DIRECTLY BURIED CABLES

1. Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255.
2. RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.
3. Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags
4. While crossing the floors, unarmored cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.

4.7CABLE TERMINATIONS & CONNECTIONS

1. The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.
2. Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.
3. The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

4. Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self-locking type nylon cable ties with de interlocking facility to keep them in position.
5. All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.
6. All cable terminations shall be appropriately tightened to ensure secure and reliable connections.MM

B-6 SCADA

1.0 GENERAL

1. Contractor shall provide complete SCADA system with all accessories, auxiliaries and associated equipment and cables for the safe, efficient and reliable operation of entire solar plant and its auxiliary systems.
2. Bidder shall include in his proposal all the Hardware, Software, Panels, Power Supply, HMI, Laser Printer, Gateway, Networking equipment and associated Cable etc. needed for the completeness even if the same are not specifically appearing in this specification.
3. SCADA System shall have the provision to perform the following functions:
   i. Remote control of all the HT Breakers either in hard or soft signal.
   ii. Remote control of Inverter active and reactive power as per requirement mentioned in respective chapter.
   iii. SCADA shall also be able to acquire, display and store real time data, status and alarm signal from following equipment included but not limited to as required or offered under the scope of this specification:
      a) All the HT Switchgear equipment
      b) Incomer and bus coupler breaker of LT Panel.
      c) Power conditioning unit (PCU)
      d) UPS and Battery charger as per requirement mentioned in respective chapter
      e) Weather Monitoring Equipment
      f) TEM/ABT/MFM meter, numerical relay, fire alarm panel, GPS time synchronization unit and transformer.
      g) SCADA Hardware, Accessories and Communication link
      h) Any other equipment required as per specification
   iv. Display of status of major equipment in Single Line/Mimic Diagram. Mimic Diagram colour shall comply to IS 11954: Guide for colour coding of electrical mimic diagrams
   v. Display and storage of derived/calculated/integrated values
   vi. Generate, store and retrieve user configurable periodic reports. SCADA shall have facility to generate report in MS Excel file type.
   vii. Remote monitoring of essential parameters of plant on the web using popular web browser without requirement of additional software. Same shall be authorised with user id and password using standard modem. User ID and password for remote view can only be changed by SCADA Administrator. Internet connection for transferring data to web shall be taken by Contractor in the name of MANIREDA Site for O & M period. Please refer relevant chapter for Nos. of Web Client Licenses for remote monitoring, Nos. of OWS/EWS/Historian with location.
   viii. Performing self-monitoring and diagnostic functions
4. The contractor shall provide at least one GPS clock, which shall be synchronized with the SCADA system. All devices having real-time clock (RTC) with time synchronization facility and are communicating with plant SCADA shall be synchronized with GPS Clock through SCADA or directly with GPS Clock. The technical details of GPS have been specified elsewhere in the specification.
5. Type of signal from equipment (Hard wired or Soft) shall be as per specification of the equipment mentioned in the respective chapter and approved during detail engineering.
6. SCADA shall provide real time performance monitoring according to IEC 61724 standard. In case of

conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail.

7. The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is affected. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit. On any of these failures the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalized during detailed engineering. System shall be designed such that there will be no upset when power is restored.
8. Contractor shall provide a Package/Split AC of suitable capacity decided by load requirement in SCADA Main control/CMCS room. All the power supply module, Ethernet switches and network accessories for non-airconditioned area shall be suitable for operating in ambient temperature of 50 Deg C minimum.
9. Power plant controller (PPC) shall be provided with two processors (main processing unit and memories), one for normal operation and one as hot standby. In case of failure of working PPC processor, there shall be an appropriate alarm and simultaneously the hot standby PPC processor shall take over the plant control function automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. It shall be possible to keep any of the PPC processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. The solar plant SCADA and PPC networks shall be suitably designed, so that PPC shall directly and independently able to control the individual solar inverter. Detailed control logic in the PPC shall be finalized during detailed engineering stage.

B-7 INSTRUMENTATION AND COMMUNICATION CABLE

1.0COMMUNICATION CABLE (OPTIC FIBRE CABLE)

1. Optic Fiber cable shall be 8/12 core, galvanized corrugated steel taped armored, fully water blocked with dielectric central member for outdoor /indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multimode fibers on as required basis so as to avoid the usage of any repeaters. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturing, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.
2. The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central number, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum & crush resistance 4000 N minimum. The operating temperature shall be -20 deg. C to 70 deg. C.
3. All testing of the optic fiber cable being supplied shall be as per the relevant IEC, EIA and other international standards.
4. Bidder to ensure that minimum 50% (but not less 4) cores are kept as spare in all types of optical fiber cables
5. Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground buried installation.
6. Spliced/ Repaired cables are not acceptable.
7. Penetration of water resistance and impact resistance shall be as per IEC standard.

1.1COMMUNICATION CABLE (MODBUS)

a) Data (Modbus) Cable to be used shall be shielded type with stranded copper conductor based on VDE 0881. Cable shall have minimum 2 pair each with conductor size of 0.5 SQMM and core identification shall comply with DIN 47100. Cable shall be flame retardant according to IEC 60332-1-2. or equivalent Standard Surge protection device to be provided shall be approved from UL/CSA or any national/international approved lab.

2.0INSTRUMENTATION CABLES

2.1COMMON REQUIREMENT

S No.	Property	Requirement
1.	Voltage grade	225V(peakvalue)
2.	Codesandstandard	All instrumentation cables shall complywith VDE 0815, VDE 0207, Part 4,Part5,Part6,VDE0816,VDE0472,SEN4241475,ANSIMC96.1,IS-8784, IS-10810(latest editions)andtheir amendmentsread alongwith this specification.
3.	Continuousoperation suitability	At70deg.Cforalltypesof cables

4.	Progressiveautomatic on-linesequential marking of length in meters	Tobeprovided ateveryonemeteron outer sheath.
5.	Markingtoread'FRLS	Tobeprovidedatevery5 meterson outer sheath
6.	AllowableToleranceo n overall diameter	+/-2mm (maximum)over thedeclaredvalue indata sheet
7.	Variationin diameter	Notmorethan1.0 mmthroughout thelength of cable.
8.	Ovalityat any cross-section	Not morethan 1.0 mm
9.	Others	a)Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs,voltagerating,typeofcable,yearofmanufacturertobeprovided. b)Cablesshallbesuitableforlayinginconduits,ducts,trenches,racks and underground-buried installation Repairedcablesshall notbeacceptable.
10.	Color	Theoutersheath shall beof blueBlue

2.2Specific Requirement

S No.	Property	Requirement
	Type of Cable	F and G Type cables
A. Conductors		
1.	Crosssectionarea	0.5 sq. mm
2.	Conductormaterial	HighconductivityAnnealed bare copper
3.	Colourcode	AsperVDE-815
4.	ConductorGrade	Electrolytic
5.	No &dia ofstrands	7x0.3mm(nom)
6.	No. of Pairs	4,8,12,16,24,48
7.	Max. conductor resistance per Km (in ohm) at 20 deg. C	73.4 (loop)
8.	ReferenceStandard	VDE0815
B. Insulation		
1.	Material	ExtrudedPVCtype YI3
2.	Thicknessinmm (Min/Nom/Max)	0.25/0.3/0.35
3.	VolumeResistivity(Min)inohm-cm	1x1014 at20 deg. C& 1x1011at 70deg. C.
4.	Reference	VDE0207Part 4
5.	Corediameteraboveinsulation	Suitableforcageclampconnector
C.Pairing& Twisting		
1.	Singlelayerofbindertapeoneachpairprovid ed	Yes
2.	Bunch(Unit formation)for morethan 4P	To be provided
3.	Conductor/pairidentificationasperVDE081	To be provided
D. Shielding		
1.	Typeofshielding	Al-Mylartape
2.	Individualpairshielding	Tobeprovided forF-typecabl

3.	MinimumthicknessofIndividualpair shielding	28 micron
4.	Overallcable assemblyshielding	To be provided
5.	Minimum thickness of Overall cable assembly shielding	55 micron
6.	Coverage Overlapping	100% coverage with 20% overlapping
7.	Drain wire provided for individual shield	Yes (for F-type)Size=0.5 mm2,No.ofstrands=7, Dia of strands =0.3 mm
8.	Drain wire provided for overall shield	Yes. Size=0.5 mm2, No.of strands=7,Dia of strands=0.3mm Annealed Tin coated copper
E. FILLERS		
1.	Non-hygroscopic,flame retardant	To be provided
F.Outer Sheath		
1.	Material	ExtrudedPVCcompoundYM1withFRLS properties
2.	MinimumThickness at anypoint	1.8 mm
3.	Nominal Thick-ness at anypoint	>1.8mm
4.	Resistanttowater,fungus, termite&rodent attack	Required
5.	MinimumOxygenindexasperASTMD-2863	29%
6.	MinimumTemperatureindexasperASTMD-2863	250 deg.C
7.	Maximumacidgasgenerationbyweightasper IEC-60754-1	20%
8.	Maximum Smoke Density Rating as per ASTMD-2843	Maximum60%
9.	Referencestandard	VDE207Part5,VDE-0816
G.ElectricalParameters		
1.	MutualCapacitanceBetweenConductors At 0.8Khz(Max.)	120nF/kmforFtype 100nF/kmforG-type
2.	InsulationResistance(Min.)	100MOhm/Km
3.	CrossTalkFigure(Min.)At0.8Khz	60dB
4.	Characteristic Impedance (Max) At 1 Khz	320 OHM FOR F-TYPE 340 OHM FOR G-TYPE
5.	Attenuation Figure At 1 Khz (Max)	1.2 db/km
H.CompleteCable		
1.	CompleteCableassembly	ShallpassSwedishChimneytestasper SEN-SS 4241475 class F3.
2.	Flammability	ShallpassflammabilityasperIEEE-383 read in conjunction to this specification
I.Tests		
1.	Routine&Acceptancetests	Refer Type Test requirement of Specification for C & I System
2.	Typetests	
JCableDrum		
1.	Type	Wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum.

