NORTHERN POWER DISTRIBUTION COMPANY OF TELANGANA LIMITED
VIDHYUTH BHAVAN:: WARANGAL

TGNPDCL

BID DOCUMENT

TECHNICAL BID

Bid No:II-106/2024-25/CE/Proj/CESS/Sircilla

Establishment of Ground Mounted Solar Photo Voltaic Power plant capacity 2MW (AC) at CESS Boinpally in Sircilla District of TGNPDCL.

Chief Engineer
Projects,
H.No.2-5-31/2, Vidyuth Bhavan,
Nakkalagutta, Hanamkonda,
Warangal – 506001

Cell: 9490612390
Fax: 0870-2461519

CONTENTS

INVITATION FOR BIDS (IFB)

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1. Northern Power Distribution Company of Telangana Limited, Warangal (TGNPDCL) has taken own funding for Establishment of Ground Mounted Solar Photo Voltaic Power plant (Total capacity 2MW) (AC) at CESS Boinpally Circilla District of TGNPDCL.

2. TGNPDCL invites bid under International Competitive Bidding (ICB) from eligible bidders on e-procurement platform for Supply, Installation, Commissioning, Operation & Maintenance of Solar Photo Voltaic Power Plant of (Total capacity 2MW) (AC) at CESS Boinpally Circilla District of TGNPDCL on 100% turnkey and Build, Operate, Maintain & Transfer (BOMT) basis.

3. All the interested bidders may visit **www.eprocurement.gov.in** to view and download the tender documents from 22.11.2024, 11:00 AM. to 12.12.2024 up to 05:00 PM.

4. Those who are interested to submit bids will have to register in the above mentioned site and also have to obtain Digital Certificates. The details and procedure for obtaining digital certificate are mentioned in the website or contact the helpdesk of the site.

5. Possession or capability for timely acquisition/procurement (own, lease, hire etc.) of the following essential equipments:
   i) Construction machinery for Civil works.
   ii) Material handling facilities for erection
   iii) Equipment for testing and commissioning
   iv) Suitable qualified and experienced personnel with at least 5 years experience in works of an equivalent nature & volume.

6. The intending bidders must have skilled and supervisory personnel having requisite electrical license for village electrification projects through Solar Photo Voltaic system and the voltage level for LT system.

7. The bid price shall have to be in Indian Rupees (INR) only.

8. TGNPDCL reserves the right to cancel/withdraw the IFB without assigning any reason for such decision. Such decision will not incur any liability whatsoever on the part of TGNPDCL consequently.

9. Alternative Bids will not be considered.

Notice Inviting Tender (NIT)		
Sl.No.	Description	
1	**Bid Number**	**Bid No: II-106/2024-25/CE/Proj/CESS/Sircilla**
2	Bid Description	Establishment of Ground Mounted Solar Photo Voltaic Power plant capacity 2MW (AC) at CESS Boinpally in Circilla District of TGNPDCL on 100% turnkey and Build, Operate, Maintain & Transfer (BOMT) basis.
3	Period of Work	Within 6 months from the date of Agreement
4	Bid Amount (INR)	Should be quoted by the contractor
5	Bid Security (INR)	2% on the quoted amount of the contractor
6	Bid Security	**Bid security should be accepted through online payment only** Firms claiming Exemptions for BID SECURITY shall submit Certificate of NSIC / MSME. The NSIC / MSME Certificate must be valid till the finalization of the Tender, however bid document fee is not exempted.
7	**Transaction** Fee	The participating bidder has to pay **Transaction fee** for all works with @ 0.03% on ECV upto Rs. 50 crores and pay **Goods & Service Tax (GST)** levied by Government of India on the above transaction fee through the electronic payment gateway as per G.O.Ms.No.13, Dt:07.05.2006. **Corpus Fund:** In addition, the successful bidder has to pay @ 0.04% of ECV with a cap of Rs. 10000 at the time of agreement, towards e-procurement corpus fund in the shape of DD in favour of Managing Director TS technology services Hyderabad.
8	**Transaction** Fee payable to	**TS Technological Services, Government of Telangana, Hyderabad**.
9	**Downloading Open** date (e-procurement)	22.11.2024 from 11.00 AM
10	**Downloading Close** date (e-procurement)	12.12.2024 upto 05:00 PM
11	**Bid Submission Closing** last date (e-procurement)	12.12.2024 upto 05:00 PM.
12	**Last date for submission of Hard Copies**	**Hard copies not necessary**
13	**Technical Bid Opening Date** (Qualification & Eligibility Stage and Technical Bid Stage)	13.12.2024 after 11.00 AM.
14	**Price Bid Opening Date** (Financial Bid Stage)	16.12.2024 after 11:00 AM.
15	Place of Tender Opening	Vidyuth Bhavan, TGNPDCL, Warangal
16	Officer Inviting Bids/ Contact Person	Chief Engineer (Projects)
17	Address/E-mail ID	H.No.2-5-31/2, TGNPDCL, Vidyuth Bhavan, Nakkalagutta, Hanamkonda, Warangal – 506001. ceproj@tgnpdcl.com
18	Contact Details/Telephone, Fax	**Cell: 9490612390**

19	Eligibility Criteria	1	Bid Security should be furnished as per Sl.Nos.5&6 of NIT
		2	**<u>Technical Experience</u>**: Empanelled vendors of REDCO/ TGNPDCL with requisite experience of at least minimum **1.0MW Cumulative Capacity** in field of Grid Connected Solar PV systems installed at Government Buildings / Subsidy Schemes during the last 03 Financial Years (i.e. FY:2021-22, 2022-23 and 2023-24).
		3	Financial Turnover: The firms having the Turnover not less than Rs.6.00 Crores, in any one financial year during the last 3 (Three) previous financial years for which the firm should obtain Turnover Certificate containing the previous 3 (Three) financial years (i.e. FY: 2021-22, 2022-23 and 2023-24). Turnover duly certified by Chartered Accountant (CA) along with UDIN generated. Certificate issued by Registered Chartered Accountant with UDIN (Unique Document Identification Number) must be uploaded. The certificate is mandatory.
		4	The Bidder should have the bid capacity not less than the estimated contract value or value of work put to tender. The bid capacity will be calculated as per formula (2 AN-B)>ECV for others and 3 AN-B>ECV for SC/STs, Waddera and Sagara (Uppara) Contract Co-operative Societies and individuals belonging to the said communities, where A=Max. value of Engineering works executed in any one financial year during the preceding 5 financial years (updated to the current price level with a simple weightage of 10% per each financial year) taking into account the competed as well as work in progress. With regard to execution of the works during the last 5 years (2017-18 to 2023-24), the bidder shall produce the copies of experience certificates issued by the <u>order placing authority</u> (or) Officer not below the rank of Executive Engineer / Divisional Engineer indicating a) Description of work, b) Date of agreement, c) Agreement value/revised agreement value, d) Date of commencement, e) Agreed date of completion, f) Actual date of completion, g) total value of work done, h) Reasons for delay, if any, and i) the physical quantities executed during each financial year etc., (or) Chartered Accountant's

certificate with audited and approved profit and loss statement shall be produced.

N= Number of years prescribed for completion of the works for which tenders are invited.

B= Value of existing commitments and ongoing works to be completed during the period of completion of work for which tenders are invited.

(i) The bidder shall produce the statement showing the value of existing commitment and ongoing works as well as the stipulated period of completion remaining for each of the works listed should be issued by the State/Central Government Department/ Under takings not below the rank of Executive Engineer or the officer of equivalent rank and counter signed by the Superintending Engineer or the officer of equivalent rank.

(or)

(ii) The bidder shall produce a declaration as mentioned below on a **non-judicial stamp paper of Rs.200/- duly notarized.**

"I, Sri/Smt/M/s…….. do here by solemnly affirm and declare that I/we have the balance works on hand as per the details furnished in tender schedule are true and also declare that in case it is found at a later date to be false fake/incorrect, I/We…….. Will abide by any action such as disqualification or determination of contract under clause 60 (a) PS to APSS or black listing or any action may deem fit."

Signature of the Bidder

Either (i) or (ii) documents are Mandatory

***** The copies of the certificates produced by the tenderer shall invariably be attested by a Gazetted Officer/Notary. Otherwise, they will be summarily rejected and will not be taken into consideration.

*** Note:** The Bidder should upload the filled data with certificates as mentioned in Section-2, B (Qualification

<table>
<tr><td></td><td></td><td><table>
<tr><td></td><td>Information) (Clauses 1 to 2.1)

ECV= Estimated Contract Value (or) The Value of work put to tender.</td></tr>
<tr><td>5</td><td>Tenders from joint venture are not acceptable</td></tr>
<tr><td>6</td><td>The bidder should produce valid Firm Registration in TGNPDCL after issuing of LoA.</td></tr>
<tr><td>7</td><td>The bidder should produce valid PAN card before issuing of LOA.</td></tr>
<tr><td>8</td><td>The bidder should produce valid Goods & Service Tax Identification Number (GSTIN) before issuing of LoA.</td></tr>
<tr><td>9</td><td>The bidder should produce valid EPF registration before issuing of LoA.</td></tr>
</table></td></tr>
<tr><td>20</td><td>Disqualified conditions</td><td>Even though the bidder meets the above qualifying criteria, they are subject to be disqualified if they have.
1) Made misleading or false representations in the forms statements and attachments submitted in proof of qualification requirements and/ or.
2) Record of poor performance such as not properly completing the contract, inordinate delays in works completion, litigation history or financial failure etc.
3) The bidder should provide detailed information on any litigation or arbitration arising out of contracts completed or under execution by it over the last five years. A consistent history of awards involving litigation against the Bidder may result in rejection of Bid.

<u>Note</u>: Not withstanding anything stated above, TGNPDCL reserves the right to assess bidder’s capability to perform the contract should be the circumstances warrant such assessment in overall interest of TGNPDCL. In this regard the decision of TGNPDCL is final.</td></tr>
<tr><td>21</td><td>Procedure for Bid Submission</td><td>1. Bids shall be submitted through online platform on <u>www.tender.telangana.gov.in</u>
2. The participating bidders in the tender should register themselves on e-procurement platform in the website <u>www.tender.telangana.gov.in</u>
3. Bidders can log-in to <u>www.tender.telangana.gov.in</u> platform by signing with the Digital certificates.
4. The bidders who are desirous of participating in e-tendering shall submit their Technical bids, Price bids as per the standard formats available at the e-market place.</td></tr>
</table>

		After uploading the documents, if the copies of any of the certificates, documents etc., uploaded by the bidder are found to be false / fabricated / bogus, the bidder will be disqualified, blacklisted, action will be initiated as deemed fit and the Bid Security will be forfeited. **5.** The department will not hold any risk and responsibility regulating non-visibility of the scanned and uploaded documents. **6.** The Documents that are uploaded through online in e-procurement platform will only be considered for Technical Bid Evaluation.
		7. <u>Important Notice to Contractors, Suppliers and Department users</u>: In the endeavor to bring total automation of processes in e-Procurement, the Govt. has issued orders vide G.O.Ms.No.13, Dt: 05.07.2006 permitting integration of Electronic Payment Gateway of ICICI/HDFC Banks with e-procurement platform, which provides a facility to participating suppliers/contractors to electronically pay the transaction fee online using their credit cards.
22	Rights reserved with the Department	TGNPDCL reserves the right to accept or reject any or all of the tenders received without assigning any reasons thereof. The TGNPDCL also reserves the right to split the tender and place contract on more than one bidder at its discretion TGNPDCL reserves the right for correction of calculation / typographical errors if any found in tender schedules at any stage as per actual Cost data
23	General Terms and Conditions	As per tender documents.
Note : Submission of hard copy is not required		

Chief Engineer (Projects)
TGNPDCL, Warangal.

SECTION 1

INSTRUCTIONS TO BIDDERS (ITB)

SECTION 1

INSTRUCTIONS TO BIDDERS

TABLES OF CLAUSES

1 A. GENERAL

1. SCOPE OF BID

1.1 The TGNPDCL (referred to as Employer in these documents) invites bids for the construction of works (as defined in these documents and referred to as "the works") detailed in the NIT given in IFB.

1.2 The successful bidder will be expected to complete the works by the intended completion date specified in the contract data.

2. SOURCE OF FUNDS

2.1 Under TGNPDCL Funds .

3. ELIGIBLE BIDDERS

3.1 This Invitation for Bids is open to all bidders. Any materials, equipment, and services to be used in the performance of the Contract shall have their origin in India.

3.2 All bidders shall provide in Section 2, Forms of Bid and Qualification Information, a Statement that the Bidder is not associated, nor has been associated in the past, directly or indirectly, with the Consultant or any other entity that has prepared the design, specifications, and other documents for the project or being proposed as Project Manager for the Contract. A firm that has been engaged by the Borrower to provide consulting services for the preparation or supervision of the works, and any of its affiliates shall not be eligible to bid.

3.3 Government-owned enterprises in the Employer's country may only participate if they are legally and financially autonomous, operate under commercial law and are not a dependent agency of the Employer.

3.4 Bidders shall not be under a declaration of ineligibility for corrupt and fraudulent practices in accordance with sub-clause 36.1.

4. QUALIFICATION OF THE BIDDER

4.1 All bidders shall provide in Section 2, Forms of Bid and Qualification Information, a preliminary description of the proposed work method and schedule, including drawings and charts, as necessary.

4.2 If the TGNPDCL has not undertaken pre-qualification of potential bidders, all bidders shall include the following information and documents with their bids in Section 2:

(a) Copies of original documents defining the constitution or legal status, place of registration, and principal place of business, written power of attorney of the signatory of the Bid to commit the Bidder;
(b) Total monetary value of construction work performed for each of the last five years;
(c) Experience in works of a similar nature and size for each of the last five years, and details of works under way or contractually committed; and clients who may be contacted for further information on those contract;
(d) Major items of construction equipment proposed to carry out the Contract;
(e) Qualifications and experience of key site managements and technical personnel proposed for the Contract.

(f) Reports on the financial standing of the Bidder, such as profit and loss statements and auditor's reports for the past five years;
(g) Evidence of adequacy of working capital for this contract (access to line (s) of credit and availability of other financial resources).
(h) Authority to seek references from the Bidder's bankers:
(i) Information regarding any litigation, current or during the last five years, in which the Bidder is involved, the parties concerned, and disputed amount.
(j) **No Subcontracting is allowed**.
(k) The proposed methodology of construction, backed with their construction equipment planning and deployment, duly supported with broad calculations and quality control procedures proposed to be adopted, justifying their capability of achieving the completion of work as per milestones specified within the stipulated period of completion. and
(l) Financial turnover should be certified by Chartered Accountant.

4.3 **Bids from Joint Ventures are not acceptable**.

4.4 To qualify for award of the contract, each bidder in his name should have the following valid certificates (last three years, **FY: 2021-22, 2022-23 and 2023-24**).

1	Bid Security should be furnished as per Sl.Nos.5&6 of NIT
2	**Technical Experience:-** Valid vendor registered with TGREDCO with requisite experience of at least minimum **1.0MW Cumulative Capacity** in field of Grid Connected Solar PV systems installed at Government Buildings / Subsidy Schemes during the last **03 Financial Years (i.e. FY:2021-22, 2022-23 and 2023-24).** The capacity of work maybe in total or in multiple denominations.
3	**Financial Turnover** : The firms having the Turnover not less than **Rs.6.00 Crores**, in any one financial year during the last 3 (Three) previous financial years for which the firm should obtain Turnover Certificate containing the previous **3 (Three)** financial years (i.e. **FY: 2021-22, 2022-23 and 2023-24).** Turnover duly certified by Chartered Accountant (CA) along with UDIN (Unique Document Identification Number) must be uploaded. **The certificate is mandatory**
4	The bidder should produce the BOQ including **CMC** for five years within the tender value
5	Tenders from joint venture are not acceptable
6	The bidder should produce **valid Firm Registration in TGNPDCL** after issuing of **LOA**
7	The bidder should produce valid **PAN card before issuing of LOA.**
8	The bidder should produce valid Goods & Service Tax Identification Number (GSTIN) before issuing of LOA.
9	The bidder should produce valid **EPF** registration before issuing of **LOA**.

Note:
Based on the studies, carried out by the Engineer the minimum suggested major equipment to attain the completion of works in accordance with the prescribed construction schedule are shown in the above list. The bidders should, however, undertake their own studies and furnish with their bid, a detailed construction planning and methodology supported with layout and necessary drawings and calculations (detailed) as stated in clause 4.2 (k) above to allow the employer to review their proposals. The numbers, types and capacities of each plant / equipment shall be shown in the proposals along with the cycle time for each operation for the given production capacity to match the requirements.

(a) Availability for this work of a Project Manager with not less than five years' experience in construction of similar Electrical engineering works and other key personnel with adequate experience as required.

4.5 To qualify for a package of contracts made up of this and other contracts for which bids are invited in the IFB, the bidder must demonstrate having experience and resources sufficient to meet the aggregate of the qualifying criteria for the individual contracts.

4.6 In case where sub-contractors are employed for the execution of the works, sub-contractor's experience and resources shall not be taken into account in determining the bidder's compliance with the qualifying criteria except to the extent stated in 4.4 above.

4.7 Even though the bidders meet the above qualifying criteria, they are subject to be disqualified if they have:

- made misleading or false representations in the forms, statements and attachments submitted in proof of the qualification requirements, and /or
- Record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completions, litigation history, or financial failures etc.

4.8 The bidders have to furnish an undertaking in the prescribed format given in Section-2 disclosing their relationship with the officers/Chief Engineers of TGTRANSCO/DISCOM failing which the tenders will be rejected. Any false information furnished in the declaration will render the contract liable for termination as well as recovery of damages.