2.	Outermostlayercoveredwith waterproof paper	Yes
3.	Painting	Entiresurfacetobepainted
4.	Length	1000m+5%forupto&including12pairs 500m+5%forabove12pairs

B-8 EARTHING SYSTEM

1.0GENERAL REQUIRMENTS

This specification is intended to outline the requirement of earthing (grounding) for Solar array (DC) side and AC Power block side of Solar PV Project. It is not the intent of the specification to specify all details of design and construction since the bidder has full responsibility for engineering and implementation of earthling system meeting the intent of the specification and functional requirement. Any additional equipment, material, services which are not specifically mentioned herein but are required for successful installation, testing and commissioning of earthling system for safe and satisfactory operation of the plant shall be included under scope of the bidder.

Electrical Resistivity Test (ERT) of the soil is included in the scope of bidder.

1.1 EARTHING DESIGN REQUIRMENT

1. The object of protective earthing system is to provide as nearly as possible a surface under and around a station which shall be at a uniform potential and as nearly zero or absolute earth potential as possible. The purpose of this is to ensure that, in general, all parts of apparatus other than live parts, shall be at earth potential, as well as to ensure that operators and attendants shall be at earth potential at all times. Also, by providing such an earth surface of uniform potential under and surrounding the station, there can exist no difference of potential in a short distance big enough to shock or injure an attendant when short-circuits or other abnormal occurrences take place.
2. Care must be taken for equipment with functional earthing that its service is not disrupted due to undesired disturbances in protective earthing system.

1.2CODES AND STANDARD

1. The equipment/product furnished for earthing system shall meet the requirements of all the applicable relevant National/International codes and standards or their latest amendment Codes and Standards. Product certification has to be CE/UL/BIS/TUV or equivalent. The relevant codes and standard for earthing system are tabulated below.

IS: 3043	Codeofpracticefor Earthing.
IEEE: 80	IEEE guide for safety in AC substation grounding
IEEE: 837	Standard for qualifying permanent connections used in substation grounding
IS: 2309	Code of Practice for the protection of building and allied structures against lightning.
IS: 802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS: 2629	Recommended practice for hot dip galvanizing of iron & steel
IS: 2633	Method for testing uniformity of coating on zinc coated articles
IS: 513	Cold rolled low carbon steel sheets and strips
IS: 6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS 2062	HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL — SPECIFICATION
IS: 4736	Hot-dip Zinc coating for MS Tubes

IS: 458	Precast Concrete Pipes (With and Without Reinforcement)
UL-467	Grounding and Bonding Equipment
IEC 62561-7	Requirements for earthing enhancing compounds
	CEA regulations for electrical safety-2010
	Indian Electricity Rules/ Indian Electricity Act.

2. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (codes and standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the above standards/ codes as applicable.
3. The earthing system includes earth electrode, installation of earth electrode in suitable pit size, construction of earth pit with cover for the installation, connection of earth electrode with equipotential earth bus and connection of equipment to equipotential earth bus.

2.0 EARTH ELECTRODE

1. The earth electrode is in direct contact with the ground provides means for conducting earth current with ground. Earth Electrode material should have good electrical conductivity and mechanical strength and should not corrode in wide variety of soil conditions. For an effective earthing system, following type of vertical earth electrodes can be used.
   - MS Rods
   - Hot rolled, Medium or High Tensile Steel Rod as per IS 2062 of length not less than 3000 mm.
   - Copper Bonded Rods
2. High tensile-low carbon steel rod having diameter not less than 14/17 mm of Length 3000 mm to be selected based on earth fault current. The Rod shall comply with requirements of BS 4360 Grade 43A or EN10025:2-004 S275JR, molecularly bonded by 99.99% pure high conductivity copper on outer surface with copper coating thickness 250 micron or more in conformity to UL-467. Its surface shall be clean, free from mechanical defect and any visible oxide layer or foreign material.

2.1EARTHING ENHANCEMENT COMPOUND

A low resistance earth electrode system is important to provide a low impedance path for the better dissipation of lightning/fault currents, and to protect personnel and equipment by minimizing and equalizing voltage potential differences. Earthing (ground) enhancement materials shall be used to improve the ground electrode resistance. Earth enhancement material shall be a superior conductive material which improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.). It shall be tested and should conform to the requirements of IEC 62561-7.It shall have the following characteristics:

1. High conductivity, improves earth's absorbing power and humidity retention capability, non-corrosive in nature having low water solubility but highly hygroscopic.
2. Carbon based with min 95% of fixed carbon content premixed with corrosion resistant cement to have set properties. Cement shall not mix separately & shall not have Bentonite.
3. Resistivity of less than 0.2 ohms -meter.
4. It shall not depend on the continuous presence of water to maintain its conductivity and shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.
5. It shall not dissolve, decompose or leach out with time and shall be environmental friendly, suitable for soils of different resistivity and any kind of earth electrode.
   The Earth enhancement material shall be supplied in sealed, moisture proof bags, marked with

Manufacturer's name or trade name, quantity etc. The minimum quantity of earth enhancement compound to be used with each earth-pit shall be 25 Kg.

2.2EARTHING CONDUCTOR

Earthing conductor is the conductor for buried below the ground at the depth of 600 mm connecting earth pits to make interconnection of earth pit. To interconnect earth pits, following type of conductor can be used. Application of specific conductor and its size has been mentioned in relevant clause:

1. Galvanized Steel Flat (GS) Flat GS/GI Flat (Strip) conductor shall comply to IS 2026 with Galvanization of 85 Micron as per IS. Material shall be clean and free form mechanical defects.
2. Copper Clad Steel (CCS) Earthing Conductor
   - The Copper Bonded Steel Grounding Conductor shall be made of steel with the coating of 99.99% pure copper complying to ASTM B 869-96 and ASTM B 452-93 standards. Each strand of CCS shall have continuous, uniform coating and the conductor surface shall be smooth and free from mechanical defects.
3. MS Rod
   Hot rolled, Medium or High Tensile Steel Rod as per IS 2062 of length not less than 3000 mm and diameter of 40 mm.

2.3 EARTHING TECHNICAL AND INSTALLATION REQUIREMENT

Careful consideration should be given to installing an earthing system that meet or exceed statutory requirements. Contractor shall select certified product and ensure good workmanship for installation for satisfactory performance to fulfill the designed parameters all the times. Following care shall be taken while installation of earthing.

1. Metallic frame/ structure of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed as per requirement mentioned elsewhere in the specification. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable. Metallic column for Inverter/Switchgear shelter/E-house shall be earthed with two distinct connections at minimum two column. All the wall cladding section shall be earthed at minimum two location with flexible copper cable of not less than 50 sq. mm.
2. Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground.
3. Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.
4. The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.
5. Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti-corrosive paint/compound.
6. Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.
7. Connections between equipment earthing leads and between main earthing conductors shall be

of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding. Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

8. Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.
9. Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.
10. A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same. Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.
11. Earth pit shall be constructed as per IS:3043. Electrodes shall be embedded preferably below permanent moisture level. Minimum spacing between electrodes shall be 600mm.
12. Earth pits shall be treated with earth enhancement compound if resistivity is more than 20 ohm meter.
13. On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.
14. Contractor shall obtain all necessary statutory approvals for the earthing system before charging of the plant and electrical equipment.

3.0 TECHNICAL DETAILS FOR AC EARTHING SYSTEM

1. This section outlines the requirements of protective and functional earthing system to discharge AC fault current to earth and provide equipotential bonding for Transformer, HT and LT Switchgear Panel and other similar electrical equipment, Transformer neutral and shield.
2. The Contractor shall furnish the detailed design and calculations as per IEEE 80/IS 3043 for Employer's approval for equipment earthing.
   a) Conductors above ground level and in built up trenches -Galvanized steel
   b) Conductors buried in earth -Mild steel rod of 40 mm dia (Any alternate proposal by bidder shall be reviewed and decided during detailed engineering based on requirement)
   c) Earth electrodes - Mild steel rod of diameter 40mm or Copper bonded steel rod of dia not less than 17 mm
   d) Life Expectancy - 25 years
   e) Fault Level - Mentioned Elsewhere
   f) Min. Steel corrosion - As per IS 3043
   g) Soil Restivity -Actual as per site condition

The sizes of earthing conductors for various electrical equipment shall be as below:

S No.	Equipment	EarthConductor buried in Earth	Earthconductoraboveground level and in built up trenches
1	33kV/11kV/6.6kV/3.3kV/switchgear equipment and 415V switchgear	--	65x8mmGS flat
2	415VMCC/Distribution boards / Transformers	--	50x6mmGS flat
3	LTMotors above125KW	--	50x6mmGS flat

4	LTMotors 25 KW to 125 KW	--	25x6mmGS flat
5	LTMotors 1KW to25KW	--	25x3mmGS flat
6	FractionalHorsepowermotor	--	8 SWG GS wire
7	Controlpanel&controldesk	--	25x25x3mmGSflat/25sqmmCucable
8	Pushbuttonstation/Junction Box	--	8 SWGGIwire
9	Columns,structures,cabletraysand bus ducts enclosures	--	50x6mmGS flat
10	Crane, rails, rail tracks & Othernon-currentcarrying metal parts	--	25x6mmGS flat

3. Contractor shall ensure there at least two earth pits each dedicated for earthing of each Transformer, HT/LT Switchgear panel, transformer neutral, Battery Charger/UPS/Control Panel etc. shall be provided. Earth electrode shall be located near to the equipment and all earth electrodes shall be interconnected with parallel conductor buried in earth surrounding the equipment.
4. Earthing system of different locations such as Inverter room/Pooling Switchgear/Sub pooling switchgear/Inverter shelter etc. shall be interconnected in single network of earthing with buried conductor of the size 65X8 MS Flat laid at 600 mm depth (if specifically required to achieve the earth resistance value within the acceptable limit based on the soil property of site). Contractor shall submit the calculation based on the system of earth conductor and electrode connected in single network. Location and manner of interconnection shall be approved during detail engineering.
6. For functional earthing of electronic component such as SCADA, contractor shall provide 1 no. (Min) isolated earth electrode near to the equipment connected with 2 run of copper cable of size not less than 25 sqmm. Contractor shall comply to the recommendation of OEM (Original Equipment Manufacturer) for electronic earthing and electrode can be connected with other earth electrode as per recommendation of OEM.
7. Each inverter duty transformer having shield between HV and LV winding shall be provided with 2 nos. Isolated earth electrode connected with each other for functional earthing of transformer shield. Each electrode shall be connected with transformer shield with separate 25X6 Cu flat.

4.0 TECHNICAL DETAIL SOLAR ARRAY (DC) EARTHING

1. This section outlines the earthing requirement for discharging DC fault current to earth of Solar PV plant and provide equipotential bonding for Module Mounting Structure (MMS), SCB Mounting structure, Module Frames etc.
2. System Requirement for the solar array DC earthing:
   a. Conductors buried in earth -GS Flat or CCS
   b. Conductors above ground level -GS Flat or CCS
   c. Earth Electrode -32 mm or higher dia MS Rod or Copper bonded Steel rod of dia. not less than 14 mm
   d. Life Expectancy -25 Years
   e. System fault level -5 KA for 1 Sec.
   f. Soil resistivity -Actual as per site conditions
   g. Min. Steel corrosion -As per IS 3043
3. Each Module mounting structure (MMS), SPV Module frames, mounting arrangement for String Combiner boxes, Metallic Junction Boxes, Metal frames/Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system for solar array shall consist interconnected earth pits electrodes connected by 25X6 GS flat (Min.) or Copper Clad Steel (CCS) earthing Conductor of size not less than 120 SQMM laid at the depth of 600 MM below the ground. Minimum size of riser conductor to connect the structures to buried earthing conductor and structure to structure in the solar farm shall be 25X3 GS Flat or

CCS of Min. 70 SQ MM size.

4. Periphery fencing wherever provided shall be earthed at every 100-meter interval with 25X3 GS flat connected with DC or AC side nearest buried earthing conductor.
5. Earthing conductor for connection to structure and equipment may be kept on the ground below MMS. However, these conductors shall be laid 300 mm below the ground along the pathway and/or crossing the pathway.
6. Equipment and structure in the solar farm shall be earthed in compliance to the IS: 3043 (Code of Practice for Earthing) and Indian Electricity Rules/Acts.
7. The Contractor shall furnish the detailed design and calculations for Owner's approval as per IS 3043 to determine the number of earth pit and size of earth conductor. However, the no. of earth pit electrodes for the DC earthing shall be as per chapter 3-B: Electrical Scope and Supply &Services
8. Buried earth conductor shall be laid all around periphery of solar array farm. GS flat above the ground for structure earthing shall be connected to the nearest buried conductor or electrode. All the earth electrodes shall be interconnected in single network/mesh and no electrode or group of electrodes shall be isolated/islanded. These electrodes shall be uniformly distributed in the solar farm at maximum practical extent and location of earth electrode shall be approved during detail engineering. A continuous earth path is to be maintained throughout the PV array.
9. Connection of DC earthing system and AC earthing system with location and manner of connection shall be approved during detail engineering. Contractor shall submit the design calculation of earthing system of AC and DC side as standalone (no interconnection) system.
10. Connection of riser to the structures shall be bolted or welded type. Portion of galvanized structure which undergoes welding at site shall be coated with two coats of cold galvanizing and anti-corrosion paint afterwards.
11. Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection, welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.
12. Each PV Module frame shall be earthed in accordance with module manufacturer guidelines. In case module frame earthing is to be separately provided, it shall be earthed with minimum 2.5 SQMM flexible copper cables with lug at suitable location of module frame. Nos. of PV modules in single loop of earthing connection to module frame shall be as per Module manufacturer recommendation. Both ends of the loop of copper cable for earthing shall be connected with nearest earthed structure or earth conductor.
13. Contractor shall seek owner's approval for connecting solar array earth mesh with any other earth mat/earth grid of the solar PV plant.
14. Size of earth conductor, nos. of earth pits given in this clause is applicable for solar array earthing only. Relevant method and practice of laying of earthing conductor, earth pits and riser not mentioned herewith but given elsewhere in this specification is applicable to solar array earthing also.
15. Inverter functional earthing (Negative earthing, Anti PID Earthing) shall be carried out as per guideline of OEM. Contractor shall submit complete detail of such earthing from OEM and implement the earthing accordingly.

5.0 EARTHING SCHEME FOR FLOATING SOLAR SYSTEM

Bidder shall propose earthing scheme for Floating solar arrays and other floating equipment along with necessary design calculations during detailed engineering as per system requirements and applicable standards. The same will be reviewed by MANIREDA.

B-9 PLANT ILLUMINATION SYSTEM

1.0 GENERAL

This chapter covers supply and installation of suitable illumination system along the approach roads to inverter room and inverter room(s), transformer yard and other facilities inside the plant.

2.0 DESIGN PHILOSOPHY

A comprehensive illumination system shall be provided in the entire project. Each building shall be provided with adequate light fittings,6A/16A socket, fans, etc. Exhaust fans shall also be provided in toilets, battery room, etc.
All outdoor lighting system shall be automatically controlled by synchronous timer or photocell.
Provision to bypass the timer or photocell shall be provided in the panel.

3.0LIGHTING SYSTEM DESCRIPTION FOR CMCS AND INVERTER ROOM

1. Normal AC Lighting System: AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels Control Board (LPs) which in turn will be fed from the lighting distribution boards (LDBs) of AC Switch board MCC.
2. Emergency AC Lightning System: The emergency lighting system consisting of 20% of the lights shall be fed from UPS DB or DCDB as per scheme adopted by the EPC bidder. Load of the same has to be considered for UPS/ Battery and charger sizing. Bidder shall provide indoor and outdoor emergency lighting at each inverter room, CMCS, security room, floating platform and main gate.

4.0LIGHTING FIXTURE, LAMPS & ACCESSORIES

1. All lighting fixtures and accessories shall be designed for continuous operation for its life under atmospheric conditions existing at site.
2. AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of +/-10%, frequency variation of +/- 5% and combined voltage and frequency variation (absolute sum) of 10% DC lighting fixtures and accessories shall be suitable for operation on 220 V, with variation between 190 V & 240 V.
3. All lighting fixtures shall be complete with lamp(s), lamp holder(s), LED chip assembly, terminal blocks, clamps, locking arrangements, fixing brackets etc. Driver circuit/Control gears shall be provided as applicable / specified. The fixtures shall be fully wired upto terminal block. The internal wiring of the fixtures shall be done with suitable low smoke halogen free thermo-plastic or silicon rubber insulated or fire-retardant PTFE copper conductor wires of suitable size and type. Further fuse protection of suitable rating in input side shall also be provided specifically for LED luminaires. However, the normal cross section of conductor shall be not less than 0.5 Sq. mm and minimum thickness of insulation shall be 0.6 mm. The wiring shall be capable of withstanding the maximum temperature to which it will be subjected under specified service conditions without deterioration and affecting the safety of the luminaire when installed and connected to the supply. All fixing /locking screws, washers, nuts, brackets, studs etc, shall be zinc plated and passivated.
4. All lighting fixtures shall be provided with an external, brass/GI earthing terminal suitable for connecting 14 SWG, GI earthing wire. All metal or metal enclosed parts of the housing and accessories shall be bonded and connected to the earthing terminal as so to ensure satisfactory earthing continuity throughout the fixture.
5. The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.
6. The reflectors shall be manufactured from CRCA sheet steel or Aluminium as specified. The aluminium reflectors shall be made of high purity aluminium sheet, polished electrochemically

brightened and anodized or proven alternate arrangement of anodizing.

7. Starters shall have bi-metal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without use of any tool. Starter shall have brass contacts and radio interference suppressing capacitor.
8. LED luminaires body shall such designed that heat sink/heat dissipating housing shall be mounted outside the overall luminaires fixture housing, and shall be suitably clearing the driver circuit. Further for outdoor type LED luminaires, the exposed heat sink shall be suitably designed to avoid dust/foreign particles accumulation on the same.
9. LED luminaires housing/body shall be pressure die cast aluminium or extruded Aluminium or CRCA as specified alongwith finished powder coating. Care shall be taken in the design that there is no water stagnation anywhere.

5.0 JUNCTION BOXES, CONDUITS, FITTING & ACCESSORIES

1. Junction box for indoor lighting shall be made of fire-retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type.
2. Junction boxes for street lighting poles and lighting mast if applicable , shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55.
3. All switches and receptacles upto 16A shall be modular type. These shall be provided with pre- galvanized/galvanized modular switchbox & plate.
4. Conduits, Pipes and Accessories:
5. Heavy duty PVC conduits conforming to IS: 9537 Part-III along with various accessories shall be used for indoor wiring in the buildings. These conduits shall be concealed in the wall/floor/roof. However, in PEB's, conduits can be fixed on surface.
6. Pull out boxes shall be provided at suitable interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, etc. Pull-out boxes shall have cover with screw. Pull out boxes used outdoor shall be weather proof type suitable for IP: 55 degree of protection and those used indoor shall be suitable for IP: 4X degree of protection.

6.0 LIGHTING WIRE

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

7.0 LIGHTING POLES

The Street Light/High Mast Tower system and peripheral lighting shall be designed generally in line with design guidelines. Height of the poles should be chosen so as not to affect working of Solar panels. The poles shall be hot- dip galvanized as per relevant IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole.

The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB. Lighting shall be provided along boundary/periphery and at roads connecting Boundary Gate to strategic locations like CMCS, and floating platform.

Hot dipped Galvanized hexagonal/Octagonal lighting pole with inbuilt JB shall also be acceptable

8.0 EARTHING

Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the

ends.