4.9 Notwithstanding anything stated above the owner reserves the right to asses capability and capacity of the bidder to successfully execute the work covered under the package within stipulated completion period. This assessment shall inter-alia include (i) document verification (ii) bidder's work/ manufacturing facilities visit (iii) manufacturing capacity, details of work executed, works in hand, anticipated in future in addition to the works involved in present bid (iv) details of plant and machinery, manufacturing and testing facilities, manpower and financial resources (v) details of quality systems in place (vi) past experience and performance (vii) customer feedback (viii) banker's feedback etc.

5 ONE CONTRACT PER BIDDER

ONLY ONE CONTRACT WILL BE AWARDED TO ONE BIDDER. However in case a bidder becomes L1 in more than one bid, the award of bid(s) to the successful bidder will be at the discretion of the employer only and the bidder will not be allowed to select his own choice from his successful bids. However TGNPDCL at its discretion may also award more than one bid to one bidder.

Each bidder should further demonstrate:

Availability (either owned or leased) of the following key and critical equipment for this work:

- Ropes, Ladders and Crow bars
- Tractor
- T & P as per Annexure 3.

6 COST OF BIDDING

6.1 The bidder shall bear all costs associated with the preparation and submission of his Bid, and the Employer will in no case be responsible and liable for those costs.

7 SITE VISIT

7.1 The Bidder, at the Bidder's own responsibility and risk is encouraged to visit, examine the Site of Works and its surroundings and obtain all information that may be necessary for preparing the Bid and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the Bidder's own expense.

B. BIDDING DOCUMENTS

8. CONTENT OF BIDDING DOCUMENTS

8.1 The set of bidding documents comprises the documents listed in the table below and addenda issued in accordance with Clause 10 and Price Bid.

Section	Description of Documents
1	Instruction to Bidders
2	Forms of Bid and Qualification Information
3	Conditions of Contract
4	Contract Data
5	Specifications
6	Quality assurance plan
7	Bill of quantities
8	Forms of Securities
9	Schedule of quantities and prices
10	Drawings

8.2 Bidders shall have to submit their bids with Sections 1 to 10 completely filled in, as applicable without deviating from the format and content.

8.3 Technical Bid and Price Bid should be uploaded on-line along with all the necessary statements, documents & certificates. After uploading the documents, hardcopies of all the uploaded statements, certificates, documents along with the original Demand Draft in respect of Bid Security (except the Price bid / offer) are to be submitted by the bidder to the Employer at the address specified in Sl.Nos.16 & 17 of NIT so as to reach before the date and time prescribed in Sl.No.12 of NIT. The Department shall not hold any risk on account of postal delay. Similarly, if any of the certificates, documents, etc., furnished by the bidder are found to be false/fabricated/bogus, the bidder will be disqualified, blacklisted and action will be initiated as deemed fit and the Bid Security will be forfeited.

9. CLARIFICATION OF BIDDING DOCUMENTS

9.1 A prospective bidder requiring any clarification of the bidding documents may notify the Employer in writing or by fax at the Employer's address indicated in the invitation to bid. The Employer will respond for clarification which he received earlier than 7 days prior to the deadline for submission of bids. Copies of the Employer's response will be placed in website of e-procurement.

10. AMENDMENT OF BIDDING DOCUMENTS

10.1 Before the deadline for submission of bids, the Employer may modify the bidding documents by issuing addenda.

10.2 Any addendum thus issued shall be part of the bidding documents and shall be placed in website of e-procurement. Prospective bidders shall acknowledge receipt of each addendum by fax to the Employer.

10.3 To give prospective bidders reasonable time in which to take an addendum into account in preparing their bids, the Employer shall extend as necessary the deadline for submission of bids, in accordance with Sub-Clause 18.2 below.

1 C. PREPARATION OF BIDS

11. LANGUAGE OF THE BID

11.1 All documents relating to the bid shall be in the English language only.

12. DOCUMENTS COMPRISING THE BID

12.1 The bid submitted by the bidder on line through e-procurement website shall comprise the following.

(a) Bid Security as per clause 16 of ITB (Section-1)
(b) Technical Bid information (in the format indicated in Section 2) &
Price Bid (in the schedule-Abstract of the price bid document enclosed separately)

And any other materials required to be complete and submitted by bidders in accordance with these instructions. The documents listed under Sections 2, 4 and 7 mentioned in Sub-Clause 8.1 of section-I shall be filled in without exception. The bidder shall submit technical bid and price bid separately through online.

13. BID PRICES

13.1 The contract shall be for the whole works as described in Sub-Clause 1.1 of Section-1

13.2 All duties, taxes, and other levies payable by the contractor under the contract, or for any other cause are included in the estimated prices. The bidder shall verify the correctness and quote his price.

13.3 The rates and prices quoted by the bidder shall be **FIRM** throughout the contract period.

14. CURRENCIES OF BID AND PAYMENT

14.1 The unit rates and the prices shall be quoted by the bidder entirely in Indian rupees only.

15. BID VALIDITY

15.1 Bids shall remain valid for a period not less than **180 days** from last date of bid submission of online date as specified in Clause 20.1 of Section-1. A bid valid for a shorter period shall be rejected by the Employer as non-responsive.

15.2 In exceptional circumstances, prior to expiry of the original time limit, the Employer may request that the bidders may extend the period of validity for a specified additional period. The request and the bidder's responses shall be made in writing or by fax. A bidder may refuse the request without forfeiting his bid security. A bidder agreeing to the request will not be required or permitted to modify his bid, but will be required to extend the validity of his bid security for a period of the extension, and in compliance with Clause 15 in all respects.

16 BID SECURITY

16.1 The Bidder shall furnish, as part of his Bid, a Bid security @ 2% on quoted bid value **compulsorily** in the shape of **online payment** as specified in Sl.No.6 of NIT to the TGNPDCL.

16.2 Firms claiming Exemptions for BID SECURITY shall submit Certificate of NSIC / MSME. The NSIC / MSME Certificate must be valid till the finalization of the Tender, however bid document fee is not exempted.
(**In case, if any successful bidder who has claimed EMD exemption and does not take up the construction within stipulated time. TGNPDCL reserves the right to recover the EMD amount and also initiate legal action against the respective bidder including blacklisting the firm for 5years throughout the India**)

16.3 Any bid not accompanied by an acceptable Bid Security and not secured as indicated in Sub-Clauses 16.1 and 16.2 above shall be rejected by the Employer as non-responsive.

16.4 The Bid Security of the unsuccessful bidder will be returned within 28 days of the end of the bid validity period specified in Sub-Clause 15.1.

16.5 The Bid Security of the successful bidder will be discharged when the bidder has signed the Agreement and furnished the required performance Security.

16.6 The Bid Security may be forfeited
(a) if the Bidder withdraws the Bid after Bid opening during the period of Bid validity:

(b) if the Bidder does not accept the correction of the Bid Price, pursuant to Clause 27; or

(c) in the case of a successful Bidder, if the Bidder fails within the specified time limit to
  (i) sign the Agreement or
  (ii) Furnish the required performance Security.

17. ALTERNATIVE PROPOSALS BY BIDDERS

17.1 Bidders shall submit offers that comply with the requirements of the bidding documents, including the basic technical design as indicated in the drawing and specifications. **Alternatives will not be considered**.

18. FORMAT AND SIGNING OF BID

18.1 The Bidder shall prepare original copy of the documents comprising the bid as described in Clause 12 of these Instructions to Bidders bound with the volume containing the Forms of Bid, and clearly marked “ORIGINAL”.

18.2 The original of the Bid shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the Bidder, pursuant to Clause 4. All pages of the bid where entries or amendments have been made shall be initialed by the person or persons signing the bid.

18.3 The Bid shall contain no alterations or additions, except those to comply with instructions, issued by the Employer, or as necessary to correct errors made by the bidder, in which case such corrections shall be initialed by the person or persons signing the bid.

18.4 The Bidder shall furnish information as described in the form of Bid on commissions or gratuities, if any, paid or to be paid to agents relating to this Bid, and to contract execution if the Bidder is awarded the contract.

18.5 The bidders shall quote their price in the appended schedules abstract in the price bid at the appropriate place duly deleting the items not applicable as shown in Schedules abstract.

18.6 The bidder shall sign at bottom of each page in the Part-II (Price Bid) and upload it on-line only.

18.7 The bidders have to quote the percentage variation from the estimate rates and shall not quote for different rates for each item in the price bid.

1 D. SUBMISSION OF BIDS

19. SEALING AND MARKING OF BIDS:Deleated

20. DEADLINE FOR SUBMISSION OF THE BIDS

20.1 Submission of bids through e-procurement website in www.eprocurement.gov.in before the date and time prescribed in Sl.No.11 of NIT.

20.2 The Employer may, at its discretion, extend the deadline for submission of bids by issuing an amendment in accordance with Clause 10. The Employer also reserves the right to extend the bid submission date without assigning any reason. In such case, all rights and obligations of the Employer and the bidders previously subject to the original deadline will then be subject to the new deadline.

21. LATE BIDS:Deleated

22. MODIFICATION AND WITHDRAWAL OF BIDS

22.1 The bidder may modify or withdraw its bid after submission of bid before the deadline prescribed in Clause 20 in **online only**.

22.2 No bid shall be permitted to be modified after the deadline of online submission.

22.3 Withdrawal/ Modification of bid between the deadline for submission of bids and the expiration of the original period of bid validity specified in the Form of Bid will result in the forfeiture of the bid security pursuant to Clause 16.6.

1 E. BID OPENING AND EVALUATION

23. BID OPENING

23.1 The TGNPDCL will open all the Bids in online only as shown in Sl.No.13 of NIT for Bid evaluation. In the event of the specified date of Bid opening being declared a holiday for the TGNPDCL, the Bids will be opened on the next working day.

24. PROCESS TO BE CONFIDENTIAL

24.1 Information relating to the examination, clarification, evaluation, and comparison of Bids and recommendations for the award of a contract shall not be disclosed to Bidders or any other persons not officially concerned with such process until the award to the successful Bidder has been announced. Any effort by a Bidder to influence the Employer's processing of Bids or award decisions may result in the rejection of his Bid.

25. CLARIFICATION OF BIDS

25.1 To assist in the examination, evaluation, and comparison of Bids, the Employer may, at his discretion, ask any Bidder for clarification of his Bid, including breakdowns of unit rates. The request for clarification and the response shall be in writing or by fax, but no change in the price or substance of the Bid shall be sought, offered, or permitted except as required to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Bids in accordance with Clause 27.

25.2 Subject to sub-Clause 25.1, no Bidder shall contact the Employer on any matter relating to its bid from the time of the bidding opening to the time the contract is awarded. If the Bidder wishes to bring additional information to the notice of the Employer, he should do so in writing.

25.3 Any effort by the Bidder to influence the Employer in the Employer's bid evaluation, bid comparison or contract award decisions may result in the rejection of the Bidder's bid.

26. EXAMINATION OF BIDS AND DETERMINATION OF RESPONSIVENESS

26.1 Prior to the detailed evaluation of Bids, the Employer will determine whether each Bid (a) meets the eligibility criteria defined in Clause 3; (b) has been properly signed; (c) is accompanied by the required securities and; (d) is substantially responsive to the requirements of the Bidding documents.

26.2 A substantially responsive Bid is one which conforms to all the terms, conditions, and specifications of the Bidding documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with the Bidding documents, the Employer's rights or the Bidder's obligations under the Contract, or (c) whose rectification would affects unfairly the competitive position of other Bidders presenting substantially responsive Bids.

26.3 If a Bid is not substantially responsive, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the non-confirming deviation or reservation.

27. CORRECTION OF ERRORS

27.1 Bids determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Errors will be corrected by the Employer as follows:

(a) Where there is a discrepancy between the rates in figures and in words, the rate in words will govern, and

(b) Where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by the quantity the unit rate as quoted will govern.

27.2 The amount stated in the Bid will be adjusted by the Employer in accordance with the above procedure for the correction of errors and with the concurrence of the Bidder, shall be considered as binding upon the Bidder. If the Bidder does not accept the corrected amount the Bid will be rejected, and the Bid security may be forfeited in accordance with Sub-Clause 16.6 (b).

28. EVALUATION AND COMPARISION OF BIDS

28.1 The Employer will evaluate and compare only the Bids determined to be substantially responsive in accordance with Clause 26.

28.2 In evaluating the Bids, the Employer will determine for each Bid the evaluated Bid price by adjusting the Bids price as follows:

(a) making any correction for errors pursuant to Clause 27; or

(b) making an appropriate adjustments for any other acceptable variations, deviations and

(c) making appropriate adjustments to reflect discounts or other price modifications offered in accordance with Sub Clause 22.

28.3 The Employer reserves the right to accept or reject any variation, deviation, or alternative offer. Variations, deviations, and alternative offers and other factors, which are in excess of the requirements of the Bidding documents or otherwise result in unsolicited benefits for the Employer shall not be taken into account in Bid evaluation.

28.4 If the Bid of the successful Bidder is seriously unbalanced in relation to the Engineer's estimate of the cost of work to be performed under the contract, the Employer may require the Bidder to produce detailed price analysis for any or all items of the Bill of Quantities, to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analyses, the Employer may require that the amount of the performance security set forth in Clause 32.1 increased at the expense of the successful Bidder to a level sufficient to protect the Employer against financial loss in the event of default of the successful Bidder under the Contract.

1 F. AWARD OF CONTRACT

29. AWARD CRITERIA

29.1 Subject to Clause 32, the TGNPDCL will award the Contract to the Bidder whose Bid has been determined to be substantially responsive to the Bidding documents and who has offered the lowest evaluated Bid Price, provided that such Bidder has been determined to be (a) eligible in accordance with the provisions of Clause 3, and (b) qualified in accordance with the provisions of clause 4.

29.2 If the quoted L1 bidder price is not acceptable to the Management, TGNPDCL, Management has rights to negotiate with L2 bidder.

30 TGNPDCL's RIGHT TO ACCEPT ANY BID AND TO REJECT ANY OR ALL BIDS

30.1 Notwithstanding Clause 29, the Employer reserves the right to accept or reject any Bid, and to cancel the Bidding process and reject all Bids, at any time prior to the award of Contract, without thereby incurring any liability to the affected Bidder or Bidders or any obligation to inform the affected Bidder or Bidders of the grounds for the Employer's action.

31. NOTIFICATION OF AWARD AND SIGNING OF AGREEMENT

31.1 The Bidder whose Bid has been accepted will be notified of the award by the Employer prior to expiration of the Bid period by fax confirmed by registered letter. This letter (hereinafter in the Conditions of Contract called the "Letter of Acceptance") will state the sum that the Employer will pay the Contractor in consideration of the execution, completion, and maintenance of the works by the contractor as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").

31.2 The notification of award will constitute the formation of the Contract, subject only to the furnishing of a performance security in accordance with the provisions of Clause 32 and signing of agreement.

31.3 The contract agreement will incorporate all agreements between the Employer and the successful Bidder. It will be signed by the Employer and sent to the successful Bidder, within 28 days following the notification of award along with the Letter of Acceptance. Within 21 days of receipt, the successful Bidder will sign the Agreement and deliver it to the Employer.

31.4 Upon the furnishing by the successful Bidder of the performance Security, the Employer will promptly notify the other Bidders that their Bids have been unsuccessful.

32. PERFORMANCE SECURITY

32.1 Within 21 days of receipt of the Letter of Acceptance, the Successful Bidder shall deliver to the employer in any of the forms given in Section-8 for an amount equivalent to 5% of the Contract price plus additional security for unbalanced Bids in accordance with Clause 27 as a bank guarantee; or Bankers cheque / demand draft, as shown in Sl.No.6 of NIT.

32.2 If the performance security is provided by the successful Bidder in the form of a Bank Guarantee, it shall be issued either (a) at the Bidder's option, by Nationalized/ Scheduled Indian Bank or (b) by a foreign Bank located in India and accepted to the Employer.

32.3 Failure of the successful Bidder to comply with the requirements of Sub-Clause 32.1 shall constitute sufficient grounds for cancellation of the award and forfeiture of the Bids Security.

33. ADVANCE PAYMENT AND SECURITY : DELETED

34. PAYMENT TOWARDS PRICE ADJUSTMENT : DELETED

35 MODE OF PAYMENT

35.1 All payment bills shall be made promptly by the Employer on or after thirty (30) days of receipt of contractor's invoice complete in all respects and supported by the requisite documents and fulfillment of stipulated conditions, if any. All the payment shall be released to the contractor directly.

35.2 All invoices under the contract shall be raised by the contractor on TGNPDCL and all payments shall be made to the contractor by Chief Engineer/Finance on behalf of TGNPDCL.

36. CORRUPT OR FRAUDULENT PRACTICES

36.1 TGNPDCL Bidders/ Contractors observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy, TGNPDCL:

(a) Defines, for the purposes of this provision, the terms set forth below as follows:

(i) "Corrupt Practice" means the offering, giving, receiving or soliciting of any thing of value to influence the action of a public official in the procurement process or in contract execution, and

(ii) "Fraudulent Practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Borrower, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition.

(b) Will reject a proposal for award if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question.

(c) Will declare a firm ineligible, either indefinitely or for a stated period of time, to be awarded a Bank financed contract if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing a Bank-financed contract.

36.2 Furthermore, Bidders shall be aware of the provision stated in sub-clause 23.2 and sub-clause 57.1 of the General Conditions of Contract.