B-10 AUXILIARY POWER SUPPLY SYSTEM

1.0GENERAL

1. Auxiliary power supply arrangement shall be in line with tender indicative AC SLD. Each Inverter Room/local pooling /CMCS room shall have its own auxiliary power supply system comprising of AC distribution board (ACDB) which shall be fed from LV side of Inverter transformer through suitably rated auxiliary transformers. Alternately, auxiliary transformer directly feed from 33kV switchgear are also acceptable. Following consideration shall be taken while arriving kVA capacity of auxiliary transformer,20 % future load margin.
2. All non-critical auxiliary loads shall be fed directly from ACDB. However, emergency, and important load shall be fed from suitable sized Uninterrupted Power Supply (UPS) or Battery system. Input AC supply for Uninterrupted Power Supply (UPS) and Battery Charger shall be fed from ACDB. Bidder shall consider the following one of the supply options for feeding different equipment loads:

SlNo	EquipmentName	Option-1 ACDB	Option-2 UPSAC	Option-3 BatteryDC
1	SCADAincludingremoteRTU/IOpanel		✓	✓
2	SCADAHMI		✓	✓
3	Datalogger		✓	✓
4	FireDetection/Alarm Panel		✓	✓
5	EmergencyLighting		✓	✓
6	CCTV(ifapplicable)		✓	✓
7	HMIofSCADA		✓	✓
8	Inverter's Auxiliarysupply(if applicable)		✓	✓
9	EnergyMeter/MFM		✓	✓
10	Suband LocalPoolingSwitchgearcontrol& protection		✓	✓
11	MainPoolingSwitchgear (CMCS)control& protection			✓
12	Switchgearspringchargingmotor		✓	✓
13	switchgearspace heater	✓		
14	Illumination,Fansupplyetc	✓		
15	Modulewashingsystem	✓		
16	Othernon-criticalauxiliaryloads	✓		

3. UPS system shall comprise of 2 x 100% UPS with 30 minutes backup for each. Each UPS shall consist of 1x100% charger and inverter, 1 x 100% Battery bank for providing required backup as above. Bypass Line static switch, manual bypass switch, 1 x 100% UPSDB, and other necessary Protective devices and accessories. In place of UPS, bidder can provide DC supply system (1 x 100% Battery with Charger system for inverter stations/sub-pooling systems and 2x 100% system for CMCS) with backup as indicated as above, if the auxiliary power supply requirement of the loads is in DC.
4. Each Battery with charger system shall consist of 1 x 100% charger and 1 x 100% Battery bank for required back up and 1 x 100% DCDB, and other necessary protective devices and accessories. DC supply system voltage shall be 12V or above upto 220V DC.
5. The rated AC output capacity shall be taken for UPS battery size calculation. However, the

minimum UPS rating shall be 2KVA and the battery sizing shall be calculated on a minimum load of 1 KW (DC) for required backup. All UPS having rating 5KVA or more shall have three phase input.

6. The Bidder can provide alternate arrangement with suitable redundancies such as power pack with required backup for switchgears located at local pooling/inverter station.
7. Solar Plant Main Pooling Switchgear shall be powered from 2X100% DC supply system. Each DC supply system shall consist of 1x100% charger, 1 x 100% station Battery bank rated 110V/220VDC (+10%,-20%) for providing minimum 30 minutes backup and DC switchgear. In case UPS fed from above DC supply system, in that case separate DC system for UPS is not required.
8. Bidder shall submit configuration diagram, power supply distribution scheme, single line diagram and data sheets, all calculations such as Rectifier Modules/UPS Charger/Inverter rating calculations, battery sizing calculation etc. for UPS, Battery Charger & Battery system during detailed engineering stage for employer's review and approval.
9. Size and rating of UPS, Battery Charger and Battery shall be finalized during details engineering stage. Following shall be considered for sizing calculation;
   i. UPS load power factor shall be taken as 0.8 lagging.
   ii. UPS efficiency shall be taken as per actual.
   iii. UPS and charger design margin shall be taken 10% at 50 deg C.
   iv. IEEE-485 standard shall be followed for sizing calculation of Lead Acid Batteries and IEEE- 1115 standard shall be followed for sizing calculation of Nickel-Cadmium batteries.
   v. For Battery sizing calculation, lowest electrolyte temperature shall be taken as 5 deg C morethan the minimum ambient temperature or 15 deg cel whichever is lower, with Temperature correction factors as per relevant standards.
   vi. Batteries aging factor shall be taken as 1.25 and design margin factor shall be taken as 1.10.

2.0 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

1. The UPS shall have an overload capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 seconds. The overall efficiency of UPS shall be at least 80% on full load.
2. The UPS system shall be capable of operating without D.C. battery in circuit under all conditions of load and the performance of various components of UPS like inverter, charger, static switch etc. shall be guaranteed without the battery in circuit.
3. For UPS capacity 5 kVA or more, in addition to indications/display on UPS panel, important alarms along with important analog signal shall also be provided for use in SCADA. For UPS capacity less than 5 kVA bidder shall provide status, common alarm, and trip DI (soft or hard) signal to SCADA
4. The UPS chargers shall be self-regulating, solid state silicon controlled, full-wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates. The charger should be capable to fully charge the required batteries as well as supply the full rated load through inverter. The charger shall be able to re-charge the fully discharge battery within 8 hours. The charger shall be design for input supply variation of ± 10% and frequency variation of ± 5%. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. The detailed specification for the battery charger for UPS rating of 5kVA and above has been mentioned in the battery charger section below in this specification.
5. The UPS inverter shall be of continuous duty, solid state type using proven Pulse Width Modulation (PWM)/Quasi square wave/step wave technique. Ferro-resonant types Inverters

are not acceptable. The nominal voltage output shall be 230 Volts single phase, 50 Hz. The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, etc. The total harmonic content shall be 5% maximum and content of any single harmonic shall be 3% maximum.

6. The static switch shall be provided to perform the function of transferring UPS loads automatically without any break from faulty inverter to standby AC source. Manual bypass switch shall be employed for isolating the UPS during maintenance.
7. Contractor has the option of supplying either Nickel Cadmium type batteries or Lead Acid Plante type batteries. The detailed specification for the batteries has been mentioned in the battery and charger section below in this specification.
8. Equipment enclosures shall match and line up in assemblies of freestanding floor mounted cabinets designed for indoor service.
9. Individual enclosure shall be ventilated switchboard type fabricated from not less than 1.6-mm thick sheet steel. Enclosures shall be furnished with concealed hinges. Front and rear doors shall be designed to permit easy access to all components for maintenance or replacement. The enclosures shall be reinforced with formed steel members as required to form a rigid self-supporting structure. Doors shall have three-point latches.
10. UPS and Battery Bank should be kept in separate enclosures. Adequate ventilating louvers and enclosure top panels shall be included. All vent openings shall be covered with corrosion resistant fine screen coverings. The location and enclosures of UPS and Battery banks shall be finalized during detail Engineering after approval from MANIREDA.
11. The cabinets shall be IP-42 protection class for indoor application and IP55 or better for outdoor application.
12. The temperature rise inside all the cabinets/enclosures shall not exceed 10 deg.C above ambient temperature.
13. The Contractor shall also carry out the site tests on UPS as required to be conducted as a standard practice of the UPS manufacture or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer.
14. One set of tools shall be provided for maintenance and testing purposes.

3.0 BATTERY CHARGER

1. The chargers shall be self-regulating, solid state silicon controlled, full-wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates, effective current limiting features and filters to minimize harmonics. The charger should be capable to fully charge the required batteries as well as supply the full rated load. Furthermore, the charger should be able to re-charge the fully discharged battery within 8 hours. The charger shall be current limited for charger circuit protectionand protection of battery from overcharge shall also be provided. The current limit shall becontinuously adjustable. The chargers shall have a slow walk-in circuit. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. The charger shall be design for input supply voltage variation of ± 10% and frequency variation of ± 5%.
2. Battery Chargers shall have a selector switch for selecting the battery charging mode i.e. whether trickle or Boost charging.
3. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. Means shall be provided to avoid current/ voltage surges of harmful magnitude/nature which may arise during changeover from Auto to Manual mode or vice-versa under normal operating condition.

4. Soft start feature shall be provided to build up the voltage to the set value slowly. The chargers shall have load limiters which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall neither damage the Charger nor shall it cause blowing of any of the charger fuses. The Charger shall not trip on overload or external short circuit. After clearance of fault, the Charger voltage shall build up automatically when working in automatic mode.
5. When on automatic control mode during Trickle charging, the Charger output voltage shall remain within +/-1% of the set value for AC input voltage variation of +/-10%, frequency variation of +3/- 5%, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from zero to full load. Uniform and step-less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire Trickle charging output range specified & shall be capable of matching the float voltage correction recommendations (w.r.t. temperature) as suggested by the respective battery manufacturer. Step-less adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Trickle charging mode.
6. During Boost charging, the Battery Chargers shall operate on constant current mode (When automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. Thecharger output voltage shall automatically go on rising, when it is operating on boost mode, as thebattery charges up. For limiting the output voltage of the charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for boost charging mode. All voltage and current setting potentiometers shall be Vernier type.
7. Energizing the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilize, to within the specified limits as mentioned elsewhere, shall be less than fifteen seconds.
8. Momentary output voltage of the Charger, without the Battery connected shall be within 94% to 106% of the voltage setting during sudden load Change from 100% to 20% of full load or vice- versa. Output voltage shall return to, and remain, within the limits specified as mentioned elsewhere in less than 2 seconds after the above-mentioned change.
9. Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 1% irrespective of the DC load, even when they are not connected to a battery.
10. The DC System shall be ungrounded and float with respect to the ground potential when healthy. An earth fault relay shall be provided by the bidder in the DC distribution board for remote annunciation.
11. Digital Outputs shall be configured for connection to the SCADA for real-time charger status updating. Outputs like charger output current, output voltage, float/boost mode, etc may be configured to provide the update to SCADA.
12. The Battery Chargers as well as their automatic regulators shall be of static type. The Chargers shall be designed to operate, as mentioned above, at an ambient air temperature of 50°C.
13. For Lead Acid plante battery: -Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC lead-acid Batteries while supplying the D.C. loads. The Batteries shall be Trickle charged at 2.25 Volts per cell. All chargers shall also be capable of Boost charging the associated D.C. Battery at 2.3 to 2.7 Volts per cell at the desired rate.
14. For Nickel-Cadmium battery:-Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC Nickel-Cadmium

Batteries while supplying the D.C. loads. The Batteries shall be Trickle charged at 1.4 to 1.42 Voltsper cell. All chargers shall be capable of Boost Charging the associated D.C. Battery at 1.54 to 1.7 Volts per cell at the desired rate.

15. All Battery Chargers shall have an AC contactor on the input side. It shall be of air break type and suitable for continuous duty. A thermal overload relay incorporating a distinct single phasing protection (using differential movement of bimetal strips) shall also be provided for the AC input. The relay shall trip the above contactor.
16. The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger.
17. Digital or analog indicating instruments shall indicate DC current, DC voltage & AC voltage.
18. The Chargers shall be indoor, floor mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Charger shall be fabricated using cold rolled sheet steel shall not be less than 1.6 mm and shall have folded type of construction. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. Removable undrilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be supplied by the Contractor. The Charger shall be tropicalized and vermin proof. Ventilation louvers shall be backed with fine brass wire mesh.
19. All doors and covers shall be fitted with synthetic rubber gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed.
20. Treatment as per IS: 6005. Two coats of lead oxide primer followed by powder painting with final shade of RAL9002 for complete panel except end covers & RAL 5012 for end covers.
21. All acceptance and routine tests as per the manufacture recommendations and relevant standards shall be carried out.
22. The cabinets shall be IP-42 protection class for indoor application and IP55 or better for outdoor application.
23. The Contractor shall also carry out the site tests on battery charger systems required to be conducted as a standard practice of the UPS manufacture or deemed necessary by the Employer and mutually agreed between the Contractor and the Employer.

4.0 BATTERY:

Bidder shall propose Battery chemistry for Auxiliary services along with necessary design calculations during detailed engineering as per system requirements and applicable standards. The same will be reviewed by MANIREDA.

B-11 LIGHTNING PROTECTION SYSTEM

1.0 GENERAL REQUIRMENTS

This specification is intended to outline the requirement of external lightning protection (ELP/Lightning protection) for Solar array (DC) side and AC Power block side of Solar PV Project. It is not the intent of the specification to specify all details of design and construction since the bidder has full responsibility for engineering and implementation of external lightning protection system meeting the intent of the specification and functional requirement. Any additional equipment, material, services which are not specifically mentioned herein but are required for successful installation, testing and commissioning of earthling system for safe and satisfactory operation of the plant shall be included under scope of the bidder.

1.1 LIGHTNING PROTECTION DESIGN REQUIRMENT

The object of a lightning protection system is to protect buildings/structure and equipment from direct lightning strikes, potential fire as well as the effects of injected lightning currents (non-incentive flash). It consists of termination systems for direct lightning, down conductors and an earth-termination system.

Care must be taken for while designing the lightning protection that surges are prevented in the electrical system to reduce failure of electrical and electronic equipment.

1.2 CODES AND STANDARD

The equipment/product furnished for earthing system shall meet the requirements of all the applicable relevant National/International codes and standards or their latest amendment Codes and Standards. Product certification has to be CE/UL/BIS/TUV or equivalent. The relevant codes and standard for earthing system are tabulated below.

IS/IEC62305	PROTECTIONAGAINST LIGHTNING
IEEE:80	IEEE guideforsafetyinACsubstation grounding
IEEE:837	Standardforqualifyingpermanentconnectionsusedinsubstationgrounding
IS 4759	Hot-dipgalvanizedsteelcoatingon structuralsteelandother elements
IS: 2629	Recommendedpractice forhotdip galvanizingof iron&steel
IS: 2633	Methodfortestinguniformityofcoatingonzinc coatedarticles
IS:513	Coldrolledlowcarbonsteelsheetsand strips
IS: 6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS 2062	Hot rolled medium and high tensile structural steel — specification
IS: 458	Precast Concrete Pipes (With and Without Reinforcement)
UL-467	Grounding and Bonding Equipment
IEC 62561-7	Requirements for earthing enhancing compounds
NFC 17 -102	Early streamer emission lightning protection systems
CEAregulationsforelectricalsafety-2010andlatestamendments*IndianElectricityRules/IndianElectricity Act.*	

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of

conflict between this specification and those (codes and standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the above standards/ codes as applicable.

The lightning protection system includes lightning terminal, Down conductor, test ink, earth electrode, installation of lightning terminal, down conductor and earth electrode in suitable pit size, construction of earth pit with cover for the installation, connection of earth electrode with lightning terminal.

Detail specification of earthing system has been mentioned elsewhere in the specification.

2.0 DOWN CONDUCTORS

1. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.
2. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.
3. All joints in the down conductors shall be welded type.
4. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.
5. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.
6. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.
7. Lightning conductors shall not pass through or run inside GI Conduits.
8. Testing link shall be made of galvanized steel of size 25x 6mm.
9. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths oxide layer or foreign material.

3.0 LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY

3.1Codes and Standards

- IS/IEC 62305: PROTECTION AGAINST LIGHTNING
- NF C 17-102: LIGHTNING PROTECTION WITH EARLY STREAMER AIR TERMINATION ROD

3.2 Complete Solar Array with associated structure shall be protected from Direct Lightning Stroke. Lightning Protection for solar array shall be achieved with any or both of the following two systems as per specification provided in the following section.

- Single Rod Air Terminal (Faraday Rods)
- Early Streamer Emission (ESE) Air Terminal

Suitable earthling and equipotential bonding shall be ensured for the lightning protection Air Terminal as per applicable standard/Equipment manufacturer guidelines.

Current carrying parts and accessories such as clamps, fasteners, down conductor, Test links and earth termination etc. shall be preferably procured from OEM of Air Terminals if it is supplied by them as part of lighting protection system.

3.3 LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY WITH E.S.E AIR TERMINAL

a. Solar array shall be protected from direct lightning stroke with Early Streamer Emission air terminal in accordance to NF C 17-102.

b. Number and location of ESE air terminal shall be decided during detail engineering. For this purpose, design calculation considering protection level IV (minimum) and Autocad drawing of the layout of ESE terminal shall be submitted to MANIREDA for approval.

c. ESE air terminal shall be type tested as per Annexure- C of NF C 17-102 (Latest Revision) in the manner as mentioned in the standard.

d. ESE Air terminal shall be supplied with test link, counter, down-conductor, Two earth pits, support mast and accessories required for completeness for ESE Lightning protection system.

e. Owner shall test ESE terminal (Each terminal/Sample basis) before installation with suitable instrument for functionality of terminal. Vendor shall replace the terminal free of cost if found defective.

f. Support mast for ESE Air terminal shall be heavy duty hot dip galvanized material and shall be suitable to withstand dynamic and static forces acting on it without failure. Foundation for the mast shall be M20 Grade concrete or better with minimum depth of 1200 MM.

4.0 LIGHTNING PROTECTION SYSTEM FOR BUILDING AND ENCLOSURE

1. Contractor shall provide lightning protection for Inverter room/shed/shelter/enclosure, main control room, Switchgear Room/shed/shelter and similar housing per IS/IEC 62305.
2. ESE Air Terminal shall not be used for lightning protection of Metering yard, if applicable.

5.0 LIGHTNING PROTECTION FOR FLOATING SOLAR SYSTEM

1. Bidder shall propose lightning protection scheme for Floating solar arrays and other floating equipment along with detailed calculations during detailed engineering as per system requirements and applicable standards. The same will be reviewed by MANIREDA.

B-12 METERING SYSTEM

1. Energy meter (0.2s accuracy class) suitable for ABT requirement with metering panel as required shall be conforming to CEA/SERC/STU/DISCOM requirement. The quantity of the energy meters shall be as per indicative tender SLD.
2. For measurement of Auxiliary power consumption, MFM in ACDB incomer shall be provided by the bidder.
3. Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment. Bidder shall synchronize the meter using GPS time synchronization equipment. All the hardware required for synchronization shall be in scope of bidder.
4. The ABT meters supplied under this contract shall also meet the requirement of respective State power Utilities.
5. This metering system shall have following features:
   a) Meters shall be microprocessor-based MWH meters having an accuracy class of 0.2S or better. MVARH meters shall have accuracy class of 0.5 or better.
   b) These meters shall have provision for downloading of data through an optical port and /or through RS 232/485 port.
   c) Even under absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.

FIVE YEARS MAINTENANCE & PERFORMANCE WARRANTY CONTRACT (MPWC)

1.0 The Maintenance and Performance Warranty Contract (MPWC):

a. After the works are awarded to the successful Bidder/Bidders, he/she/they enter into a Maintenance & Performance Warranty Contract (MPWC) with MANIREDA which includes the scope of operation and maintenance of the SPV Power Plants for a period of 5(five) years. The date of MPWC period shall begin from the date of actual commissioning of the Solar Power Plant which was commissioned last among all three solar power plants. The Maintenance & Performance Warranty Contract shall include servicing & replacement guarantee for parts and components (such as electronics, PCU/Inverter, etc.) of Solar Power Plants for 5 years from the date of commissioning. For PV modules, the guarantee should be of 25 years.

b. The Contractor should have trained person/s at Imphal for day today operation, troubleshooting, maintenance etc. at the SERVICE CENTRE for attending any fault as and when occurred.

c. The maintenance service provided shall ensure proper functioning of all the three Solar Power Plants as a whole. All preventive/routine maintenance and breakdown/corrective maintenance required for ensuring maximum uptime shall have to be provided by the Contractor. MANIREDA will provide the format of Maintenance sheet for submitting the Performance Report half yearly. The Contractor shall furnish a Performance Report duly attested by the Engineer concerned along with the hard copy/printout of performance data of the Plant for every (6 months) shall be submitted to MANIREDA half yearly within 15th day of following month during the MPWC period. The Maintenance and Performance Warrantee Contract (MPWC) shall have two distinct components as described below.

2.0 Preventive/Routine Maintenance:

2.1 This shall include activities such as, cleaning and checking the health of the Solar Power plants, cleaning of module surface, troubleshooting and maintenance of inverters, tightening of all electrical connections, changing of tilt angle of module mounting structure, and any other activity that may be required for proper functioning of the Solar Power Plants as a whole.

3.0 Breakdown/Corrective Maintenance:

3.1 Whenever a complaint is lodged by the consumer, the bidder shall attend to the same within a reasonable period of time 3 days and in any case the breakdown shall be corrected within a period not exceeding 7 days from the date of complaint.

3.2 The bidder shall maintain the following facilities at the local Service Centre for ensuring highest level of services to the end user:

(i) Adequately trained manpower, specifically trained by the bidder for carrying out the service activities.

(ii) Adequate provisions for record keeping, which shall inter-alia, include the following:

(a) Details of system supplied within the command area of the service station including full name and address of consumer, system and sub-system serial numbers and records of routine maintenance carried out (duly signed by the consumer). These records shall include voltage, current, specific gravity, inverter operation, electronics, etc.

(b) History record sheets of maintenance done.

(iii) Adequate spares and manpower for ensuring least down time of an individual system.

(iv) The Service Center shall send summary service reports to MANIREDA. These reports shall include the following information:

(a) Number/Type of components of the Plant covered by the Service Center.

(b) Number/Type of components/systems working satisfactorily on the reporting date.

(c) Number of complaints received during the period of reporting.

(d) Number of complaints attended during the period of reporting.

(e) Major cause of failure, as observed

(f) Major replacement made during the reporting period. Separate report shall be submitted for each type of systems manufacture wise in case the service center caters to the requirement of more than one manufacture

(g) Hard copy/printout of the daily performance data of the Plant for the last quarter.