37 QUALITY ASSURANCE PLAN

The quality assurance plan of contractor shall be generally in accordance with ISO-9000/ IS-14000. This information shall be furnished with his bids as per section-7, failing which his bid shall be liable for rejection.

SECTION 2

FORMS OF BID, QUALIFICATION INFORMATION AND LETTER OF ACCEPTANCE

SECTION 2

FORMS OF BID, QUALIFICATION INFORMATION AND LETTER OF ACCEPTANCE

CONTRACTOR'S BID

Description of the Works: _____

_____

_____

To : Chief Engineer (Projects)
H.No.2-5-31/2, TGNPDCL, Vidyuth Bhavan,
Nakkalagutta, Hanamkonda,
Warangal – 506001.

Gentlemen,

We offer to execute the works described above in accordance with the Conditions of contract accompanying this Bid for the Contract Price of ` _____ (in figures) (Rupess_____) in letters.

The Bid and your written acceptance of it shall constitute a binding contract between us. We understand that you are not bound to accept the lowest or any Bid you receive.

Commission or gratuities, if any, paid or to be paid by us to agents relating to this Bid, and to contract execution if we are awarded the contract, are listed below:

Name and address of agent	Amount	Purpose of Commission or gratuity

(if none, state "none")

We hereby confirm that this Bid complies with the Bid Validity and Bid Security required by the Bidding documents.

We attach herewith our current income-tax clearance certificate.

Yours faithfully,

Authorized Signature:

Name & Title of **Signatory:**

Name of Bidder:

Address:

2. To be filled by Bidder, together with his particulars and date of submission at the bottom of the form of Bid.

QUALIFICATION INFORMATION

The information to be filled in by the Bidder in the Following pages will be used for purposes of post-qualification as provided for in Clause 4.2 of the Instructions to Bidders. This information will not be incorporated in the Contract.

1. For Individual Bidders

1.1 Constitution of legal status of Bidder
(Attach Copy)

Place of Registration:

Principal place of business:

Power of Attorney of Signatory of Bid
(Attach)

1.2 Total value of Electrical Engineering Construction Work performed in the last 3 years (` lakhs)

2021-22 _____

2022-23 _____

2023-24 _____

1.3.1 Work performed as prime contractor (in the same name) on works of a similar nature over the last 3 years.

Project Name	Name of Employer	Description of work	Contract No.	Value of contract (` lakhs)	Date of issue of work order	Stipulated period of completion	Actual date of completion	Remarks Explaining reasons for delay and work completed

- Enclosed certificate(s) from the Engineer(s) in-Charge.

1.3.2 Quantities of work executed as prime contractor (in the same name and style) in the last 3 years: ** 2021-22, 2022-23 and 2023-24

Year	Name of the work	Qty in Nos.	Amount (` lakhs)	Remarks * (Indicate contract ref.)

- Enclosed certificate(s) from the Engineer(s) in-Charge.

* Immediately proceeding the financial year in which bids are received

1.4 Information on Bid Capacity (works for which bids have been submitted and works which are yet to be completed) as on the date of this bid.

(A) Existing commitments and on-going works:

Description of work	Place & State	Contract No. & Date	Name and Address of Employer	Value of Contract (` Lakhs)	Stipulated period of completion	Value of works * remaining to be completed (` lakhs)	Anticipated date of completion
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

(B) Works for which bids already submitted:

Description of work	Place & State	Estimated value of works (` lakhs)	Stipulated period of completion	Date when decision is completed	Remarks if any expected
(1)	(2)	(3)	(4)	(5)	(6)

*Enclosed certificate (s) from the Engineer(s)-in-Charge.

1.5 The following items of Contractors Equipment are essential for carrying out the Works. The Bidder should list all the information requested below. Refer also to Sub Clause 4.2 (d) of the Instructions to Bidders.

Item of Equipment	Requirement No.	Capacity	Availability proposals Owned/leased to be procured	Nos./ capacity	Age/ condition	Remarks (from whom to be Purchased)

1.6 Qualifications and experience of key personnel proposed for administration and execution of the contract. Attach biographical data. Refer also to Sub Clause 4.2 (e) of instructions to Bidder and Sub Clause 9.1 of the General Conditions of Contract.

Position	Name	Qualifications	Years of Experience (general)	Years of experience in the proposed position
Project Manager				
Etc.				

1.7 Proposed subcontracts and firms involved (Refer ITB Clause 4.2(j))

Sections Of the works	Value of Sub-contract	Sub-contractor (name and address)	Experience in similar work

1.8 Financial reports for the last Five years: balance sheets, profit and loss statements, auditors report (in case of companies / corporation) etc. List them below and attach copies.

1.9 Evidence of access to financial resources to meet the qualification requirements: cash in hand, lines of credit, etc., List them below and attach copies of support documents.

1.10 Name, address and telephone and fax numbers of the Bidders' bankers who may provide references if contacted by the Employer.

1.11 Information on litigation history in which the Bidder is involved.

Other party(ies)	Employer	Cause of dispute	Amount involved	Remarks showing present status

1.12 Statement of compliance under the requirements of Sub Clause 3.2 of the instructions to Bidders.

1.13 Proposed work method and schedule. The Bidder should attach descriptions, drawings and charts as necessary to comply with the requirements of the Bidding documents. (Refer ITB Clause 4.1 and 4.2 (k))

2. Additional Requirements

2.1 Bidders should provide any additional information required to fulfill the requirements of Clause 4 of the Instructions to the Bidders, if applicable.

LETTER OF ACCEPTANCE

(Letterhead paper of the Employer)

_____(date)

To

_____ (name and address of the Contractor)

_____

_____

Dear Sirs:

This is to notify you that your Bid dated _____ for execution of the _____

[name of the contract and identification number, as given in Instruction to Bidder][1] for the Contract Price of Rupees _____ _____(_____)

[Amount in words and figures], as corrected and modified in accordance with the instructions to Bidders' is hereby accepted by our Agency.

You are hereby requested to furnish Performance Security, plus additional security for unbalanced bids in terms of ITB clause 28.4 in the form detailed in Para 32.1 of ITB for an amount of `_____ within 14 days of the receipt of this letter of acceptance valid upto 28 days from the date of expiry of Defects Liability Period i.e., upto. ……and sign the contract, failing which action as stated in Para 32.3 of ITB will be taken.

Yours faithfully,

Authorized Signature

Name and Title of Signatory

Name of Agency

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1. Delete "correct and" or "and modified" if only one of these actions applies. Delete "as corrected and modified in accordance with the Instructions to Bidders" if corrections or modifications have not been effected.

2. To be used only if the Contractor disagrees in his Bid with the Technical Expert proposed by the Employer in the "Instructions to Bidders".

NOTICE TO PROCEED WITH THE WORK

(letterhead of the Employer)

_____(date)

To
_____ (name and address of the Contractor)

_____

_____

Dear Sirs:

Pursuant to your furnishing the requisite security as stipulated in ITB clause 32.1 and signing of the contract for the _____ @ Bid Price of `_____ you are hereby instructed to proceed with the execution of the said works in accordance with the contract documents.

Yours faithfully,

(Signature, name and title of Signatory
authorized to sign on behalf of Employer)

AGREEMENT FORM

Agreement

The agreement, made the_____ day of _____20_____ between _____[name and address of Employer] (hereinafter called "the employer)" and _____ _____[name and address of contractor] (hereinafter called "the Contractor" of the other part).

Whereas the Employer is desirous that the Contractor execute _____ _____ _____)

name and identification number of Contract] (hereinafter called "The Works") and the Employer has accepted the Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein, at a cost of ` _____ _____.

NOW THIS AGREEMENT WITNESSTH as follows:

1. In this Agreement, words and expression shall have the same meanings as are respectively as signed to them in the Conditions of Contract hereinafter referred to, and they shall be deemed to form and be read and constructed as part of this Agreement.

2. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein conformity in all aspects with the provisions of the Contract.

3. The Employer hereby covenants to pay the contractor in consideration of the execution and completion of the Works and remedying the defects where in the Contract Price or such other sum as may become payable under provisions of the Contract at the times and in the manner prescribed by the Contract.

4. The following documents shall be deemed to form and be read and constructed as part of this Agreement, viz.:

   1 Agreement
   2 Letter of Acceptance
   3 Notice to proceed with the works
   4 Contractor's Bid
   5 Contract Data
   6 Conditions of Contract
   7 Technical Specifications
   8 Price bid document where Bill of quantities and their estimated values are mentioned
   9 Drawings
   10 Any other document listed in the Contract Data as forming part of the Contract

In witness whereof the parties there to have caused this Agreement to be executed the day and year first before written.

The Common Seal of _____

Was hereunto affixed in the presence of:

Signed, Sealed and Delivered by the said

_____

_____

_____

in the presence of:

Binding Signature of Contractor _____

Binding Signature of Employer _____

ANNEXURE-I

Undertaking to be given by the Company/ Partnership Firm/ Contractor along with the Tender

I, _____ representing the Company /Partnership Firm/ Contractor responding to the bid invitation by the TGTRANSCO/DISCOM vide Specification No. _____ hereby sincerely and solemnly affirm and state as follows:

(Strike out that which is not applicable)

a) That myself or any of the representatives of my company/ firm do not have any relatives as defined in the appended Annexure-III in the TGTRANSCO/ DISCOM.

(or)

b) That the following officers/ employees of the TGTRANSCO/ DISCOM are related to me and to the representatives of my company / firm and their status in the TGTRANSCO/ DISCOMs is as under.

Sl.No.	Name of the officer/employee	Designation and Place of working	TGTRANSCO / DISCOM	Relationship
1				
2				
3				
4				
5				
6				

It is certified that the information furnished above is true to the best of my knowledge and belief. It is hereby undertaken that in the event of the above information found to be false or incorrect at a later date, the TGTRANSCO/ DISCOM is entitled to terminate the contract/ agreement entered into besides recovering damages as may be found necessary, with due notice.

Signature of the authorized representative

ANNEXURE-II

Declaration to be given by the Company/Partnership Firm/Contractor at the time of entering into agreement with TGTRANSCO/DISCOMs

(Strike out that which is not applicable)

a) I declare that myself or any one of the representatives of my Company/Firm do not have any relatives as defined in the appended Annexure-III in the TGTRANSCO/DISCOM

OR

b) that the following officers /employees of the TGTRANSCO/DISCOM are related to me and to the representatives of my Company/Firm as mentioned here under.

Sl.No.	Name of the officer/employee	Designation and Place of working	TGTRANSCO / DISCOM	Relationship
1				
2				
3				
4				
5				
6				

It is certified that the information furnished above is true to the best of my knowledge and belief. It is hereby undertaken that in the event of any of the above information found to be false or incorrect at a later date, the TGTRANSCO/DISCOM is entitled to terminate the contract/agreement entered into, besides recovering damages as may be found necessary with due notice.

Signature of the authorized representative

ANNEXURE-III

LIST OF RELATIVES

1. Father
2. Mother (including Step mother)
3. Son (including Step Son)
4. Son's Wife
5. Daughter (including Step Daughter)
6. Father's Father
7. Father's Mother
8. Mother's Mother
9. Mother's Father
10. Son's Son
11. Son's Son's Wife
12. Son's Daughter
13. Son's Daughter's Husband
14. Daughter's Husband
15. Daughter's Son
16. Daughter's Son Wife
17. Daughter's Daughter
18. Daughter's Daughter's Husband
19. Brother
20. Brother's Wife
21. Sister (including Step Sister)
22. Sister's Husband
23. Son's Wife's Father
24. Son's Wife's Mother
25. Daughter's Husband's Father
26. Daughter's Husband's Mother

and their siblings

SECTION 3

GENERAL CONDITIONS OF CONTRACT

SECTION 3
GENERAL CONDITIONS OF CONTRACT
TABLE OF CLAUSES

3 A. GENERAL

1. DEFINITIONS

1.1 Terms which are defined in the Contract Data are also defined in the Conditions of contract but keep their defined meanings. Capital initials are used to identify defined terms.

Compensation Events are those defined in Clause 41 hereunder.

The Completion Date is the date of completion of the Works as certified by the Engineer in accordance with Sub Clause 49.1

The Contract is the contract between the Employer and the Contractor to execute, complete and maintain the Works. It consists of the documents listed in Clause 2.3 below.

The Contract Data defines the documents and other information, which comprise the Contract.

The Contractor is a person or corporate body whose Bid to carry out the Works has been accepted by the Employer.

The Contractor's Bid is the completed Bidding documents submitted by the Contractor to the Employer.

The Contract Price is the price stated in the Letter of Acceptance and thereafter as adjusted in accordance with the provisions of the Contract.

Days are calendar days; months are calendar months.

A defect is any part of the Works not completed in accordance with the Contract.

The Defects Liability period is the period named in the Contract Data and calculated from the Completion Date.

The Employer is the party who will employ the Contractor to carry out the Works.

The Engineer is the person named in the Contract Data (or any other competent person appointed and notified to the contractor to act in replacement of the Engineer) who is responsible for supervising the Contractor, administering the Contract, certifying payments due to the Contractor, issuing and valuing variations to the contract, awarding extensions of time, and valuing the Compensation Events.

Equipment is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works.

The initial Contract Price is the Contract Price listed in the Employer's Letter of Acceptance.

The Intended Completion Date is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is specified in the Contract Data. The Intended Completion Date may be revised only by the Engineer by issuing an extension of time.

Materials are all supplies, including consumables, used by the contractor for incorporation in the Works.

Plant is any integral part of the Works, which is to have a mechanical, electrical, electronic or chemical or biological function.

The Site is the area defined as such in the Contract Data.

Site Investigations Reports are those which were included in the Bidding documents and are factual interpretative reports about the surface and sub-surface conditions at the site.

Specifications mean the Specification of the Works included in the Contract and any modification or addition made or approves by the Engineer.

The Start Date is given in the Contract Data. It is the date when the Contractor shall commence execution of the works. It does not necessarily coincide with any of the Site Possession Dates.

A Subcontractor is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract which includes work on the Site.

Temporary Works are works designed, constructed, installed, and removed by the Contractor, which are needed for construction or installation of the Works.

A Variation is an instruction given by the Engineer, which varies the Works.

The Works are what the Contract requires the contractor to construct, install, and turn over to the Employer, as defined in the Contract Data.

2. INTERPRETATION

2.1 In interpreting these Conditions of Contract, singular also means plural, male also means female or neuter, and the other way around. Headings have no significance. Words have their normal meaning under the language of the Contract unless specifically defined. The Engineer will provide instructions clarifying queries about the Conditions of Contract.

2.2 If sectional completion is specified in the Contract Data, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the works (other than references to the Completion Date and Intended Completion date for the whole of the Works).

2.3 The documents forming the Contract shall be interpreted in the following order of priority:

1 Agreement
2 Letter of Acceptance
3 Notice to proceed with the works
4 Contractor's Bid
5 Contract Data
6 Conditions of Contract
7 Technical Specifications
8 Price bid document where Bill of quantities and their estimated values are mentioned
9 Drawings
10 Any other document listed in the Contract Data as forming part of the Contract

3. LANGUAGE AND LAW

3.1 The language of the Contract and the law governing the Contract are stated in the Contract Data.

4. ENGINEERS DECISIONS

4.1 Except where otherwise specifically stated, the Engineer will decide contractual matters between the Employer and the Contractor in the role representing the Employer.

5. DELEGATION

5.1 The Engineer may delegate any of his duties and responsibilities to other people except to the Adjudicator after notifying the Contractor and may cancel any delegation after notifying the contractor.

6 COMMUNICATIONS

6.1 Communications between parties which are referred to in the conditions are effective only when in writing. A notice shall be effective only when it is delivered (in terms of Indian Contract Act).

7. SUBCONTRACTING : DELETED

8. OTHER CONTRACTORS

8.1 The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and the Employer between the dates given in the Schedule of Other Contractors. The Contractor shall as referred in the Contract Data, also provide facilities and services for them as described in the Schedule. The employer may modify the schedule of other contractor and shall notify the contractor of any such modification.

9. PERSONNEL

9.1 The Contractor shall employ the key personnel named in the Schedule of Key Personnel as referred to in the Contract Data to carry out the functions stated in the Schedule to other personnel approved by the Engineer. The Engineer will approve any purposed replacement of Key personnel only if their qualifications, abilities, and relevant experience are substantially equal to or better than those of the personnel listed in the Schedule.

9.2 If the Engineer asks the Contractor to remove a person who is a member of the Contractor's staff or his work force stating the reasons the Contractor shall ensure that the person leaves the site within seven days and has no further connection with the work in the Contract.

10. EMPLOYER'S AND CONTRACTORS RISKS

10.1 The Employer carries the risks which this Contract states are Employer's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.

11. EMPLOYER'S RISKS

11.1 The Employer is responsible for the exceptional risks which are (a) in so far as they directly affect the execution of the Works in the Employer's country, the risks of war, hostilities, invasion, act of foreign enemies, rebellion, revolution, insurrection or military or usurped power, civil war, riot commotion or disorder (unless restricted to the Contractor's employees), and contamination from any nuclear fuel or nuclear waste or radioactive toxic explosive, or (b) a cause due solely to the design of the Works, other than the Contractor's design.

12. CONTRACTOR'S RISKS

12.1 All risks of loss of or damage to physical property and of personal injury and death which arise during and in consequence of the performance of the Contract other than the excepted risks are the responsibility of the Contractor.

13. INSURANCE

13.1 The Contractor shall provide, in the joint names of the Employer and the Contractor, insurance cover from the start Date to the end of the Defects Liability Period, in the amounts and deductibles stated in the Contract Data for the following events which are due to the Contractor's risks:

(a) Loss of or damage to the Works, Plant and Materials;
(b) Loss of or damage to Equipment
(c) Loss of or damage of property (except the Work, Plant, Materials and Equipment) in connection with the Contract; and
(d) Personal injury or death.