3.3 The records maintained at the Service Center shall be available from time to time to MANIREDA.

3.4 The date of MPWC maintenance period shall begin on the date of actual commissioning of the Solar systems. If during the MPWC period, the Solar Power Plants becomes non-functional due to any defect or shortage of spares etc. for a period more than 1 week then the time duration of this non-functional period will be extended in the MPWC period.

3.5 Any payment for release of MPWC charges will not be entertained or put up to Higher Authority of MANIREDA without the Performance Report duly attested by the concerned MANIREDA Engineer.

3.6 Bidder shall furnish details of infrastructure that are available for establishing of Service Centers.

SECTION - III

FORMATS FOR BIDDING

Proforma – 1

Forwarding Letter

(The Forwarding Letter should be submitted on the Letter Head of the Bidding Company)

Ref No. …….…… Date. ……..

To,

The Director

Manipur Renewable Energy Development Agency (MANIREDA),

2nd Floor, South Block, Secured Office Complex, AT Line, Near Imphal Hotel, Imphal - 795001.

Sub: Offer in Response to Notice Inviting Bid No. ……. for:

Design, supply, installation and commissioning including integration to Grid of:

i. 600 kW Grid connected Solar Power Plant at 132/33 kV Elangkhangpokpi Power Sub-Station, Kakching District, Manipur.

ii. 800 kW Grid connected Solar Power Plant at 132/33 kV Kakching Power Sub-Station, Kakching District, Manipur.

iii. MW Grid connected Floating Solar Power Plant at Thoubal Multi-purpose Project Reservoir, near Chadong Village of Kamjong District, Manipur.

and 5 years Maintenance and Performance Warranty Contract (MPWC).

Sir,

With reference to the above we are submitting this offer after having fully read andunderstood the nature of the work and having carefully noted all the specifications, terms & conditions laid down in the bid document. This offer is hereby submitted in sealed envelopes duly marked as indicated below:

1. Technical Proposal submitted in original
2. Financial Proposal is submitted online in e-tender.

We also confirm that:

(i) We are an Indian company.

(ii)The components of SPV systems shall be indigenously manufactured.

(iii) We have never been debarred from executing similar type of work by any Central/ State/ Public Sector Undertaking/Department/Nodal Agency.

(iv) The Bid Document is downloaded from MANIREDA website and necessary document in support is enclosed.

(v) We shall execute the offer/work order as per specifications, terms & conditions of the Bid Document on award of work.

(vi) Our offer shall remain valid for placement of purchase orders up to 365 days from the due date of submission of offer.

(vii) If at any time, any of the declarations submitted by us is found to be false, our offer or order is liable to rejection.

Yours faithfully,

(Signature of Authorized Signatory)

Name : Designation

Company Seal :

Proforma – 2

Authorization Letter for attending Pre-Bid, Opening of Bid & Signing of Bid Document

(should be submitted on the Letter Head of the Bidding Company)

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 Date .../07/2025

To,
The Director
Manipur Renewable Energy Development Agency (MANIREDA),
2nd Floor, South Block, Secured Office Complex, AT Line, Near Hotel Imphal, Imphal-795001.

Sub: Authorization Letter for attending Pre-Bid Meeting, Bid Opening & Signing Bid Document.

I hereby authorize (Name & Designation) …….
to attend the Pre-Bid meeting, Bid Opening & signing of the Bid Document (tick wherever applicable or tick all three, if same person is responsible for all three) to be held on …… at ……
MANIREDA on behalf of our company.

He/She is also authorized to provide clarifications/confirmations, if any, and such clarifications/ confirmations shall be binding on the company. The specimen signature is attested below.

…….. ……

(Specimen Signature) (Signature of Authorized Signatory)
Name:..... Name:.....
Designation:…… Designation:…….....
Company Seal: :

Yours faithfully,
(Signature of Authorized Signatory)
Name :
Designation :

Proforma – 3

Information about the Bidding Firm

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 Date .../07/2025

Sr. No.	Description	Remarks
1	Name of the Bidder *(In case of JV/ Consortium, name of all the members to be indicated and lead member to be identified)*	
2	Status of the Firm	
3	Mailing Address of Registered Office	
4	Mailing Address of Operation Office	
5	E-mail	
6	Web site	
7	Authorized Contact Person(s) with Name, Designation, Address and Mobile Phone No., E- mail address / Fax No. to whom all references shallbe made	
8	Year of Incorporation	
9	Number of Years in Operation	
10	ISO Certifiation Yes/No	
11	Name of the Banker	
12	Branch Details of Bank	
13	Type of Account with Account Number	
14	IFSC Code	
15	Permanent Account Number (PAN) of the Bidder	*(Copy of PAN Card to be enclosed)*
16	GST ID (Proof to be submitted – GST No acknowledgement OR Email from GoI)	
17	GSTN Address	
18	PF Registration Number with Details	(Copy of Registration to be enclosed)
19	ESI Registration Number with Details	(Copy of Registration to be enclosed)
20	Have the Bidder/ MANIREDA ever been debarred by any Govt. Dept./ Undertaking for undertaking any work	Yes/No(IfanswerisYES,please provide details)
21	Reference of any document information attached by	

	the Bidder other than specified in the tender.	
22	Bidding Company is listed in India	Yes/No
23	Whether Company is MSME as on the bidding date	Yes/No

Yours faithfully,
(Signature of Authorized Signatory)

Name :
Designation :
Company seal :

(Separate sheet may be used for giving detailed information in seriatim duly signed. This bid proforma must be submitted duly signed in case separate sheet is submitted).

Proforma – 4

Details ofOrdersReceivedandExecuted inPastYears

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 Date .../07/2025

Details of Orders received &executed by the Company for Design, supply, installation and commissioning including integration to Grid of Floating Solar and Ground Mounted PV Power Plants to SNA/Govt. Organization/ Govt. Deptt. during past Years.

Sl. No.	Nameof Agency/ Organization	PurchaseOrder No., Date &	Nameofthe Work	Date of Completion

Yours faithfully,

(Signature of Authorized Signatory with Name Designation & Company Seal)

Note:

(a) Attach Photocopies of Purchase Orders

(b) Separate sheet may be used for giving detailed information in seriatim duly signed. This bid proforma must be submitted duly signed in case separate sheet is submitted

Proforma – 5

No Deviation Certificate

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 Date .../07/2025

To,
The Director
Manipur Renewable Energy Development Agency (MANIREDA),
2nd Floor, South Block, Secured Office Complex, AT Line, Near Imphal Hotel, Imphal-795001.

Dear Sir,

We understand that any deviation/exception in any form from our bid against the above-mentioned reference number may result in rejection of our bid. We, therefore, certify that we have not taken any exceptions/deviations anywhere in the bid and we agree that if any deviation is mentioned or noticed, our bid may be rejected.

Yours faithfully,

(Signature of Authorized Signatory)
Name:
Designation:
Company seal:

Note: This “No Deviation Certificate” should be written on the letter head of the bidder indicating BID No. duly signed and stamped with date by a person competent and having the power of attorney to bind the bidder.

Proforma – 6

Format for Guarantee Card to be Supplied with Solar Power Plant

(To be supplied by bidders on the official letter head of the company)

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 Date .../07/2025

GuaranteeCard

1.	Name&Addressof the Manufacturer/ SupplieroftheSystem		
2.	Name&Addressofthe PurchasingAgency		
3.	DateofSupplyof theSystem		
4.	DetailsofPVModule(s)Suppliedinthe System		
	(a)	Nameofthe Manufacturer	
	(b)	Make	
	(c)	Model	
	(d)	Serial No.	
	(e)	WattageofthePVModule(s) under	
	(f)	GuaranteeValidUpto	
5.	DetailsofPCU/Inverter&OtherBOSItems		
	(a)	Nameofthe Manufacturer	
	(b)	Make	
	(c)	Model	
	(d)	SerialNo(s).	
	(e)	Month &YearofManufacture	
	(f)	GuaranteeValidUpto	
6.	EnergyMeter/NetMeter		Particularsandits configuration TobeapprovedbyCEA, ii) Prior approval from MSPDCL and MANIREDA to be accorded
7.	Name,Designation,AddressandMobile NumberofthePersontobeContactedfor Claiming Guarantee Obligations		

Proforma – 7

PROFORMA OF APPLICATION FOR PAYMENT

(To be on the official letter head of the company)

NIB No. MANIREDA/SPP(NESIDS)/2024-25/48 Date .../07/2025

Unit Reference: Date:

NameofContractor:	ContractNo.:
ContractName:	
ApplicationSerialNumber:	ContractValue:

To,

The Director

Manipur Renewable Energy Development Agency (MANIREDA),

2nd Floor, South Block, Secured Office Complex, AT Line, Near Imphal Hotel, Imphal-795001.

Dear Sir,

APPLICATION FOR PAYMENT

Pursuant to the above referred Contract dated the undersigned hereby applies for payment of the sum of …….. (Specify amount and currency in which claim is made).

9. The above amount is on account of :[TICK whichever is applicable]
   - Initial advance
   - Interim Payment as advance
   - Progressive payment against dispatch of equipment
   - Progressive payment against receipt of equipment at site
   - Progressive payment against Erection/installation & commissioning/testing
   - Ocean freight & marine insurance
   - Inland transportation Inland insurance
   - Price adjustment
   - Extra work not specified in Contract
   - (Ref. Contract Change Order No…)
   - Other (specify)
   - Final payment

As detailed in the attached Schedule (S) which form an integral part of this application.

10. The payment claimed is as per item(s) No.(s) ……. of the payment schedule annexed to the above –mentioned Contract.
11. The application consists of this page, a summary of claim statement and the following signed schedule

    i) ……

    ii)…… iii) .....

    The following documents are also enclosed

    a) ……

    b)……..
    c)……

Signature of Contractor/ Authorised Signatory

Seal

Proforma – 8

MATERIALS INSPECTION CLEARANCE CERTIFICATE (MICC)

1. Name of the Work:
2. Name of the Firm/Contractor: : .....
3. Work Order No.: ..... dated .....
4. Shipment No.....
5. Date shipped: ,
6. Shipped From .....
7. Shipped To Imphal

SL. No.	Item Description	Qty./system	Invoice No.&date	Challan No.&date	Make	Unitprice	Amount	Remarks
1	2	3	4	5	6	7	8	9
1.(a)	SPV Module							
(b)	Module/array Structure							
(c)	Junction Box							
2.(a)	PCU/Inverter							
(b)	Electronics							
3.(a)	Chargecontrolling unit							
(b)	ACDB, DCDB							
4.(a)	Cable&Wire							
(b)	Earthingsystem, Lightningarrester							
(c)	Exhaust Fan, FireExtinguishers,SandBuckets,Sign Board.							
5.(a)	Manual							
(b)	Othersif any							

8. Enclosed documents: Packing List with model numbers, Invoice, Challan, Goods Consignment Note, Way Bill etc.
9. Inspected on: .....and ..... jointly by MANIREDA officials and representative of M/s
. and found okay.