13.2 Policies and certificates for insurances shall be delivered by the Contractor to the Engineer for the Engineer's approval before the Start Date. All such insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred.

13.3 If the Contractor does not provide any of the policies and certificates required, the Employer may effect the insurance which the Contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due.

13.4 Alterations to the terms of insurance shall not be made without the approval of the Engineer.

13.5 Both parties shall comply with any conditions of the insurance policies.

14. SITE INVESTIGATION REPORTS

14.1 The Contractor, in preparing the Bid, shall rely on any site Investigation Reports referred to in the Contract Data, supplemented by any information available to the Bidder.

15. QUERIES ABOUT THE CONTRACT DATA

15.1 The Engineer will clarify queries on the Contract Data.

16. CONTRACTOR TO CONSTRUCT THE WORKS

16.1 The Contractor shall construct and install the Works in accordance with the Specifications and Drawings.

17 THE WORKS TO BE COMPLETED BY THE INTENDED COMPLETION DATE

17.1 The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the program submitted by the Contractor as updated with the approval of the Engineer, and complete them by the intended completion Date.

18 APPROVAL BY THE ENGINEER

18.1 The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Engineer, who is to approve them if they comply with the Specifications and Drawings.

18.2 The Contractor shall be responsible for design of Temporary Works.

18.3 The Engineer's approval shall not alter the Contractor's responsibility for design of the Temporary Works.

18.4 The Contractor shall obtain approval of third parties to the design of the Temporary Works where required.

18.5 All Drawings prepared by the Contractor for the execution of the temporary or permanent Works, are subject to prior approval by the Engineer before their use.

19 SAFETY

19.1 The Contractor shall be responsible for the safety of all activities on the Site.

20 DISCOVERIES

20.1 Anything of historical or other interest or of significant value unexpectedly discovered on the Site is the property of the Employer. The Contractor is to notify the Engineer of such discoveries and carry out the Engineer's instructions for dealing with them.

21 POSSESSION OF THE SITE

21.1 The Employer shall give possession of all parts of the Site to the Contractor. If possession of the part is not given by the date stated in the Contract Data the Employer is deemed to have delayed the start of the relevant activities and this will be Compensation Event.

22 ACCESS TO THE SITE

22.1 The Contractor shall allow the Engineer and any person authorized by the Engineer access to the Site, to any place where work in connection with the Contract is being carried out or is intended to be carried out and to any place where materials or plant are being manufactured/fabricated/assembled for the works.

23 INSTRUCTIONS

23.1 The Contractor shall carry out all instructions of the Engineer which comply with the applicable laws where the Site is located.

23.2 The Contractor shall permit employer or his representative to inspect the Contractor's accounts and records relating to the performance of the Contractor.

24 DISPUTES : DELETED

3 B. TIME CONTROL

25 PROGRAME

25.1 Within the time stated in the Contract Data the Contractor shall submit to the Engineer for approval a program showing the general methods, arrangements, order, and timing for all the activities in the Works along with monthly cash flow forecast.

25.2 An update of the Program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work including any changes to the sequence of the activities.

25.3 The Contractor shall submit to the Engineer, for approval, an updated program at intervals no longer than the period stated in the Contract Data. If the Contractor does not submit an updated program within this period, the Engineer may withhold the amount stated in the Contract Data from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue program has been submitted.

25.4 The Engineer's approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the Engineer again at any time. A revised Program is to show the effect of variations and Compensations Events.

26 EXTENSION OF THE INTENDED COMPLETION DATE

26.1 The Engineer shall extend the Intended Completion Date if a Compensation Event occurs or a variation is issued which makes it impossible for Completion to be achieved by the intended Completion Date without the Contractor taking steps to accelerate the remaining work and which would cause the Contractor to incur additional cost.

26.2 The Engineer shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Engineer for a decision upon the effect of a Compensation Event or variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with delay, the delay by this failure shall not be considered in assessing the new intended Completion Date.

27 DELAYS ORDERED BY THE ENGINEER

27.1 The Engineer may instruct the Contractor to delay the start or progress of any activity within the Works.

28 MANAGEMENT MEETINGS

28.1 Either the Engineer or the Contractor may require the other to attend management meeting. The business of a management meeting shall be to review the plants for remaining work and to deal with matters raised in accordance with the early warning procedure.

28.2 The Engineer shall record the business of management meetings and is to provide copies of his record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken is to be decided by the Engineer either at the management meeting or after the management meeting and stated in writing to all who attend the meeting.

29 EARLY WARNING

29.1 The Contractor is to warn the Engineer at the earliest opportunity of specific likely future events of circumstances that may adversely affect the quality of the work, increase the Contract Price or delay the execution of works. The Engineer may require the Contractor to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate is to be provided by the Contractor as soon as reasonably possible.

29.2 The Contractor shall cooperate with the Engineer in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Engineer.

3 C. QUALITY CONTROL

30 IDENTIFYING DEFECTS

30.1 The Engineer shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Engineer may instruct the Contractor to search for a Defect and to uncover and test any work that the Engineer considers may have a Defect.

31 TESTS

31.1 INSPECTION: The following materials to be supplied by the Contractor shall have to be inspected by the TGNPDCL Engineer at manufacturer's premises at any stage of manufacturing as per the approved drawings of TGNPDCL at the discretion of TGNPDCL. The materials shall be purchased from the approved vendors of MNRE as per the approved drawings.

i) Solar Photo Voltaic plant equipments.

31.2 If the Engineer instructs the contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect the test shall be a Compensation Event.

32 CORRECTION OF DEFECTS

32.1 The Engineer shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion and is defined in the Contract Data. The Defects Liability period shall be extended for as long as Defects remain to be corrected.

32.2 Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Engineer's notice.

33 UNCORRECTED DEFECTS

33.1 If the Contractor has not corrected a Defect within the time specified in the Engineer's notice, the Engineer will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

3 D. COST CONTROL

34 BILL OF QUANTITIES

34.1 The Bill of Quantities shall contain items for the construction, installation, testing, and commissioning work to be done by the Contractor.

34.2 The Bill of Quantities is used to calculate the Contract Price. The Contractor is paid for the quantity of the work done at the rate in the Bill of Quantities for each item.

35 CHANGES IN THE QUANTITIES

35.1 If the final quantity of the work done differs from the quantity in the Part-II for the particular item by more than 25 percent provided the change not exceeds 1% of initial Contract Price, the Engineer shall adjust the rate to allow for the change.

35.2 The Engineer shall not adjust rates from changes in quantities if thereby the initial Contract Price is exceeded by more than 15 percent, except with the Prior approval of the Employer.

35.3 If requested by the Engineer, the Contractor shall provide to the Engineer with a detailed cost breakdown on any rate in the Bill of Quantities.

36 VARIATIONS

36.1 All variations shall be included in updated program produced by the Contractor.

37 PAYMENTS FOR VARIATIONS

37.1 The Contractor shall provide the Engineer with a quotation for carrying out the Variation when requested to do so by the Engineer. The Engineer shall assess the quotation, which shall be given with seven days of the request or within any longer period stated by the Engineer and before the Variation is ordered.

37.2 If the work in the Variation corresponds with an item description in the Bill of Quantities and if, in the opinion of the Engineer, the quantity of work above the limit stated in Sub Clause 35.1 or the timings of its execution do not cause the cost per unit of quantity the rate in the Bill of Quantities shall be used to calculate the value of the Variation. If the cost per unit of quantity changes, or if the nature or timing of the work in the Variation does not correspond with items in the Bill of Quantities, the quotation by the Contractor shall be in the form of new rates for the relevant items of work.

37.3 If the Contractor's quotation is unreasonable, the Engineer may order the Variation and make a change to the Contract Price which shall be based on Engineer's own forecast of the effects of the Variation on the Contractor's costs.

37.4 If the Engineer decides that the urgency of varying the work would prevent a quotation being given and considered without delaying the work, no quotation shall be given and the variation shall be treated as Compensation Event.

37.5 The Contractor shall not be entitled to additional payment for costs which could have been avoided by giving early warning.

38 CASH FLOW FORECASTS

38.1 When the Program is updated, the Contractor is to provide the Engineer with an updated cash flow forecast.

39 PAYMENT CERTIFICATES

39.1 The Contractor shall submit to the Engineer monthly statements of the estimated value of work completed less the cumulative amount certified previously.

39.2 The Engineer shall check the Contractor's monthly statement within 14 days and certify the amount to paid to the Contractor.

39.3 The value of work executed shall be determined by the Engineer.

39.4 The value of work executed shall comprise the value of the quantities of the items in the Bill of Quantities completed.

39.5 The value of work executed shall include the valuation of Variations and Compensation Events.

39.6 The Engineer may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.

40 PAYMENTS

40.1 Payments shall be adjusted for deductions for advance payments, retention and other recoveries in terms of the contract and deduction at source of taxes as applicable under the law. The Employer shall pay the Contractor the amounts certified by the Engineer within 30 days of the date of each certificate.

40.2 Items of the Works for which no rate or price has been entered it will not be paid for by the Employer and shall be deemed covered by other rates and prices in the Contract.

40.3 The following terms of payment shall apply for the tender:-

a) **70%** of the value of the project cost excluding cost of O&M (cost of providing power) after successful installation and synchronization of the plant at site linked to the project completion milestones.

b) **20%** amount of the work value shall be paid after3 months from the date of commissioning of solar power plant at site duly obtaining the Commissioning certificate.

c) Balance **10%** of the 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. This amount shall be paid after completion of CMC period.

d) 5% Security money deposited by the contractor at the time of signing of contract agreement will be released after completion of 5 years Warrantee, operation and maintenance period, after handing over of the Solar Power Plant to TGNPDCL in satisfactory running conditio

41 COMPENSATION EVENTS

41.1 The following are Compensation Events unless they are caused by the Contractor:

(a) The Employer does not give access to a part of the Site by the Possession Date stated in the Contract Data.
(b) The Employer modifies the schedule of other contractors in a way which effects the work of the contractor under the contract.
(c) The Engineer orders a delay or does not issue drawings, specifications or instructions required for execution of works on time.
(d) The Engineer instructs the Contractor to uncover or to carry out additional tests upon work which is then found to have no Defects.
(e) The Engineer unreasonably does not approve for a subcontract to be let.
(f) Ground conditions are substantially more adverse than could reasonably have been assumed before issuance of Letter of Acceptance from the information issued to Bidders (including the Site Investigation Reports), from information available publicly and from a visual inspection of the Site.
(g) The Engineer gives an instruction for dealing with an unforeseen condition, caused by the Employer, or additional work required for safety or other reasons.
(h) Other contractors, public authorities, utilities or the Employer does not work within the dates and other constraints stated in the Contract, and they cause delay or extra cost to the Contractor.
(i) The advance payment: **DELETED.**
(j) The effect on the Contractor of any of the Employer's Risks.
(k) The Engineer unreasonably delays issuing a Certificate of Completion.

(l) Other Compensation Events listed in the Contract Data or mentioned in the Contract.

41.2 If a Compensation Event would cause additional cost or would prevent the work being completed before the intended Completion Date, the Contract Price shall be increased and/or the Intended Completion Date is extended. The Engineer shall decide whether and by how much the Contract Price shall be increased and whether any by how much the Intended Completion Date shall be extended.

41.3 As soon as information demonstrating the effect of each Compensation Event upon the Contractor's forecast cost has been provided by the Contractor, it is to be assessed by the Engineer and the Contract Price shall be adjusted accordingly. If the Contractor's forecast is deemed unreasonable, the Engineer shall adjust the Contract Price based on Engineer's own forecast. The Engineer will assume that the Contractor will react competently and promptly to the event.

41.4 The Contractor shall not be entitled to compensation to the extent the Employer's interest are adversely affected by the Contractor not having given early warning or not having cooperated with the Engineer.

42 TAX

42.1 The rates quoted by the contractor is inclusive of all taxes and will be paid as per rules in vogue.

42.2 The rates quoted by the Contractor shall be deemed to be inclusive of the sales and other taxes that the contractor will have to pay for the performance of this contract. The Employer will perform such duties in regard to the deduction of such taxes at source as per applicable law. The VAT, Service Tax, CESS is included in the unit rates. As per the notification No.14/2015 service tax GOVT of India the reverse charge mechanism has come into force w.e.f. 01.06.2015 Both service receiver and service provider has to pay service tax 7.5% on labour and there will be no reimbursement of service tax paid by the service provider. Rates are inclusive of service tax @ of 15% on labour. 50% service tax will be deducted from contractor bill and transferred to concerned department (service receiver portion) and the balance 50% service tax shall be paid by the contractor to concerned department which is not reimbursable (service provider portion).

43 CURRENCIES

43.1 All payments shall be made in Indian Rupees.

44 PRICE ADJUSTMENT : DELETED

45 RETENTION

45.1 The Employer shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole of the Works.

45.2 On Completion of the whole of the Works half the total amount retained is repaid to the Contractor and half when the Defects Liability Period has passed and the Engineer has certified that all Defects notified by the Engineer to the Contractor before the end of this period have been corrected.

45.3 On completion of the whole works, the contractor may substitute retention money with an "on demand" Bank guarantee.

46 LIQUIDATED DAMAGES

46.1 The Contractor shall pay liquidated damages to the Employer at the rate per day stated in the Contract Data for each day that the Completion Date is later than the intended Completion Date (for the whole of the works or milestone as stated in the contract Data). The total amount of liquidated damages shall not exceed the amount defined in the Contract Data. The Employer may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages does not affect the Contractor's liabilities.

46.2 If the Intended Completion Date is extended after liquidated damages have been paid, the Engineer shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate. The Contractor shall be paid interest on the over payment calculated from the date of payment to the date of repayment at the rates specified in Sub Clause 41.1

47 SECURITIES

47.1 The Performance Security (including additional security for unbalanced bids) shall be provided to the Employer no later than the date specified in the Letter of Acceptance and shall be issued in an amount form and by a bank or surety acceptable to the Employer, and denominated in Indian Rupees. The Performance security shall be valid until a date 28 days from the date of expiry of Defects Liability Period and the additional security for unbalanced bids shall be valid until a date 28 days from the date of issue of the certificate of completion.

48 COST OF REPAIRS

48.1 Loss or damage to the Works or Materials to be incorporated in the Works between the Start Date and the end of Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions.

3 E. FINISHING THE CONTRACT

49 COMPLETION

49.1 Work should be completed within 9 months from the date of entering into agreement as per the following schedule:

1st month	Survey & procurement of materials
2nd month	20%
3rd month	40%
4th month	60%
5th month	80%
6th month	100%

49.2 The Contractor shall request the Engineer to issue a Certificate of Completion of the Works and the Engineer will do so upon deciding that the work is completed.

50 TAKING OVER

50.1 The Employer shall take over the Site and the Works within seven days of the Engineer issuing a certificate of completion.

51 FINAL ACCOUNT

51.1 The Contractor shall supply to the Engineer a detailed account of the total amount that the Contractor considers payable under the contract before the end of the Defects Liability Period. The Engineer shall issue a Defect Liability Certificate and certify any final payment that is due to the Contractor within 56 days of receiving the Contractor's account if it is correct and complete. If it is not, the Engineer shall issue within 56 days a schedule that states that scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the Engineer shall decide on the amount payable to the Contractor and issue a payment certificate, within 56 days of receiving the Contractor's revised account.

52 OPERATING AND MAINTENANCE MANUALS

52.1 If "as built" Drawings and/or operating and maintenance manuals are required, the Contractor shall supply them by the dates stated in the Contract Data.

52.2 If the Contractor does not supply the Drawings and / manuals by the dates stated in the Contract Data, or they do not receive the Engineer's approval, the Engineer shall with hold the amount stated in the Contract Data from payments due to the Contractor.

53 TERMINATION

53.1 The Employer or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract.

53.2 Fundamental breaches of Contract include, but shall not be limited to the following.

(a) The Contractor stops work for 28 days when no stoppage of work is shown on the current program and the stoppage has not been authorized by the Engineer.
(b) The Engineer instructs the Contractor to delay the progress of the Works and the instruction is not withdrawn within 28 days.
(c) The Employer or the Contractor is made bankrupt or goes into liquidation other than for reconstruction or amalgamation.
(d) A payment certified by the Engineer is not paid by the Employer to the Contractor within 120 days of the date of the Engineer's certificate:
(e) The Engineer gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Engineer.
(f) The Contractor does not maintain a security which is required;
(g) The Contractor has delayed the completion of works by the number of days for which the maximum amount of liquidated damages can be paid as defined in the Contract data; and
(h) If the Contractor, in the judgment of the Employer has engaged in corrupt or fraudulent practices in competing for or in the executing the Contract.

For the purpose of this paragraph: "corrupt practice" means the offering, giving receiving or soliciting of any thing of value to influence the action of a public official in the procurement process or in contract execution. "Fraudulent Practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Borrower, and includes collusive practice among Bidders

(prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition.

53.3 When either party to the Contract gives notices of a breach of contract to the Engineer for a cause other than those listed under Sub Clause 53.2 above, the Engineer shall decide whether the breach is fundamental or not.

53.4 Notwithstanding the above, the Employer may terminate the Contract for convenience.

53.5 If the Contract is terminated the Contractor shall stop work immediately, make the Site safe and secure and leave the Site as soon as reasonably possible.

54 PAYMENT UPON TERMINATION

54.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Engineer shall issue a certificate for the value of the work done less advance payments received up to the date of the issue of the certificate, less other recoveries due in terms of the contract, less taxes due to the deducted at source as per applicable law and less the percentage to apply to the work not completed as indicated in the Contract Data. Additional Liquidated Damages shall not apply. If the total amount due to the Employer exceeds any payment due to the Contractor the differences shall be a debt payable to the Employer.

54.2 If the Contract is terminated at the Employer's convenience or because of a fundamental breach of contract by the Employer, the Engineer shall issue a certificate for the value of the work done, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the works, and the Contractor's costs of protecting and securing the Works and less advance payments received up to the date of the Certificate, less other recoveries due in terms of the contract and less taxes due to be deducted at source as per applicable law.

55 PROPERTY

55.1 All materials on the Site, Plant, Equipment, Temporary Works and Works are deemed to be the property of the Employer, if the Contract is terminated because of a Contractor's default.

56 RELEASE FROM PERFORMANCE

56.1 If the Contract is frustrated by the outbreak of war or by another event entirely outside the control of either the Employer or the Contractor the Engineer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which commitment was made.

3 F. SPECIAL CONDITIONS OF CONTRACT

1. DESCRIPTION

The Contractor shall, at all times during the continuance of the contract, comply full with all existing Acts, regulations and byelaws including all statutory amendments and re-enactments of State or Central Government and other local authorities and any other enactments, notifications and acts that may be passed in future either by the State or the Central Government or local authority, including Indian workmen's Compensation Act, 1923. Contract Labour (Regulation and Abolition) Act 1970, the Child Labour Prohibition and Regulation Act, 1986 an Equal Remuneration Act 1976, Factories Act, Minimum Wages Act 1948, Provident Fund Regulations, Employees Provident Fund Act 1952 EPF Act 1996 and related acts passed from time to time. Schemes made under the Same Act the Buildings and other construction workers (Regulation of Employment and condition of service) Act 1996, the CESS Act 1996 and also applicable Labour Regulations, Health and Sanitary Arrangement for Workmen, Insurance and other benefits and shall keep Employer indemnified in case any action is commenced by Competent authorities for contravention by the Contractor.

If the Employer is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated above on the part of the Contractor, the Engineer shall have the right to deduct from any amounts due to the Contractor, his amount of Performance Security or recover from the Contractor personally any sum required or estimated to be required for making good the loss or damage suffered by the employer, responsibility in connection with the employees of the contractor, who shall, in no case, be treated as the employees of the Employer at any point of time.

1.1 A RESPONSIBILITY FOR EXECUTION OF THE CONTRACT (CLAUSE 16 OF G.C.C)

The Contractor shall carry out the entire work according to sound engineering practices. The responsibility lies with the Contractor for the proper execution of the erection work according to existing laws and bye laws at the time of contract execution. The Contractor shall confirm in respects to the requirements to CEIG (Chief Electrical Inspector to Government of A.P.) as and when required by them. However, the Contractor shall have to follow the instructions of the Employer or his authorized representative in respect of the following.

a. Progress reports to be submitted from time to time.
b. Progress and completion of the work according to the time schedule.
c. Execution of contract works to the Purchaser's entire satisfaction.
d. Submitting the details regarding the name of the responsible persons for execution of this contract.
e. Preparing, submission and getting approval of the complete electrical system of the power plant including the switch yard.

1.1.B. NOTICES:

1.1.1 All Certificates, notices or written orders to be given by the Employer to the Contractor under the terms of the contract shall be served by sending by post to or delivering the same to Contractor's principal place of business, or such other address as the Contractor shall nominate for this purpose.

1.1.2 All notices to be given to the TGNPDCL or to the Engineer under the terms of the Contract shall be served by sending by post or delivering the same to the respective addressee nominated for that purpose.

The TGNPDCL address is
Chief Engineer (Projects)
H.No.2-5-31/2, TGNPDCL,
Vidyuth Bhavan, Nakkalagutta,
Hanamkonda, Warangal – 506001.

The Engineer's address is
Divisional Engineer/Construction/Karimnagar.

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2. WORKING HOURS (CLAUSE 12 OF G.C.C)

Before commencement of work, the contractor shall inform in writing, the normal working hours for his staff and workers. These hours be as far as possible in consonance with the Employer's working hours for better coordination.

All the staff and workers should positively leave the site premises after these hours, except for authorized watch and ward personnel, approved by the employer.

3. EXTRA SHIFT & OVERTIME WORK (CLAUSE 12 OF G.C.C)

At the commencement of work, the Contractor shall arrange for a general shift, as per working hours.

If, at a later date the employer feels that extra shift should be started to complete work allotted to the contractor within the time stipulated or to make up for any past delays. The contractor shall arrangement for.

4. ACCIDENTS (CLAUSE 12 OF G.C.C)

The employer will not be responsible for any damages or compensation payable inconsequence of an accident or injuries to any of the Contractor's personnel or any third party.

The contractor shall insure at his cost-against any such eventuality as per rules in force and submit the documentary evidence of the Insurance Policy taken, positively prior to commencement of work at site and should keep policy valid by paying premium and other changes will handing over of the plant.

In case of any accidents at or near the site in connection with the execution of work, the contractor shall with in 24 hours, make a detailed report of accident and submit the same to the purchaser in the form provided by the purchaser.

The contractor shall also report such accidents to the competent authority as laid down by the existing rules and regulations and inform the Employer regarding the same.

5.0 INSURANCE FOR MATERIALS SUPPLIED BY TGNPDCL (CLAUSE 13 OF G.C.C)

The Contractor shall insure in the name of the TGNPDCL for the amount equal to the value of material supplied to him by the TGNPDCL against loss or damage for the period from the time of taking over the materials from the TGNPDCL to the date of issue of completion certificate. The value of the policy shall be enhanced from time to time depending upon the value of the TGNPDCL materials taken over. TGNPDCL will reimburse the above insurance charges on submission of his claim together with insurance policy.

5.1 Insurance coverage for all items shall be at the risk of the contractor.

5.2 INDEMNITIES

The contractor is liable for and indemnifies the TGNPDCL against losses, expenses and claims for loss or damage to physical property, personal injury and death caused by his own acts or omissions.

5.3 The contractor claiming indemnity is to take all reasonable steps to mitigate the lower damage will occur.

5.4 The contractor indemnifies the TGNPDCL against claims to damages caused by the movements of his equipment or temporary works.

5.5 The Contractor shall submit an "Indemnity Bond" to the TGNPDCL incorporating the above points before taking up the execution of the work.

6. LICENSE (CLAUSE 16 OF G.C.C)

The contractor or his sub-contractor shall have valid contractor's license from Electrical Inspector of AP State, and he shall maintain its validity for the complete duration of the contract.

7. TRANSPORT ARRANGEMENT (CLAUSE 17 OF G.C.C)

The contractor shall make the transport arrangement at his cost for his staff and workers to site.

8. MACHINERY, TOOLS & TACKLES (CLAUSE 17 OF G.C.C)

The Contractor shall provide the required machinery/equipment, accessories, necessary tools and tackles, instruments, and all the normal consumable materials required for the satisfactory execution of this contract. The Contractor shall arrange for cranes for unloading and erection purpose, if required.

Gate Pass for Materials:

All tools, tackles, construction materials, welding materials etc., will be taken inside the site limits only after registration with security personnel. Also any material will be taken out only on valid gate pass issued by purchaser's representative after checking the proper "IN" gate passes. The contractor shall have to preserve the "IN" gate passes obtained from security when every /any material is route inside the site to enable taking back the balance/excess materials, Tools and Tackles after completion of works.

9. SAFETY PRECAUTIONS (CLAUSE 19 OF G.C.C)

All the safety measures to avoid accidents shall be followed strictly in accordance with the safety rules and regulation laid down by the government authorities.

The Contractor shall take all safety precautions and shall provide proper scaffolding, life-belts, ladder shock proof helmets, etc. to avoid accidents and to ensure safety, of not only his personnel but also the safety of the staff and workers of other contractors working at the same site.

The contractor shall take necessary precautions to ensure that no part of the building/structure damage or disfigured due to negligence on his part while carrying out the work. In case of excess damage, the same shall be made good by the contractor immediately at his own cost.

Re-commissioning on energized equipment shall be carried out with proper safety permits issued by the Purchaser/Competent authorities. When required to work at heights or at hazardous location areas, the contractor shall carryout the same with utmost care and all safety precautions.

10. FIRE PRECAUTIONS (CLAUSE 19 OF G.C.C)

The contractor shall strictly instruct his site staff and workers to abide by the regulations in force at the site regarding all precautions to be taken to avoid fire hazards.

11. WORKING AREA & CLEANLINESS (CLAUSE 21 OF G.C.C)

The Contractor shall keep the site of work in a clean and sanitary condition. After the completion of the entire work, the contractor shall arrange to remove all the temporary structures, surplus materials, dirt, debris, etc. from the site and finished work shall be handed over the employer in a clean and complete shape.

12. SITE DISCIPLINE (CLAUSE 21 OF G.C.C)

Strict discipline shall be observed by all the contractor's personnel inside the premises of the site. The contractor and his personnel shall abide by all the rules and regulations of the Employer, Disciplinary action shall be taken against the Contractor/his personnel and their services liable to be terminated, if found quarrelling/ violating the rules.

13. SITE OFFICE & SITE STORES (CLAUSE 21 OF G.C.C)

The Contractor will make necessary arrangements for erection of his site office and site stores after getting written permission from the employer to erect such temporary structure at his own cost. Temporary power supply will be provided at one point at the nearest switch room. The power consumption charges will have to be borne by the Contractor. However, non-availability of the Crane does not leave the contractor off his responsibilities. The contractor is permitted to make use of water source available in any sub-station sites for construction purpose. Transport of water from the source to the working areas will be contractor's responsibility.

14. APPROVAL OF INSTALLATION BY GOVERNMENT AUTHORITIES (CEIG)

Wherever approval of government authorities is required, as per existing rules and regulations, the Contractor shall obtain the same.

15. MEASUREMENT (CLAUSE 40 OF G.C.C)

The Engineer shall, except as otherwise stated ascertain and determine by measurement the value in terms of the contract of work done in accordance with the contract. He shall, when required any part or parts of the works to be measured, give notice to the contractor's authorized agent or representative, who shall forth with attend or send a qualified agent to assist the Engineer or the Engineer's Representative in making such measurement, and shall furnish all particulars required by either of them. Should the contractor not attend or neglect or omit to send such agent, then the measurement of the work. For the purpose of measuring such permanent work as is to be measured by records and drawings, the Engineer's representative shall prepare records and drawings month by month of such work and the contractor, as and when called upon to do so in writing, shall within fourteen days, attend to examine and agree such records and drawings, they shall be taken to be correct. If, after examination of such records, and drawings, they shall nevertheless be taken to be correct, unless the contractor shall, within Fourteen days of such examination, lodge with the Engineer's Representative, for decision by the Engineer, notice in writing of the respects in which such records and drawings are claimed by him to be incorrect. Payments will be made to the contractor by cheque at monthly intervals. The contractor shall submit his hills for work accomplished and measured by Engineer on or before the last day of month.

16. INCOME TAX (CLAUSE 42 OF G.C.C)

a) Deductions will be made towards Income Tax at source by the TGNPDCL as directed by Income Tax Department.

b) The Contractor's staff, personnel and labour will be liable to pay personnel income taxes in India in respect of such of their salaries and wages as are chargeable under the laws and regulations for the time being in force, and the contractor shall perform such duties in regard to such deductions there of as may be imposed on him by such laws and regulations.

17. TERMINATION OF CONTRACT FOR TGNPDCL CONVENIECE (CLAUSE 53.4 OF G.C.C)

The TGNPDCL shall be entitled to terminate this contract at any time for the TGNPDCL convenience after giving 30 days prior notice to the contractor with a copy to the Engineer.

18. LABOUR

The Contractor shall, unless otherwise provided in the contract, make his own arrangements, for the engagements of all staff and labour, local, or other, and for their payment, housing, feeding and transport.

The Contractor shall, if required by the Engineer, deliver to the Engineer a return in detail, in such form and at such intervals as the Engineer may prescribe showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such information respecting Contractor's Equipment as the Engineer may require.

19 COMPLIANCE WITH LABOUR REGULATIONS

During continuance of the Contract, the Contractor and his sub contractors shall abide at all times by all existing labour enactment's and rules made there under, regulations, notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules), regulations, bye laws that may be passed or notification that may be issued under any labour law in future either by the State or the Central Government or the local authority. Salient features of some of the major labour laws that are applicable to construction industry are given below. The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by the Competent authority on account of contravention of any of the provisions of any Act or rules made there under, regulations or notifications including amendments. If the Employer is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/bye laws/Acts/Rules /regulations including amendments, if any, on the part of the Contractor, the Engineer/Employer shall have the right to deduct any money due to the contractor including his amount of performance security. The Employer/Engineer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer.

The employees of the Contractor and the Sub-Contractor in no case shall be treated as the employees of the Employer at any point of time.

Salient features of some major labour laws applicable to establishments engaged in building and other construction work.

a) **Workmen Compensation Act 1923:** The Act provides for compensation in case of injury by accident arising out of and during the course of employment.

b) **Payment of Gratuity Act 1972:** Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years service or more or on death the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.

c) **Employees PF and Miscellaneous Provision Act 1952:** The Act for monthly contributions by the employer plus workers @10% or 8.33%. the benefits payable under the Act are:

   (i) Pension or family pension on retirement or death, as the case may be
   (ii) Deposit linked insurance on the death in harness of the worker.
   (iii) Payment of PF accumulation on retirement /death etc.

d) **Maternity Benefits Act 1951:** The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.

e) **Contract labour (Regulation &Abolition) Act 1970:** The Act provides for certain welfare measures to be provided b y the contractor to contract labour and in case the Contractor fails to provide, the same are required to be provided, by the principal Employer by Law. The Principal Employer is required to take Certificate of Registration and the Contractor is required to take license from the designated officer. The Act is applicable to the establishments or Contractor of Principal Employer if they employ 20 or more contract labour.

f) **Minimum Wages Act 1948:** The Employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provision of the Act if the employment is a scheduled employment. Construction of Buildings, Roads, and Runways are scheduled employments.

g) **Payment of Wages Act 1936:** It lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers.

h) **Equal Remuneration Act 1979:** The Act provides for payment of equal wages for work of equal nature to Male and Female workers and for not making discrimination against Female employees in the matters of transfers, training and promotions etc.

i) **Payment of Bonus Act 1965:** The Act is applicable to all establishments employing 20 or more employees. The Act provides for payments of annual bonus subject to a minimum of 8.33% of wages and maximum of 20% of wages to employees drawing Rs.3500 per month or less. The bonus to be paid to employees getting Rs.2500 per month or above up to Rs.3500 per month shall be worked out by taking wages as Rs.2500 per month only. The Act does not apply to certain establishments. The newly set-up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of this Act.

j) **Industrial Disputes Act 1947:** The Act lays down the machinery and procedure for resolution of Industrial disputes, in what situations or lock-out becomes illegal and what are the requirements of laying off or retrenching the employees or closing down the establishments.

k) **Industrial Employment (Standing Orders) Act 1946:** It is applicable to all establishments employing 100 or more workmen (employment size reduced by some of the States and Central government to 50). The Act provides for laying down rules governing the conditions of employment by the Employment on matters provided in the Act and get the same certified by the designated Authority.

l) **Trade Union Act 1926:** The Act lays down the procedure for registration of trade unions of workmen and employers. The Trade Unions registered under the Act have been given certain immunities from civil and criminal liabilities.

m) **Child Labour (prohibition & Regulation) Act 1986:** The Act prohibits employment of children below 14 years of age in certain occupations and process and provides for regulation of employment of children in all other occupations and processes. Employment of Child Labour is prohibited in Building and Construction Industry.

n) **Inter-State Migrant Workmen's (Regulation of Employment & Conditions of Service) Act 1979:** The Act is applicable to an establishment which employ 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The Inter State migrant workmen, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home up to the establishment and back, etc.

o) **The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 and the Cess Act of 1996:** All the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the Government. The Employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as Canteens, First- Aid facilities, Ambulance, Housing accommodations for workers near the work place etc. The Employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.

p) **Factories Act 1948:** The Act lays down the procedure for approval at plans before setting up a factory, health and safety provisions, welfare provisions, working hours, annual earned leave and rendering information regarding accidents or dangerous occurrences to designated authorities. It is applicable to premises employing 10 persons or more with aid of power or 20 or more persons without the aid of power engaged in manufacturing process.

20 ARBITRATION: DELETED

21 RESPONSIBILITY FOR EXECUTION OF THE CONTRACT

The contractor shall carryout the entire work according to sound Engineering practices. The responsibility lies with the contractor for proper execution of work according to existing loss and bylaws. The contractor shall have to follow the instructions of the Employer or Engineer–In–Charge.

a) Progress reports shall be furnished fortnightly.
b) The details of project manager and site supervisors.
c) Inspection of supports and other equipment at manufacturer's site by the Employer.
d) Approval test certificates before dispatch the material /equipment to site.
e) Proper storage of material / equipment.
f) "As Built" drawings and schedules shall be submitted with in 15 days of completion of the work.
g) Operating manuals and operating instructions shall be furnished.

22 LINE CLEARS

i) In rural areas Line Clears (LCs) will be issued only for 6 Hrs. duration between 6 AM and 6 PM daily and the contractor has to program the works i.e., mobilization of men and materials accordingly.
ii) LCs in towns / cities will be issued at a stretch up to 4 Hrs. on any 11 kv feeder per day between 6 AM and 6 PM subject to prior approval by the Engineer and the contractor has to program the works i.e., mobilization of men and materials accordingly.