Date:

Signature of authorized MANIREDA representative
Name:
Designation:

Proforma – 9

COMPLETIONCERTIFICATE(SolarPowerPlant)

1. NameoftheWork:

2. Name of Worksite/Location: :

3. NameoftheFirm/Contractor.:.....

4. WorkOrderNo.:.....dated.....

5. DateofCompletionofInstallation:……..….

6. DateofCommissioningoftheSolarPowerPlant:.……..…….

SL. No.	ItemDescription	Qty	Make	Product SerialNo.	Remarksifany
1	2	3	4	5	6
1.(a)	SPVModules				
(b)	ModuleMountingStructures				
(c)	JunctionBox				
2.(a)	PCU/Inverter(30kVA)				
(b)	Electronics				
3.(a)	EnergyMeter/NetMeter				
(b)	ACDB/DCDB				
4.(a)	Cable& wire				
(b)	Earthing,Lightningarrestor				
(c)	ExhaustFan,Fire Extinguishers, Sand Buckets, Solar Still, Sign Board.				
5.(a)	Manual				
(b)	Othersifany				

7. Enclosed documents: 3 copies of Completion Reports along with photographs of the system installed are hereby submitted to MANIREDA, both in hard and soft copies wherein details of equipment given in format above.
8. Signature of Beneficiary: Quantities shown in column 2 were received, installed and tested at the location intimated by us.

Date of received and installed:

Signature of Scheme Officer, MANIREDA
Name:
Designation:

9. Inspected on: .....and ..... jointly by MANIREDA officials and representative of M/s ..... at the site and found okay.
10. For Contractor Use only: Endorsed and certified the above report on behalf of M/s..…….....

Proforma – 10

Format of Consortium Agreement to be entered amongst all Membersof a bidding Consortium

(ForfirmsbiddingasConsortium)

[To be on Non Judicial Stamp paper of Rupees One Hundred only (IN R 100/-) or appropriate value as per Stamp Act relevant to place of execution, duly signed on each page. Foreign entities submitting Bid are required to follow the applicable law in their country.]

FORM OF CONSORTIUM AGREEMENT BETWEEN

M/s. ..... and M/s. ..... bidding for NIB No. MANIREDA/SPP(NESIDS)/2024-25/42 dated .../07/2025for:

Design, supply, installation and commissioning including integration to Grid of:

i. 600 kW Grid connected Solar Power Plant at 132/33 kV Elangkhangpokpi Power Sub-Station, Kakching District, Manipur.

ii. 800 kW Grid connected Solar Power Plant at 132/33 kV Kakching Power Sub-Station, Kakching District, Manipur.

iii. 5 MW Grid connected Floating Solar Power Plant at Thoubal Multi-purpose Project Reservoir, near Chadong Village of Kamjong District, Manipur.

and 5 years Maintenance and Performance Warranty Contract (MPWC).

THIS CONSORTIUM AGREEMENT (hereinafter referred to as “Agreement”) executed on this ..... [date] day of ..... [month], [year] between:

1. M/s. ....., a company incorporated under the laws of and having its Registered Office at , (hereinafter called the "Member 1," which expression shall include its successors, executors and permitted assigns);
2. M/s. ....., a company incorporated under the laws of and having its Registered Office at , (hereinafter called the "Member 2," which expression shall include its successors, executors and permitted assigns);

which expression shall include its successors, executors and permitted assigns); for the purpose of submitting the Bid in response to the Tenders and in the event of selection as Selected Bidder to comply with the requirements as specified in the Tenders and ensure execution of the Tenders’ Scope of Work as may be required to be entered into with Manipur Renewable Energy Development Agency (MANIREDA) having its office at Secured Office Complex, 2nd Floor, South Block, A.T. Line, Near Imphal Hotel, Imphal – 795001.

Member 1, and Member 2 are hereinafter collectively referred to as the “Members” and individually as a “Member”.

WHEREAS the Tenders stipulate that the Bidders qualifying on the strength of a Bidding Consortium shall submit a legally enforceable Consortium Agreement in a format specified in the Tender, whereby each Consortium Member undertakes to be liable for its Roles and Responsibilities, provide necessary guarantees and pay required fees as required as per the provisions of the Tender, as

specified herein.

WHEREAS any capitalized term in this Agreement shall have the meaning ascribed to such term in the Tender document.

NOW THEREFORE, THIS INDENTURE WITNESSTH AS UNDER:

In consideration of the above premises and agreement all the Parties in this Consortium do hereby mutually agree as follows:

1. In consideration of the selection of the Consortium as the Bidding Consortium by MANIREDA, we the Members of the Consortium and Parties to the Consortium Agreement do hereby unequivocally agree that M/s. ..... [Insert name of the Lead Member], shall act as the Lead Member for self and agent for and on behalf of M/s..... and M/s. ..... [the names of all the other Membersof the Consortium to be filled in here].
2. The Lead Member is hereby authorized by the Members of Consortium to the Consortium Agreement to bind the Consortium and receive instructions for and on behalf of all Members. The Roles and Responsibilities of all other members shall mentioned be as per the Annexure to this Agreement.
3. The Lead Member shall be liable and responsible for ensuring the individual and collective commitment of each of the Members of the Consortium in discharging all their respective Roles and Responsibilities. Each Consortium Member further undertakes to be individually liable for the performance of its part of the Roles and Responsibilities without in any way limiting the scope of collective liability envisaged in this Agreement in order to meet the requirements and obligations of the Tender.
4. Subject to the terms of this Agreement, the share of each Member of the Consortium in the issued equity share capital of the Project Company is/shall be in the following proportion:

Name	**Percentage**
Member 1	---
Member 2	---
Total	100%

5. In case of any breach of any of the commitment as specified under this Agreement by any of the Consortium Members, the Lead Members of the Consortium shall be liable to meet the obligations under the Tender.

6. Except as specified in the Agreement, it is agreed that sharing of responsibilities as aforesaid and obligations thereto shall not in any way be a limitation of responsibility of the Lead Member under these presents.
7. This Consortium Agreement shall be construed and interpreted in accordance with the Laws of India and Courts at Imphal alone shall have the exclusive jurisdiction in all matters relating thereto and arising there under.
8. It is hereby agreed that the Lead Consortium Member shall furnish the Bid Security, as stipulated in the Tender, on behalf of the Bidding Consortium.
9. It is hereby agreed that in case of selection of Bidding Consortium as the Project Implementing

Consortium, the Parties to this Consortium Agreement do hereby agree that they shall furnish the Performance Guarantee and other commitments to MANIREDA as stipulated in the Tender. The Lead Member shall be responsible for ensuring the submission of the Performance Guarantee and other commitments on behalf of all the Consortium Members.

10. It is further expressly agreed that the Consortium Agreement shall be irrevocable and, for the Project Implementing Consortium, shall remain valid over the term of the Project, unless expressly agreed to the contrary by MANIREDA.
11. The Lead Member is authorized and shall be fully responsible for the accuracy and veracity of the representations and information submitted by the Consortium Members respectively from time to time in response to the Tender for the purposes of the Bid.
12. It is expressly understood and agreed between the Members of the Consortium and Parties that the responsibilities and obligations of each of the Members shall be as delineated as annexed hereto as Annexure forming integral part of this Agreement. It is further agreed by the Members that the above sharing of responsibilities and obligations shall not in any way be a limitation of joint and several responsibilities and liabilities of the Members, with regards to all matters relating to the execution of the Bid and implementation of the Project envisaged in the Tender.
13. It is hereby expressly agreed between the Parties to this Consortium Agreement that neither Member shall assign or delegate or subcontract its rights, duties or obligations under this Agreement except with prior written consent of MANIREDA.
14. This Consortium Agreement:
    a. has been duly executed and delivered on behalf of each Member hereto and constitutes the legal, valid, binding and enforceable obligation of each such Member;
    b. sets forth the entire understanding of the Parties hereto with respect to the subject matter hereof; and
    c. may not be amended or modified except in writing signed by each of the Parties and with prior written consent of MANIREDA.

IN WITNESS WHEREOF, the Parties to the Consortium Agreement have, through MANIREDA, executed these presents and affixed common seals of their respective companies on the Day, Month and Year first mentioned above.

1. ForM/s ..... (Member1)

[SignatureofAuthorizedRepresentative]
……
……..
NameofAuthorizedRepresentative]
[DesignationofAuthorizedRepresentative]

Witness1:	Witness2:
[SignatureofWitness1]	*[SignatureofWitness2]*
……	……
Name:	Name:
Designation:	Designation:

2. ForM/s.....(Member2)

[SignatureofAuthorizedRepresentative]
……
……..
NameofAuthorizedRepresentative]

[DesignationofAuthorizedRepresentative]

Witness1:	Witness2:
[SignatureofWitness1]	*[SignatureofWitness2]*
……	……
Name:	Name:
Designation:	Designation:

Attested:
[Signature]
…….
(NotaryPublic)
Place:…….
Date:…….

Annexure to the Consortium Agreement

Role and Responsibility of each Member of the Consortium:

1. Roles and Responsibilities of the Member 1 (Lead Consortium Member):
2. Roles and Responsibilities of the Member 2
3. Roles and Responsibilities of the Member 3

Proforma – 11

Format for Submitting the PRICE SCHEDULE/FINANCIAL BID (To be uploaded ONLINE only) for

Price Schedule

UPLOADED ON www.manipurtenders.gov.in
(as in below page)

(DO NOT SUBMIT FINANCIAL BID IN PHYSICAL FORM, TO BE UPLOADED ONLINE ONLY)

BID No.:MANIREDA/SPP(NESIDS)/2024-25/48: Date:…….

To,

The Director
ManipurRenewableEnergyDevelopmentAgency (MANIREDA)
2nd Floor, South Block, Near 2ndM.R. Gate, Imphal-Dimapur Road, Imphal-795001

Price Schedule

Design, supply, installation and commissioning including integration to Grid and 5 years Maintenance and Performance Warranty Contract (MPWC)for:

A) Cost for installation of 600 kW Grid Connected Solar Power Plants at 132/33 kV Elangkhangpokpi Power Sub-Station, Kakching District, Manipur.