SECTION 4

CONTRACT DATA

CONTRACT DATA

Item marked "N/A" do not apply in this Contract.
The following documents are also part of the Contract:

Reference	GCC Clause No.
• The Schedule of Operating and Maintenance Manuals	(52)
• The Schedule of Other Contractors	(8)
• The Schedule of Key Personnel	(9)

The above insertions should correspond to the information provided in the Invitation of Bids.

The Employer is
Name: Chief Engineer (Projects)
Address: H.No.2-5-31/2, TGNPDCL,
Vidyuth Bhavan, Nakkalagutta,
Hanamkonda, Warangal – 506001.

Name of **authorized Representative**: Chief Engineer/Construction/Warangal

The Engineer is
Name: Divisional Engineer/Construction/Karimnagar.
Address: TGNPDCL/

The name and **Identification Number** of the Contract is **Bid No.II-106/2024-25/CE/Proj/CESS/Sircilla**
(Insert Name and Number as indicated in the Invitation for Bids (or Prequalification, if any)
(1.1)

The **Works consist** of _____
(Brief Summary, including relationship to other contracts under the Project)

The **Start Date** shall be Date of Entering into Agreement. (1.1)

The **Intended completion Date** for the whole of the works
should comply with the following milestones: (17, 26)

Milestone dates:

Physical works to be completed	Period from date of issue of Notice to proceed with the work
1st month	Survey & procurement of materials
2nd month	20%
3rd month	40%
4th month	60%
5th month	80%
6th month	100%

The following documents also part of the Contract: (2.3)

The Contractor shall submit a revised Program for the Works within 30 days of delivery of the Letter of Acceptance. (25)

The **Site is located** at **on CESS Boinpally, Karimnagar of TGNPDCL**

The **Defects Liability Period** is **60 Months** from the date of issue of completion certificate (33)

The all equipments of the plant should having warranty for five years from the date of issue of completion certificate.

The minimum insurance cover for physical property, injury and death is ` 5 lakhs per occurrence with the number of occurrences limited to 4. After each occurrence, contractor will pay additional premium necessary to make insurance valid for four occurrences always. (13)

The Compensation Events: (41)

The period between program updates shall be 30 days (25)

The language of the Contract documents is English (3)

The law which applies to the Contract is the law of India (3)

The currency of the Contract is Indian Rupees (43)

The proportion of payments retained (retention money) shall be 6% from each bill subject to a maximum of 5% of contract value (45)

The liquidated damages for the whole of the works are at ` 0.2% on the estimated cost per day (amount) and that for the milestones (46)

The maximum amount of liquidated damages for the whole of the works is 10% of final contract price. (46)

SECTION - 5

TECHNICAL SPECIFICATIONS

Technical Specification for Establishment of Ground Mounted Solar Photo Voltaic power plant capacity 2 MW (AC) At CESS BOINAPALLY of SIRICILLA District in TGNPDCL.

Design Philosophy

1 The main objective of the design philosophy is to construct the plant 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.

1.1 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, site conditions etc.

1.2 Use of energy efficient (all type of transformers, inverters etc.) equipment to minimize the ohmic losses and systems with proven design and performance that have high availability track records under similar service conditions. The auxiliary consumption should not exceed 0.75% of solar generation.

1.3 Selection of the equipment and adoption of a plant layout to ensure ease of maintenance.

1.4 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 site), during erection, testing and commissioning.

1.5 Proper monitoring of synchronization and recording, to ensure availability of power to the grid.

1.6 The plant instrumentation and control system should be designed to ensure high availability and reliability of the plant to assist the operators in the safe and efficient operation of the plant with minimum effort.

1.7 It should also provide the analysis of the historical data and help in the plant maintenance people to take up the plant and equipment on predictive maintenance.

1.8 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 Plant.

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

2.1 SPV power plant 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 plant.

2.2 The Module Mounting Structures shall be designed for such that SPV arrays produce maximum energy during the period of respective tilt.

2.3 Shadow free plant layout to ensure minimum losses in generation during the day time.

2.4 Higher system voltage and lower current options to be followed to minimize ohmic losses

2.5 Selection of PCUs with proven reliability and minimum downtime. Ready availability of requisite spares.

2.6 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.

2.7 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 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.

2.8 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.

2.9 Bidder shall design the plant and equipment in order to have sustained life of 25 years with minimum maintenance efforts.

2.10 The work execution planning for supply, erection, commissioning and all other allied works for SPV Power Plant shall be such that it is completed within stipulated time from the date of Purchase order/ LOI, whichever is later.

3 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 site and satisfy themselves before bidding.

Electrical System

1 **Photovoltaic Modules**

1.1 Standards and Codes

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

Standard	Description
IEC 61215-1:2016Ed.1	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements
IEC 61215-1-1:2016Ed.1	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61730-1:2016Ed.2	Photovoltaic (PV) module safety qualification - Part 1:Requirements for construction
IEC 61730-2:2016Ed.2	Photovoltaic (PV) module safety qualification - Part 2:Requirements for testing
IEC 61701:2011/ 2020 Ed.2	Salt mist corrosion testing of photovoltaic (PV) modules (Applicable for coastal and marine environment)
IEC 62716:2013Ed.1	Photovoltaic (PV) modules - Ammonia corrosion testing (if applicable)
IEC TS 62804-1:2015Ed.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 Photovoltaics, 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 for Compulsory Registration) Order, 2019 including subsequent amendments/orders, if any.	

1.2 Technical Requirements

Parameter	Specification
Cell/ Module Technology	Mono PERC cells of high efficiency & Half cut
Module Efficiency	≥ 20.9 %
Product Warranty	12 years or more
Linear power warranty	For 27 years with 2% degradation for 1st year and 0.55% from the 2nd year onwards
Temperature co-efficient of power	-0.35%/°C
Application Class as per IEC 61730	Class A

1.3 Component Specifications

1.3.1 The PV Modules glass panel shall be:

i. For PV Modules with back sheet, high transmission, low iron tempered glass with minimum thickness of 3.2 mm.
ii. In case of glass-glass PV Modules, glass thickness shall be minimum of 2 mm on each side. It shall be laminated using a laminator with symmetrical structure, i.e., heating plates on both sides.
iii. The glass used shall have transmittance of above 90%.

1.3.2 The back sheet used in the PV modules shall be three-layered structure with outer (air side) layer having fluoro polymer or a material with superior UV stability properties. The back sheet shall have the following properties.

Parameter	Value
Material thickness	≥ 300 micron
Water vapour transmission rate	< 2 g/m^2/day
Partial discharge test voltage	≥ 1500 V
Elongation at break	> 100%
Adhesion strength with encapsulant	> 40 N/cm
Interlayer adhesion strength	> 4 N/cm

TGNPDCL reserves the right to conduct Pressure Cooker (PC) test/ Highly Accelerated Stress Test (HAST) to confirm the durability of the back sheet in accelerated conditions.

1.3.3 The encapsulant used for the PV modules should be UV resistant and PID resistant in nature. No yellowing of the encapsulant with prolonged exposure shall occur. In case of glass-glass PV modules, encapsulant shall be polyolefin type. The encapsulant shall have the following properties.

Parameter	**Value (for PV modules with back sheet)**	**Value (for glass-glassPV modules)**
Gel content	> 75%	> 70%
Volume resistivity	$> 1\times10^{14}$ Ω.cm	$> 1\times10^{15}$ Ω.cm
Peeling strength with glass	> 40 N/cm	> 40 N/cm

1.3.4 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.

1.3.5 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 earthing to connect it to the earthing grid. The anodization thickness shall not be less than 15 microns.

1.3.6 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 IP67. 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.

1.3.7 Each PV Module shall be provided a RFID tag which is embedded inside the module lamination and must be able to withstand harsh environmental conditions. RFID scanner and database of all the modules containing the following information shall also be provided.

i. Name of the manufacturer of PV Module
ii. Name of the Manufacturer of Solar cells
iii. Type of cell
iv. Month and year of the manufacture (separately for solar cells and module)
v. Country of origin (separately for solar cells and module)
vi. I-V curve for the module
vii. Peak Wattage, Im, Vm and FF for the module

viii. Unique Serial No. and Model No. of the module.

ix. Date and year of obtaining IEC PV module qualification certificate,
Name of the test lab issuing IEC certificate

x. Other relevant information on traceability of solar cells and modules.

Note: Procurement and supply of dedicated RFID scanner and handing over to plant permanently is under the scope of EPC contractor.

1.4 Warranty

1.4.1 PV modules must be warranted with linear degradation rate of power output except for first year (maximum 2%) and shall guarantee 83% of the initial ratedpower output at the end of 27 years.

1.4.2 The modules shall be warranted for minimum of 12 years against all material/ manufacturing defects and workmanship.

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

1.5 Approval

1.5.1 The Contractor shall provide Guaranteed Technical Particular (GTP) datasheet and Bill of Materials (BOM) of the module that is submitted for approval along with the datasheets of each component. The component datasheet shall contain all the information to substantiate the compliance for component specifications mentioned above.

1.5.2 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.

1.5.3 The BOM proposed shall be the subset of Constructional Data Form (CDF)'s of all the test reports.

1.5.4 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.

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

1.6 Manufacturing and Inspection

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

1.6.2 TGNPDCL or its consultant 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.

1.6.3 The Manufacturing shall start only after the clearance by TGNPDCL after the material inspection.

1.6.4 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.

1.6.5 The modules shall be uniformly laminated without any lamination defects.

1.6.6 Current binning of modules shall be employed to limit current mismatch of modules. Different colour codes shall be provided on the modules as well as pallet for identification of different bins. Maximum three nos. of bins will be allowed for each module rating.

1.6.7 Pre-dispatch inspection of modules shall be performed as per the inspection protocol attached in Annexure – A.

1.7 Transportation, Handling, Storage and Installation

1.7.1 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.

1.7.2 It is required to construct a temporary platform (graded) while keeping the modules at least above the highest flood level. If the contractor scheduled/ planned to mount the modules immediately after the receipt at site, then the module shall be kept in common storage area with proper arrangement.

1.7.3 Modules shall be dispatched in line with the Construction schedule. If modules are dispatched ahead of schedule, Modules shall be stacked as per manufacturer's recommendations only and following measures shall be undertaken:

i. Modules shall be covered with tarpaulin sheet. Alternatively, the Modules, properly stacked as per OEM recommendations, shall be stores under a temporary shed.

ii. Further, the temporary platform for keeping the modules shall be treated with anti-termite treatment.

1.8. Supplier Qualification criteria:

The solar PV module supplier should have supplied a cumulative minimum of **1.0 MW** in India in the last **3.0Years**.

2 String Monitoring Box (SMB)

2.1 Standards and Codes

Standard/Code	Description
IEC 60529	Enclosure Ingress Protection
IEC 62262	Enclosure Impact Protection
IEC 60269	Fuse
IEC 61643-31 or EN50539-11	Surge Protection Device
IEC 62852 or EN 50521	Solar cable connector
IEC 60695-2-11	Fire hazard testing

2.2 Construction

SMB enclosure shall be made of UV resistant, fire retardant, thermoplastic material. Enclosure degree of protection shall be at least IP 67 and mechanical impact resistance shall be at least IK10 with hinge and latch lock.

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

2.2.3 Every SMB input shall be provided with fuses on both positive and negative side. In case of negative grounded system, fuse at positive side only is acceptable. 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.

2.2.4 DC switch disconnector of suitable rating shall be provided at SMB output to disconnect both positive and negative side simultaneously.

2.2.5 Type-I surge protective device (SPD) conforming to IEC 61643-11/IEC 61643-31/ EN 50539-11 shall be connected between positive/negative bus and earth.

2.2.6 Resistance Temperature Detector (RTD) type or semiconductor type temperature sensor shall be provided to monitor the cabinet temperature.

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

2.2.8 UV resistant printed cable ferrules for solar cables & communication cables and punched/ embossed aluminium tags for DC cables shall be provided at cable termination points for identification.

2.2.9 Suitable communication interface shall be provided to communicate the data to SCADA. The following parameters of SMB shall be measured/ monitored and made available at SCADA.

(i) String current

(ii) Bus voltage

(iii) Output current

(iv) Cabinet temperature

(v) DC disconnector switch ON/OFF status

(vi) SPD operating status

2.3 Warranty

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

2.4 Tests

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

3 Solar and DC Cables

3.1 Standards and Codes

Cable	**From**	**To**	**Conductor/ Insulation**	**Voltage Rating**	**Applicable Standard**
Solar Cable*	Module	SMB	Copper/ XLPO	1.5 kV DC	IEC 62930 / EN 50618
DC Cable	SMB	PCU	Aluminium/ XLPE	1.5 kV DC	IS 7098
* Cable used for module interconnection shall also be referred as solar cable.					

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

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

3.4 In addition to manufacturer's identification on cables as per relevant standard, following marking shall also be provided over outer sheath. Cable size and voltage grade, Word 'FRNC/ FRLS' (as applicable) at every meter, Sequential marking of length of the cable in meters at every meter

3.5 Cables shall be sized based on the following considerations:

i. Rated current of module

ii. In case of central inverters, average voltage drop in the cables (from PV Modules to PCU) shall be limited to 1.5 % of the rated voltage. In case of stringInverters, average voltage drop (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

3.6 Warranty

The cables (Solar and DC) shall be warranted against all material/ manufacturing defects and workmanship for minimum of 1 (one) year from the date of supply.

3.7 Tests

Type test, routine test and acceptance tests requirements shall be as per IEC 62930/EN 50618 for solar cables and IS 7098 for DC cables.

3.8 Installation

3.8.1 Cable installation shall be as per IS 1255.

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

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

3.8.4 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.

3.8.5 Solar cables, wherever exposed to direct sunlight and buried underground as per prevailing solar industry practice and 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.

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

3.8.7 A.C and D.C cables shall be kept in separate trenches. The horizontal and vertical clearances between power and communication cable shall not be less than 300mm.

3.8.8 However HT AC cables shall be buried underground as per IS 1255.

3.8.9 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 MCR/ICR enclosures. Cable sealing system shall consist of multi-diameter type peelable blocks of different sizes to suit 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. Frame & 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.

4 Power Conditioning Unit

4.1 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 - Procedurefor measuring efficiency
IEC 62109-1 Ed. 1	Safety of power converters for use in photovoltaic powersystems - Part 1: General requirements
IEC 62109-2 Ed. 1	Safety of power converters for use in photovoltaic powersystems - 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 - Testprocedure 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: Changeof temperature

IEC 60068-2-30:2005	Environmental testing - Part 2-30: Tests - Test Db: Dampheat, cyclic (12 h + 12 h cycle)
CEA Technical Standards for Connectivity to the Grid Regulations 2007 with 2013and 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.	

4.2 Supplier Qualification Criteria

The Inverter Supplier should have supplied minimum 2 MW in India in the past 3 years. (as on last date of the bid submission). The solar inverter supplier shall be Class-1 local supplier as per MNRE Order issued vide F.No.283/22/2019 – Grid solar, dated 23rd Sep, 2020 on Public Procurement (Preference to Make in India) to provide for purchase preference (linked with local content) in respect of Renewable Energy Sector.

4.3 Technical Requirements

Parameter	**Specification**
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 67

4.3.1 The rated/ name plate AC capacity of the PCU shall be AC power output of the PCUat 50°C.

4.3.2 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 enough to accommodate the output voltage of the PV array at extreme temperatures prevailing at site.

4.3.3 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 as per Indian Grid code (IGC) as well as Telangana state Grid code.

4.3.4 The PCU shall always monitor the reactive power management during the generation and non generation time as per Indian Grid code (IGC) as well as Telangana state Grid code.

4.4 Construction

4.4.1 Power Conditioning Unit (PCU) shall consist of an electronic three phase inverter along with associated control, protection, filtering, measurement and data logging devices.

4.4.2 Every DC input terminal of PCU shall be provided with Fuse/MCB/MCCB of appropriate rating with lockout feature for isolation of DC input. 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.

4.4.3 Type-I surge protective device (SPD) conforming to IEC 61643-11 / IEC 61643-31 / EN 50539-11 shall be connected between positive/ negative bus and earth.

4.4.4 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.

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

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

4.4.7 In case of central inverter, PCU cabinet shall have manual switches (on front side) controlling the inverter & its contactors. START/STOP, DC Disconnect ON/OF, AC Disconnect ON/OFF, Emergency STOP shall be provided to stop the inverter operation & disconnect PCU from DC input & the grid during emergency conditions.

4.4.8 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.

4.4.9 Dedicated communication interface shall be provided to monitor the PCU from SCADA. It should also include remote operation control (STOP) from the SCADA itself.

4.4.10 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 (for each terminal)
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

4.4.11 String inverter, if installed in open, shall be placed inside a canopy shed with at least 15 cm in all directions. Alternatively, the Contractor may 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.

4.4.12 AC combiner box for string inverter configuration shall comply with Clause 9 of the Technical Specifications with exception of rated system voltage.

4.5 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.

4.5.1 Standby Mode

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

4.5.2 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.

4.5.3 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.

4.6 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

4.7 Grid Support Functions

4.7.1 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.

4.7.2 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.

4.7.3 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 reactive power during the period of voltage dip as per Indian Grid code (IGC) as well as Telangana state Grid code.

4.7.4 Frequency Ride through

The PCU shall follow the frequency ride through capability as per Indian Grid code (IGC) as well as Telangana state Grid code.

4.8 Warranty

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

4.9 Tests

4.9.1 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 web link 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.

4.9.2 Routine Tests

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

5 Inverter Transformer and Auxiliary Transformer

5.1 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, IEC 60076	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
IS 12063	Degree of protection provided by enclosures
CBIP publication no. 295	
CEAR and other statutory regulations	

5.2 Technical Requirements

Parameters	**Inverter Transformer**	**Auxiliary Transformer**
VA Rating	As per system design requirement	
Voltage Ratio	33 kV / Inverter output voltage	As per system design
Duty, Service &Application	Continuous Solar Inverter application and Converter Duty (Outdoor)	Continuous application(Outdoor)
Winding	As per system design requirement	2
Frequency	50 Hz	50Hz
Nos. of Phase	3	3
Vector Group &Neutral earthing	As per system/inverter manufacturer requirement	Dyn11
Cooling	ONAN	ONAN
Tap Changer	OCTC, No. of steps shall be as per system requirement	
Impedance at 75°C	As per Inverter Manufacturer requirement	As per system requirement
Minimization of Ohmic losses	Design should be as per Energy Efficient IDT's	Design should be as per IS-1180

Permissible Temperature rise over an ambient of 50°C (irrespective of tap)		
Top Oil	50°C	As per IS/IEC
Winding	55°C	As per IS/IEC
SC withstand time(thermal)	2 second	2 second
Short Circuit Apparentpower	As per system requirement	
Termination	As per system requirement	
Bushing rating, Insulation class (Winding & bushing)	36 kV – porcelain bushings 1.1 kV – epoxy bushings	As per the 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/fratio by 10% corresponding to the tap. Transformer shallalso 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 overfluxing characteristic up to 150%	
Air Clearance	As per CBIP	

5.3 Construction

5.3.1 The transformer shall be provided with conventional single compartment conservator with prismatic toughened glass oil gauge. The top of the conservator shall be connected to 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 alarm contact.

5.3.2 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.

5.3.3 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.

5.3.4 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.

5.3.5 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 tank through shield bushing and the same shall be brought down to the bottom of the tank using copper flat and support insulator for independent grounding.

5.3.6 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 for earthing.

5.3.7 Transformer 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.

5.3.8 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.

5.3.9 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.

5.3.10 Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement shall be provided.

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

5.3.12 Filter valve at top the tank and drain cum sampling valve at bottom of the tank shall be provided.

5.3.13 All external surface of the transformer shall be painted with two coats of epoxy-based paint of colour 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.

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

5.3.15 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.

5.3.16 All Inverter duty transformers having oil capacity more than 2000 liters shall be provided with Nitrogen Injection Fire Protection System (NIFPS).

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

5.3.18 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.

5.3.19 Fire-protection for inverter transformer shall be provided in accordance with relevant CEA regulations as amended time to time.

5.4 Auxiliary Transformer

5.4.1 Transformer shall be oil immersed type, made of cold rolled grain-oriented silicon steel laminations of M4 grade or better. Winding conductor shall be electrolytic grade Copper/Aluminium and insulation shall be Class F or better.

5.4.2 The transformers shall be housed in a metal protective housing, having a degree of protection suitable for outdoor installation. The enclosure shall be provided with suitable hardware and accessories required for satisfactory operation of the transformer per the relevant standard.

5.5 Warranty

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

5.6 Testing and Inspection

5.6.1 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.

5.6.1.1 Type Tests

i. Lightning impulse (Full & Chopped Wave) test on windings as per IEC60076-3

ii. Temperature Rise test at a tap corresponding to maximum losses as per IEC 60076-2

5.6.1.2 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

Note: 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 TGNPDCL or its consulting agency.
Type and Special tests are not required for auxiliary transformers of rating including100 kVA and below. The auxiliary transformers of plant should be designed as per IS-1180.

Routine Tests

Each completed transformer shall be subjected to following routine tests as per the 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

5.6.2 Tests at Site

After erection at site 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

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

6 HT Switchgear

6.1 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 Disconnector 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 Above1 kV and Up 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 nominal voltages greater than 1000 V up to and including 300 kV
IEC 60099-4	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for A.C. systems
IS 3070-3	Lightning Arresters for Alternating Current Systems - Part 3:Metal Oxide Lightning Arresters Without Gaps
IEC 62052-11	Electricity metering equipment (A.C.) - General requirements, tests and 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

6.2 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	70 kV (r.m.s.)
Lightning impulse withstand voltage	170 kV (peak)
System fault current	As per system requirement
Internal Arc Classification Rating	System fault current for 1 s
Circuit Breaker	
Type	Vacuum type
Operating duty cycle	O – 0.3sec – CO – 3min – CO
Short circuit breaking current	As per system requirement
Short circuit making current	2.5 times S.C. breaking current
Re-strike performance class	C2
Mechanical endurance class	M1
Current Transformer	
Accuracy class	0.2 for metering (0.2s for metering atoutgoing 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

6.3 Switchgear Panel

6.3.1 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.

6.3.2 The circuit breakers shall be mounted on horizontally withdrawable trucks with locking facility in SERVICE and TEST positions.

6.3.3 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.

6.3.4 All surfaces shall be painted with two coats of epoxy-based paint of colour shade RAL 7032. The minimum dry film thickness (DFT) shall be 100 microns.

6.3.5 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.

6.3.6 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.

6.3.7 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.

6.3.8 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.

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

i. The breaker shall be operated only if it is in SERVICE or TEST position.

ii. Movement of the breaker truck between SERVICE and TEST positions shall be possible only if the breaker is OFF.

iii. It shall be possible to open the door only when the breaker is in TEST position.

iv. Rear cover OPENING SAFETY MECHANICAL INTERLOCK (CASTLE KEY SYSTEM with coordination to corresponding breaker) shall be provided to prevent accidental opening of rear covers of 33 kV HT switchgear panels when the corresponding breakers is in charged condition.

6.3.10 Panel shall be provided with local bus-bar protection

6.3.11 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.

6.3.12 240 V, 5 A, SPN industrial socket-outlet with ON/OFF switch shall be provided in each panel.

6.3.13 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.

6.3.14 Gapless, metal-oxide surge arrestors shall be provided between line and earth in cable compartment of the switchgear panel.

6.3.15 Suitable lifting hooks shall be provided for each panel.

6.4 Circuit Breakers

6.4.1 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.

6.4.2 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, withanti-pumping feature.

6.4.3 The rated control voltage of the spring charging motor shall be 110 VDC/230 VAC. 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.

6.4.4 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.

6.4.5 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.

6.4.6 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.

6.5 Relays

6.5.1 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 front with connections from the inside.

6.5.2 The relays shall be capable of operating continuously between 80 – 120% of auxiliary voltage.

6.5.3 All numerical relays shall have adequate number of freely configurable, optically isolated, Binary Inputs (BI) and potential free Binary Outputs (BO).

6.5.4 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.

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

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

6.5.7 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.

i. Definite time (DT) phase over current protection
ii. Inverse Definite Minimum Time (IDMT) phase over current protection
iii. Definite time (DT) earth fault current protection
iv. Inverse Definite Minimum Time (IDMT) earth fault current protection
v. Under Voltage protection
vi. Over Voltage protection

6.5.8 Following protection functions shall be provided:

For 33 kV transmission line:

a. 3 (Three) directional IDMT over current protection relays
b. 1 (One) directional IDMT E/L protection relay

6.5.9 Transformer feeder protection relay shall have provision for the following protection functions.

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

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

6.5.11 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 – At least 200 events with date and time stamp.

6.5.12 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.

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

6.5.14 The numerical relay shall have RS-232/RS-485/RJ-45/USB ports on front side for local communication with PC and on rear side for remote communication to SCADA system.

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

6.5.16 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.

6.6 Instrument Transformers

6.6.1 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 ambient temperature is 50°C.

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

6.6.3 Voltage transformers shall be single phase units. Bus voltage transformers shall be housed in a separate panel on withdrawable truck.

6.6.4 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 with its supervision facility.

6.7 Earthing

6.7.1 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.

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

6.7.3 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.

6.7.4 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.

6.7.5 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.

6.7.6 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.

6.7.7 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 with stand capability equal to that of the associated switchgear panel.

6.7.8 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.

6.8 Bus bar

6.8.1 Bus bar shall be made of copper or aluminium 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.

6.8.2 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 aluminium to copper connections are required, suitable bimetallic connectors or clamps shall be used.

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

6.8.4 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.

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

6.9 Measuring Instruments

6.9.1 All the measuring instruments shall be digital, flush mounting type with
communication facility.

6.9.2 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.

6.9.3 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)

6.10 Wiring and Terminal blocks

6.10.1 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.

6.10.2 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 wire terminations.

6.10.3 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.

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

6.10.5 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.

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

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

6.11 Warranty

The HT panel unit shall be warranted against all material/ manufacturing defects and workmanship for minimum of 2 (Two) years from the date of supply.

6.12 Testing and Inspection

6.12.1 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.

Test	**Standard**	**Relevant IEC Clause**
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 control circuits	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 breaking capacities	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 compatibility requirements	IEC 60255-26	
Product Safety requirements	IEC 60255-27	
Common requirements	IEC 60255-1	
Functional requirements	Relevant parts of IEC 60255-100 series	
Communication requirements	IEC 61850	
Current Transformers		
Temperature rise test	IEC 61869-2	7.2.2
Impulse voltage withstand test on primary terminals	IEC 61869	7.2.3
Tests for accuracy	IEC 61869	7.2.6
Short time current tests	IEC 61869-2	7.2.201
Voltage Transformers		
Temperature rise test	IEC 61869-3	7.2.2
Impulse voltage withstand test on primary terminals	IEC 61869-3	7.2.3
Tests for accuracy	IEC 61869-3	7.2.6
Short circuit withstand capability test	IEC 61869-3	7.2.301

Note: 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 TGNPDCL or its consulting agency.

6.12.2 Routine Tests

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

7 AC Cables

7.1 Standards and Codes

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

IS 7098	Cross linked polyethylene insulated PVC sheathed cables, Part 1: For working voltage up to and including 1100 V
IS 7098	Cross linked Polyethylene Insulated Thermoplastics Sheathed Cables Part 2: for Working Voltages from 3.3 kV up to and Including 33 kV

7.2 All AC cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions.

7.3 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 TGNPDCL approval.

7.4 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.

7.5 Cables shall be sized based on the following considerations:

i. Rated current the equipment

ii. In case of central inverters, maximum voltage drop in LT cable (from PCUto inverter transformer) shall be limited to 0.5% of the rated voltage. In case of string inverters, maximum voltage drop (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 plant 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 with stand capability as per design for 1s.

iv. De-rating factors according to laying pattern

7.6 Warranty

All cables shall be warranted for minimum of 1 (one) year against all material/ manufacturing defects and workmanship.

7.7 Testing

Type tests, routine tests and acceptance tests requirements shall be as per relevant standards for all cable sizes.

7.8 Installation

7.8.1 Cable installation shall be as per IS 1255.

7.8.2 Cables within transformer yard and switchyard shall be laid through RCC cable trench with supports.

7.8.3 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.

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

8 Auxiliary Supply System

8.1 Scheme for Auxiliary supply system shall be submitted by contractor during detailed engineering for the approval by TGNPDCL or its consulting agency.

8.2 It shall mainly comprise of auxiliary transformer, AC distribution board(s) (ACDB), Battery & battery charger system, emergency lighting network, Uninterrupted power supply (UPS), distribution cables and metering & protective devices.

8.3 Auxiliary system shall be provided with two independent sources for reliable
auxiliary power supply.

8.4 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

9. **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.

- 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 - Electromechanical control circuit devices
IEC 62052-11	Electricity metering equipment (a.c.) - General requirements, tests and test conditions - Part 11: Metering equipment
IS 694	Polyvinyl chloride insulated unsheathed-and sheathed cables/ cords with rigid and flexible conductor for rated voltages - up to and including 450/750V
IEC 61869	Instrument Transformers
IS 3043	Code of practice for earthing
IEC 60255	Measuring relays and protection equipment - Part 1: Common requirements

9.2 Technical Parameters

System Details	
Rated system voltage	415 V ± 10%, 3 Phase, 4 wire, Neutral Solidly Earthed
Rated frequency	50 Hz ± 5%
System fault current	As per system requirement
Air Circuit Breaker	
Type	Air-break
Rated Current	As per system requirement
Operating Duty	O – 3min – CO – 3min – CO
Rated Ultimate Short-Circuit Breaking Capacity & Rated Service Short-Circuit Breaking Capacity	As per system fault current
Rated Short-Circuit Making Capacity	As per rated ultimate short-circuit breaking capacity
Moulded 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 requirement
Rated Short-Circuit Making Capacity	2.1 X Short circuit breaking Capacity
Utilization category	A
Current transformer (CT)	
Type	Cast Resin Bar Primary
Voltage class and frequency	650 V, 50 Hz
CT Secondary Current	1 A
Class of insulation	Class E or better
Accuracy class & burden	
a) For Protection	5P20, 5 VA PS Class for REF and corebalance CT (CBCT)
b) For Metering	Class 0.5, 5 VA (min)
Minimum primary earth fault current to be detected by CBCT	1 A
Instrument Security Factor for metering CT	5
Voltage Transformer (VT)	
Type	Cast Resin
Accuracy Class	0.5
Rated Voltage Factor	1.1 Continuous, 1.5 for 30 seconds
Class of Insulation	E or better
Digital Multifunctional Meter (MFM)	
Accuracy class	0.5 class
Communication with SCADA	RS485 communication with Modbus RTU

9.3 Constructional Details

9.3.1 The panel shall be metal enclosed, free standing, floor mounted, modular type with compartmentalized construction having degree of protection of IP 2X (Indoor) and IP54 (Outdoor) as per IS/IEC 60529. All doors and covers shall be provided with neoprene gaskets to prevent entry of vermin and dust.

9.3.2 All switches, push buttons etc. shall be operated front and shall be flush/semi-flush mounted.

9.3.3 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 mounted on them.

9.3.4 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.

9.3.5 Earthing bus bar of suitable cross section shall be provided throughout the length of panel.

9.3.6 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.

9.3.7 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.

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

9.3.9 240 V, 5 A, 3 pin industrial socket-outlet with ON/OFF switch shall be provided in each panel.

9.3.10 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.

9.3.11 Suitable lifting hooks shall be provided for each panel.

9.3.12 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.

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

9.3.14 <u>Air Circuit Breaker</u>

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

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

9.3.17 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.

9.3.18 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 between70% and 110% of rated voltage.

9.3.19 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.

9.3.20 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.

9.3.21 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.

9.3.22 The circuit breaker shall be provided with microprocessor based front adjustable protection release for overload, short circuit and earth fault.

9.3.23 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.

9.3.24 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.

9.3.25 The circuit breaker shall have suitable provision for integration with SCADA.

9.4 Instrument Transformers

9.4.1 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 ambient temperature is 50°C.

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

9.4.3 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.

9.4.4 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.

9.5 Bus bar

9.5.1 Bus bar shall be made of copper or aluminium 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.

9.5.2 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 aluminium to copper connections are required, suitable bimetallic connectors or clamps shall be used.

9.5.3 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.

9.5.4 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.

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

9.6 Earthing

9.6.1 An earth bus made of copper or aluminium 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.

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

9.6.3 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.

9.6.4 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.

9.6.5 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.

9.6.6 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.

9.7 Multi-Function Meter

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

9.7.2 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)

9.8 Wiring and Terminal blocks

9.8.1 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.

9.8.2 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 wire terminations.

9.8.3 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.

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

9.8.5 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.

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

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

9.9 Warranty

LT Switchgear shall be warranted against all material/ manufacturing defects and workmanship for minimum of 1 (one) year from the date of supply.

9.10 Testing and Inspection

9.10.1 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.

Equipment	**Standard**
Switchgear Panel	Relevant parts of IEC 61439
Air Circuit Breaker	IEC 60947-2
Moulded 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 TGNPDCL or its consulting agency.

9.10.2 Routine Tests

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

10 Uninterrupted Power Supply

10.1 Standards and Codes

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

10.2 General Requirements

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

i. Data logger / SCADA
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

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

10.3 System Description

10.3.1 The UPS shall automatically provide continuous, regulated AC power to critical loadsunder 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 2 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

10.3.2 The UPS shall meet the following minimum specifications.

Parameter	**Specification**
Topology	Online double conversion UPS
Input	
Voltage	230 V ± 10% AC
Frequency	50 ± 5 Hz
Power factor	0.95
Output	
Voltage	230V ± 1% AC
Frequency	50 Hz
Power factor	0.8
Battery	
Type	Sealed, Maintenance-Free (AGM) battery
Capacity	100% UPS load for 4 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: 1. Unit on Battery 2. Low Battery 3. Summary Alarm 4. UPS On 5. 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

10.3.3 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.

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

10.4 Warranty

UPS shall be warranted for minimum of 5 (five) years and batteries shall be warranted for a minimum of 2 (two) years against all material/ manufacturing defects and workmanship from the date of supply.

10.5 Tests

10.5.1 Routine tests and acceptance tests on final product shall be done as per QAP approved by TGNPDCL.

10.5.2 On completion of installation and commissioning of the equipment on site tests shall be carried out with the max. available load, which does not exceed the rated continuous load. An on-site test procedure shall be submitted by contractor include a check of controls and indicators after installation of the equipment.