Sl. No.	Item Description	Quantity	Unit	Amount (Rs.)
1	**2**	**3**	**4**	**5**
1	Project Cost for Installation of 600 kWp Grid connected SPV Power Plant (Ground Mounted) at 132/33 kV Elangkhangpokpi Power Sub-Station, Kakching District, Manipur including 5 years Maintenance and Performance Warranty Contract (MPWC). (2+3+4+5+6)	1.000	Set	
2	Cost of Materials comprising of Solar Modules, Grid Inverter and accessories such a structures, cables, distribution boxes, net meter, solar meter, earthing kits, lightning arrestor etc.	1.000	Set	
3	Installing and Commissioning Cost	1.000	Set	
4	Maintenance and Performance Warranty Contract (MPWC)	1.000	Set	
5	Oil-cooled inverter duty transformer including all necessary cables, switches, safety equipments and accessories, as per specifications mentioned in the tender document.	1.000	Set	
6	Site preparation and civil work including but not limited to site assessment, survey, contouring, clearing vegetation and debris, grading and leveling the land, conducting soil tests, drainage systems, pathways etc.			
7	GST 12% on **Sl. No. 2.**	1.000	Set	
8	GST 18% on **Sl. No. 3.**	1.000	Set	
9	GST 18% on **Sl. No. 4.**	1.000	Set	
10	GST 18% on **Sl. No. 5.**	1.000	Set	
11	GST 12%oin **SL No. 6.**	1.000	Set	
12	**Total Cost of the Project Sl. Nos. (1+7+8+9+10)**	1.000	Set	
13	**State Govt. Charges:**			
14	LabourCess @1% on **Sl. No. 3.**	1.000	Set	

15	LabourCess @1% on **Sl. No. 4.**	1.000	Set	
16	Labour Cess @1% on **Sl. No. 6.**	1.000	Set	
17	Contingency Charge @3% on **Sl. No. 3.**	1.000	Set	
18	Contingency Charge @3% on **Sl. No. 4.**	1.000	Set	
19	Contingency Charge @3% on **Sl. No. 6.**	1.000	Set	
20	**Grand Total Cost of the Project Sl. Nos. (12+14+15+16+17+18+19)**	1.000	Set	
Total in Words:				

B) Cost for installation of 800 kW Grid Connected Solar Power Plants at 132/33 kV Kakching Power Sub-Station, Kakching District, Manipur.

Sl. No.	Item Description	Quantity	Unit	Amount (Rs.)
1	**2**	**3**	**4**	**5**
1	Project Cost for Installation of 800 kWp Grid connected SPV Power Plant (Ground Mounted) at 132/33 kV Kakching Power Sub-Station, Kakching District, Manipur including 5 years Maintenance and Performance Warranty Contract (MPWC). (2+3+4+5+6)	1.000	Set	
2	Cost of Materials comprising of Solar Modules, Grid Inverter and accessories such a structures, cables, distribution boxes, net meter, solar meter, earthing kits, lightning arrestor etc.	1.000	Set	
3	Installing and Commissioning Cost	1.000	Set	
4	Maintenance and Performance Warranty Contract (MPWC)	1.000	Set	
5	Oil-cooled inverter duty transformer including all necessary cables, switches, safety equipments and accessories, as per specifications mentioned in the tender document.	1.000	Set	
6	Site preparation and civil work including but not limited to site assessment, survey, contouring, clearing vegetation and debris, grading and leveling the land, conducting soil tests, drainage systems, pathways etc.	1.000	Set	
7	GST 12% on **Sl. No. 2.**	1.000	Set	
8	GST 18% on **Sl. No. 3.**	1.000	Set	
9	GST 18% on **Sl. No. 4.**	1.000	Set	
10	GST 18% on **Sl. No. 5.**	1.000	Set	
11	GST 12% on **Sl. No. 6.**	1.000	Set	
12	**Total Cost of the Project Sl. Nos. (1+7+8+9+10)**	1.000	Set	
13	**State Govt. Charges:**			
14	LabourCess @1% on **Sl. No. 3.**	1.000	Set	
15	LabourCess @1% on **Sl. No. 4.**	1.000	Set	
16	Labour Cess @1% on **Sl. No. 6.**	1.000	Set	
17	Contingency Charge @3% on **Sl. No. 3.**	1.000	Set	
18	Contingency Charge @3% on **Sl. No. 4.**	1.000	Set	
19	Contingency Charge @3% on **Sl. No. 6.**	1.000	Set	
20	**Grand Total Cost of the Project Sl. Nos. (12+14+15+16+17+18+19)**	1.000	Set	

Total in Words:

C) Cost for installation of 5 MW Grid connected Floating Solar Power Plant at Thoubal Multi-purpose Project Reservoir near Chadong Village of Kamjong District, Manipur

Sl. No.	Item Description	Qty.	Unit	Amount (Rs.)
1	Project Cost for Installation of 5 MW (AC) Grid connected Floating solar PV Power Plant (Float Mounted) at Thoubal Multipurpose Project Reservoir, Kamjong District, Manipur including 5 years Maintenance and Performance Warranty Contract (MPWC) (2+3+4+5+6+7)	1	Set	
2	Cost of Materials comprising of Solar Modules, Floating system, mooring and anchoring, Grid Inverter and accessories, cables, distribution boxes, net meter, solar meter, earthing kits, lightning arrestor etc.	1	Set	
3	Installing and Commissioning Cost	1	Set	
4	Maintenance and Performance Warranty Contract (MPWC)	1	Set	
5	800V/33kV, 6.25 MVA transformer station complete with 5 kVA Auxiliary Transformer, LV & HV switchgear and control & relay panel (In a 20 feet ISO container)	1	Set	
6	33 kV transmission line with 100 mm2 ACSR conductor & transmission poles for evacuation power at substation [6.5 km approx.]	1	Set	
7	Site preparation and civil work including but not limited to site assessment, survey, clearing vegetation and debris, grading and leveling the land for construction of launch ramp and control room, etc.	1	Set	
8	GST 12% on Sl. No. 2.	1	Set	
9	GST 18% on Sl. No. 3.	1	Set	
10	GST 18% on Sl. No. 4.	1	Set	
11	GST 18% on Sl. No. 5.	1	Set	
12	GST 18% on Sl. No. 6.	1	Set	
13	GST 12% on Sl. No. 7.	1	Set	
14	Total Cost of the Project Sl. Nos. (1+8+9+10+11+12)	1	Set	
15	LabourCess @1% on Sl. No. 3.	1	Set	
16	LabourCess @1% on Sl. No. 4.	1	Set	
18	Labour Cess @1% on Sl. No. 7.	1	Set	
18	Contingency Charge @3% on Sl. No. 3.	1	Set	
19	Contingency Charge @3% on Sl. No. 4.	1	Set	
20	Contingency Charge @3% on **Sl. No. 7.**	1	Set	
21	Grand Total Cost of the Project Sl. Nos. (14+15+16+17+18+19+20)	1	Set	
Total in Words:				

Note.:

1. LabourCess @1% would be deducted at source out of labour charge applicable.
2. AbovequotedpricearecompleteinallrespectasperTechnicalSpecificationsinclusiveofall Central/State/Localtaxes&duties,packing,forwarding,transitinsurance,loading&unloading,transportation & other charges etc. FOR sites.

3. The above quoted price is also inclusive ofinstallation, testing,commissioning,performancetesting and training at respective sites of Manipur.
4. Certifiedthatratesquotedareasperspecifications,terms&conditionsmentionedinthe bid document.

Yoursfaithfully,

(SignatureofAuthorizedSignatory)
Name:
Designation:
Firmseal:

Check List & Format for Submission of Bid

The following information/documents are to be annexed and flagged by the bidders along with the BID

Sl. No	Annexure and Proforma No.	Particulars	Yes/No, Flag/Page No.	To be done
1	Annexure-I	Details of Earnest Money (D.D from any nationalized bank and validity for at least 3 months from the last date of submission of bids)		To be uploaded
2	Annexure-II	A copy of the document/certificate that the bidder is Company/Firm/Corporation registered in India.		To be uploaded
3	Annexure-III	Consortium Agreement in Non-Judicial Stamp Paper (if any Firm is applying with Consortium partners)		To be uploaded
4	Annexure-IV	Test Reports for the components of Grid connected Rooftop Solar Power Plant like PCU/Inverter, PV module, Energy Meter, ACDB, DCDB etc. from an approved/ competent testing centres as per requirements under the JNNSM scheme of the MNRE, GOI.		To be uploaded
5	Annexure-VI	A copy of valid GST Registration Certificate		To be uploaded
6	Annexure-VII	A summarized sheet of cumulative experience of the bidder as per bid document should be enclosed.		To be uploaded
7	Annexure-XII	Overall Average Annual Turnover of the Company/Firm/Corporation in the last 3 financial years (A summarized sheet of turnover of last 3 Financial Years certified by registered CA)		To be uploaded
8	Annexure-XIII	Demand Draft for cost of bid document/Photocopy of Demand Draft		To be uploaded
9	Proforma – 1	Forwarding Letter		To be uploaded
10	Proforma – 2	Authority Letter for Attending Pre-Bid Meeting, Bid Opening Meeting and Signing Bid Document.		To be uploaded
11	Proforma – 3	Information about the Bidding Firm		To be uploaded

12	Proforma – 4	Past experiences with details of work orders		To be uploaded
13	Proforma – 5	No Deviation Certificate		To be uploaded
14	Proforma – 10	Format for Consortium Agreement		
15	Proforma – 11	Price Bid		To be uploaded

Please ensure:

1. That all information is provided strictly in the order mentioned in the check list mentioned above.
2. Note that this is a zero-deviation tender. Bidders are advised to strictly confirm compliance to bid conditions and not to stipulate any deviation/conditions in their offer. Subsequent to bid submission, MANIREDA may or may not seek confirmations/clarifications and any offer(s) not in line with Bid conditions shall be liable for rejection.
3. Any clarification/confirmation bidder may require shall be obtained from MANIREDA before submission of the bid.
4. Bidder shall submit complete bidding document including subsequent amendment, modification and revision, duly signed and stamped as a token of having read, understood and accepted all the terms and condition mentioned therein.

…….. End of the Bid Document……..