11 Battery and Battery Charger

11.1 Standards and Codes

Standard/Code	Description
IEC 60896-22:2004	Stationary lead-acid batteries - Part 22: Valve regulated types - Requirements
IEC 60896-21:2004	Stationary lead-acid batteries - Part 21: Valve regulated types - Methods of test
IS 1652	Specification for stationary cells and batteries, lead acidtype (with plante positive plates)
IS 8320	General requirements and methods of tests for lead acid storage batteries.
IS 15549	Stationary Regulated Lead Acid Batteries

11.2 General

110 V DC system (Battery, Battery Charger & DCDB) in accordance with this specification and standards stated herein, shall comprise of the following.

i. Sealed Maintenance Free (VRLA) Battery complete with racks & accessories.

ii. One No. Float charger.

iii. One No. Float cum Boost charger.

iv. DC Distribution Board (DCDB)

11.3 Battery

11.3.1 Battery shall be used to supply the following loads with back up of four hours in case of complete power failure:

i. Trip and closing coil of HT circuit breaker

ii. Spring charging motors for HT circuit breaker

iii. Annunciator and Indication circuit of HT panel

iv. Auxiliary supply to protection relays

11.3.2 The battery sizing shall account for suitable temperature correction factors, ageing factors of 1.25, design margin of 1.25 & depth of discharge of 80%.

11.3.3 The design of the battery bank and sizing calculation along with the data sheet for the battery and battery charger shall be submitted for approval.

11.3.4 Battery voltage – 220V dc or 110V dc

11.4 Battery Charger

11.4.1 The Float Charger shall be used to supply normal DC loads and float charging current of charged battery. The Float cum Boost charger shall be designed to supply boost charging current requirement of the associated battery as well as to supply normal DC load. After full discharge of battery bank, the Float Cum boost charger shall be capable of charging the battery to its full capacity in 8 hours duration while supplying normal DC load.

11.4.2 The float charger shall have both auto and manual voltage regulation arrangements with provision of selector switch.

11.4.3 Suitable filter circuits shall be provided in all the chargers to limit the ripple content (peak to peak) in the output voltage and current to 2% and 5% respectively.

11.4.4 Digital Outputs shall be configured for connection to the SCADA to monitor the outputs like charger output current, output voltage, float/boost mode, etc.

11.4.5 The charging equipment shall be housed in a free standing, floor mounted compartmentalized panels. Panel shall have provision for bottom cable entry with removable undrilled cable gland plate of 3.0 mm thickness.

11.4.6 The panel shall be of CRCA sheet steel construction having thickness of at least 2.0 mm. Degree of protection provided by the enclosure to the internals of charger shall be IP-42.

11.4.7 The instruments, switches and indicating lamps shall be flush mounted on the front panel.

11.5 DC distribution board (DCDB)

11.5.1 DCDB shall be an integral part of battery charger panel board.

11.5.2 Doors and covers shall be provided with neoprene gaskets to prevent entry of vermin and dust. Also, door shall be provided with lock and key arrangement to prevent unauthorized access to the board.

11.5.3 DCDB shall have adequate number of outgoing feeders with double pole, DC MCBs. At least 20% feeders shall be provided as spare.

11.6 Warranty

Batteries and battery charger shall be warranted for minimum of 2 (two) years against all material/ manufacturing defects and workmanship.

11.7 Tests

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

12 Earthing

12.1 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 following standards and codes.

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

12.2 General Requirements

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

12.2.2 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 micron 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 provided as per IS 3043.

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

12.2.4 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.

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

12.2.6 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.

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

12.3 Earthing of PV array field

12.3.1 All PV Modules, Module Mounting Structures (MMS) and String Combiner Box (SCB) structures in the PV array field shall be bonded to the earthing system by two distinct connections.

12.3.2 Each PV Module frame shall be earthed using copper wire of sufficient cross section. The copper wire shall be connected to the earth hole provided in the module frame using suitable arrangement in line with the manufacturer recommendation. The earthing arrangement shall use stainless washers to prevent galvanic corrosion between aluminium frame and copper wire. In order to achieve effective earthing, serrated washers shall be employed to penetrate the anodization layer of the module frame.

12.3.3 Continuous copper earthing wire shall be run to connect a group of modules and both ends of the loop shall be bolted to the DC earth grid using bimetallic lugs and stainless-steel fasteners. The copper earthing wire shall be routed in such a way to avoid physical contact with the module aluminium frame.

12.3.4 The connection between MMS and DC earth grid shall be bolted or welded. Portion of the MMS which undergoes welding at site shall be coated with two coats of cold galvanizing and anti-corrosion paint afterwards.

12.3.5 Earth electrodes of the DC earth grid shall be uniformly distributed throughout the PV array field so that optimum earth resistance is offered to leakage current flowing from any module frame or MMS.

12.3.6 For SMB equipment earthing, SMB shall be provided with two exclusive earth pits asper CEIG instructions.

12.4 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 DC negative grounding is not possible, appropriate anti-PID device shall be provided.

12.5 Transformer Earthing

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

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

12.5.3 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.

12.5.4 Neutral and body of the auxiliary transformer shall be earthed.

12.6 Inverter Room and Main Control Room Earthing

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

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

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

12.7 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.

Note: Switchyard shall be shielded against direct lightning strike by provision of overhead shield wire or earth wire or spikes(masts) or a combination thereof as per CEA regulations 2010 (Technical standards)-42(2)(C).

12.8 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.

13 Lightning Protection System

13.1 Lightning Protection System (LPS) for entire plant against direct lighting strokes shall be provided as per IEC 62305:2010 or NFC 17-102:2011.

13.2 Protection level for the entire plant should be Level-I

13.3 LPS as per IEC 62305 Location of air terminals shall be designed as per rolling
sphere method.

13.4 LPS as per NFC 17-102

Lightning Protection System shall consist of following accessories.

i. Early Streamer Emission (ESE) air terminal

ii. Highly insulated poly-plastic adaptor to fix the ESE air terminal with the FRP mast

iii. Fiberglass Reinforced Plastic (FRP) mast

iv. Coupler to connect FRP mast with GI mast

v. Galvanized Iron mast with base plate and guy wire kit

vi. Down-conductor: PVC insulated flexible copper cable of suitable size complying with EN 50164-2 or equivalent standard. It shall be routed along the mast with suitable fixings and connecters

vii. Test joint with each down conductor

viii. Lightning event counter complying with EN 50164-6 or equivalent standard. It shall be fixed at suitable height in series with the down conductor.

ix. Earth termination system in accordance with NFC 17-102. Earth electrodes shall comply with the EN 50164-2 or equivalent standard. Earth enhancing compounds complying with EN 50164-7 or equivalent standard, may be used where soil resistivity is higher and making it impossible to achieve system resistance within specified limit.

13.5 Accessories listed above are indicative only and any other fittings or accessories, which are usual or necessary for satisfactory operation of the lightning protection shall be provided by the Contractor without extra charges.

13.6 Necessary foundation/anchoring for holding the lightning mast in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.

13.7 As per CEIG instructions, 2 (two) earth pits shall be constructed & 25x6 mm copper flats shall be connected from counter of lightening conductors to earth pits. Earth pit chambers shall be constructed for earth rod of lightening conductors.

13.8 The product shall be warranted for minimum of 2 (two) years against all material/ manufacturing defects and workmanship.

13.9 Type test reports as per IEC 62305:2010 or NFC 17-102:2011 shall be submitted during detailed engineering for approval.

14 Communication Cables

14.1 Optical Fibre Cables

14.1.1 Optic Fibre 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.

14.1.2 The cable shall have multiple single-mode or multimode fibres on as required basis so as to avoid the usage of any repeaters.

14.1.3 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.

14.1.4 The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling.

14.1.5 All testing of the optic fibre cable being supplied shall be as per the relevant IEC, EIA and other international standards.

14.1.6 The Contractor shall ensure that minimum 100% cores are kept as spare in all types of optical fibre cables.

14.1.7 Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground buried installation.

14.1.8 Spliced/ Repaired cables are not acceptable. Penetration of water resistance and impact resistance shall be as per IEC standard.

14.2 Communication Cable (Modbus)

14.2.1 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 flame retardant according to IEC 60332- 1-2.

14.2.2 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).

14.2.3 Communication cable shall be laid through underground with suitable HDPE ducts.

15 SCADA

15.1 General Requirements

15.1.1 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 plant and its auxiliary systems.

15.1.2 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.

15.1.3 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 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 Surveillance System(s), Module Cleaning System and various other O&M support systems to provide a Data Analysis and Decision Support System for smooth and efficient Plant Operations.

v. AI based Distributed Analytics for Predictive Maintenance, trend analysis and Alerts.

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

vii. Interface with different field equipment in the plant and work seamlessly with field equipment supplied by different companies.

viii. Transfer of plant data reliably, to a Cloud server on any kind of remote

Network including low bandwidth and wireless links such as 2G/3G/VSAT

Note: Telecom Lease line connection, if required for transferring data from Plant over internet shall be taken by Contractor in the name of TGNPDCL for O&M period

15.1.4 The Control system shall be designed to operate in non-air-conditioned area. However, the Contractor shall provide a Package/ Split AC of suitable capacity decided by heat load requirement in SCADA room at Main Control Room.

16.1 Architecture

16.1.1 The SCADA System shall be built over Industrial IoT architecture with integrated Analytics, secure web access, enterprise software and Database.

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

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

16.1.4 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.

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

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

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

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

16.1.8 Operator Workstation/PC shall be of Industrial Grade for browser-based access to plant data from Plant or remote server. Plant 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 Plant 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.

16.1.9 Internet/Intranet at Plant: Public or private network access shall be provided at the plant through any broadband/VSAT connectivity of 2Mbps or higher bandwidth. In case no broadband/VSAT connectivity can be provided at the plant, a 3G/4G data

card from any Internet Service Provider (ISP) may be provided. SCADA system shall be capable of sending all plant data in real time to the Remote Server.

16.1.10 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.

16.2 Industrial IoT Controllers & Data Acquisition

The Plant 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:

16.2.1 The IoT Controllers shall be distributed in nature and work independently of other IoT Controllers or any central controller in the system.

16.2.2 Shall be capable of supporting wide range of field protocols to communicate with different field equipment (Modbus over RS485/Ethernet, etc.)

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

16.2.4 Provide web-based interface to configure the controller for various equipment in the field.

16.2.5 IO Functionality: Shall support status monitoring of VCBs & Trip relays on RMU/HT & Transformer panels through distributed DI/AI modules.

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

16.2.7 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.

16.2.8 Controllers shall be capable of sending data over Internet connections USB data cards.

16.2.9 Shall not require a static public IP address, at the plant for the purpose of remote access.

16.3 Functionalities

16.3.1 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.

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

16.3.3 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.

16.3.4 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.

16.3.5 The SCADA system shall provide configurable alerts on any parameter crossing settable thresholds. The list of such parameters shall be finalised in consultation with TGNPDCL.

16.3.6 The SCADA system shall enable integration with other sub-systems at the plant for supporting O&M activities. The list shall include but not limited to:

i. Surveillance Cameras,

ii. Module Cleaning System – For monitoring of water usage and efficacy of cleaning process (in case of Wet Type Cleaning System).

16.3.7 The SCADA system shall have user-friendly browser-based User Interface for secure access from anywhere, for minimum ten concurrent connections from the Operator PC or other securely connected laptop/mobile, for plant monitoring, O&M, daily reporting, and analysis. A dashboard providing summary details of total plant generation, day's export, irradiance, Inverter Control Room level generation and performance indicators like PR and CUF.

16.3.8 Reporting: The SCADA system shall provide downloadable reports in Excel/PDF, configurable for equipment parameters across the plant.

16.3.9 The system shall have Configurable Analysis page for self-configured as well as on demand Analytics charts.

16.3.10 The SCADA system shall be extensible to include maintenance of O&M schedules and related activities for plant equipment as per the O&M Manual.

16.3.11 Connectivity shall be provided to Owner's Data Monitoring Centre. Data collected by Plant SCADA shall be replicated in real-time, using industry standard interfaces suchas Web Services, OPC-UA, data files, as required – with TGNPDCL Central Monitoring System in Hanamkonda. The data recording intervals for different parameters from different devices in the solar plant shall be considered when creating schedules to "push" the data from Plant SCADA to data receivers stationed at New Delhi.

16.3.12 Mobile User Interface: summary of plant performance and issues should be accessible in a mobile Native UI or browser UI.

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

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. Communication equipment and its software shall be compatible with the existing communication system of grid connected substation and same is to be approved by TGTRANSCO/SLDC etc.

16.3.14 Power Plant 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.

16.3.15 Forecasting and Scheduling: SCADA shall provide day ahead and week ahead forecasting and scheduling for power generation at the plant as per SLDC/Utility stipulations.

16.3.16 Predictive Maintenance: SCADA system shall have in-built or pluggable frameworks to support AI based Predictive Maintenance for all key equipment including inverters, transformers and switchgear at the plant.

16.3.17 All programming functionalities shall be password protected to avoid unauthorized modification.

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

16.4 Earthing

16.4.1 Two isolated electronic earth pits near to SCADA panel at every Inverter and Control Room with < 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.

16.4.2 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 SMBs, Inverters, WMS and Switchgear panels.

16.5 Communication Cable Laying

16.5.1 All RS485, IO and CAT6 cables shall be laid in separate conduits with a minimum separation of 1.5ft from AC/DC power cables all along.

16.5.2 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.

16.5.3 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.

16.5.4 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 AC Power cables.

16.6 Control Cabinets / Panels / Desks at Main Control Room

16.6.1 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.

16.6.2 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 supplier's standard practice for similar applications.

16.7 Software Licences

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.

16.8 Hardware at Main Control Room

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

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

Plant 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 (preferably RedHat Linux or equivalent Linux OS, Oracle/MySQL orequivalent DB), with required CMC for 5 years.
Accessories	i. Monitor: Min 22" LED Flat Monitor with non-interfaced refresh rate min. 75 Hz. ii. Keyboard: ASCII type iii. Pointing Device: Mouse iv. Intelligent UPS (on line): Minimum 2 hour battery backup.
Operator Workstation	

Hardware	i7 CPU running at 3.0 GHz or faster with 8GB RAM, 500GB hard disk, 25" LED monitor, keyboard and mouse, 4 USB ports, LAN port
Operating System	Windows operating system with necessary tools, anti-virus software.
Accessories	i. Screen Display Unit: Min 50" LED Flat Monitor with wall mounted arrangement for the display of SCADA screen ii. A4 size monochrome laser printer. iii. UPS of required capacity with 2 hour battery backup

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

16.9 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 plant and same shall be demonstrated during the FAT.

17 Energy Management System

17.1 Energy Management System (EMS) system shall be a computerized system for real time monitoring, operation, control, reliable & efficient operation of the Plant facilities. EMS shall be able to acquire real time data of various equipment of Plant facilities, have in built logic/programming to monitor, control, and optimize the performance of Plant facilities as per specification. Contractor shall provide complete EMS system with all accessories, auxiliaries and associated equipment and cables for the safe, efficient

and reliable operation of entire Plant facilities and its auxiliary systems. Contractor shall include in his proposal all the Industrial Grade 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.

17.2 Standards and Codes

17.2.1 The EMS shall comply with IEC 61970 for interoperability.

17.2.2 The EMS shall have the functionality to ensure compliance to the CEA Technical standards for Connectivity (2019) regulations.

17.2.3 The EMS shall comply with cyber security guidelines issued by the Central Government, from time to time, and the technical standards for communication system in Power Sector laid down by the Authority.

17.3 EMS functionality for the Plant Control

17.3.1 The EMS monitors grid and Plant facility variables and should be programmable for selecting the optimum-operating mode of the whole plant
w.r.t. active and reactive power, grid voltage, grid frequency, etc. Additionally, it can receive external set points and automatically adapt the Plant Facility behaviour to the new settings.

17.3.2 The EMS shall perform following functionality to Control the Plant facilities:

i. Communication with grid or SCADA

ii. Communications with PV Inverters and other power units

iii. Measuring and processing of the electrical magnitudes at EMS (voltage, current, PF)

iv. Control capability of PV Inverters and other power units

v. The EMS shall allow following operation modes for the Plant facilities:

vi. Reactive Control (Q Control, setting point of reactive power Q at EMS)

vii. Power Factor Control (PF Control, setting point of cos(L) at EMS)

viii. Voltage Control (V closed loop control, setting point of V at EMS)

ix. Voltage Droop (Reactive power vs Voltage programmable curve or droop)

x. Apparent Power Control (S Lim, setting point of S Lim at EMS)

xi. Active Power Limitation (P Lim, setting point of P Lim at EMS)

17.3.3 The EMS shall have the functionality to receive the target values specified by operators using a standard protocol (i.e. Modbus TCP/IP).

17.4 Control & Power Supply Scheme

Contractor shall provide the UPS/ DC Power supply of suitable rating to cater all the load requirements of EMS system and its auxiliaries

18 Power Transformer

18.1 Standards and Codes

Power Transformer 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 2099, IEC 60137	Bushings for alternate voltage above 1000 V
IS 8468, IEC 60542	On-load tap changers
IS 335, IEC 60296	Insulating oil
IS 3639	Fittings and Accessories for Power Transformers

18.2 Technical Requirements

Parameter	**Specification**			
Rated Capacity	As per system design			
Rated Voltage	33 kV / 132 kV			
Duty & Service	Continuous duty & Outdoor			
Number of phases	3			
Frequency	50 Hz			
Vector group	As per system requirement			
Cooling	ONAN / ONAF			
Impedance at principal tap and 75°C	10%			
Tap changer	On Load Tap Changer (OLTC) on HV side, +/-10% with steps of 2.5%			
Winding Insulation Level	HV	HVN (If applicable)	LV	LVN (If applicable)
One min power frequency withstand voltage (kV)	275	38	70	38
Full wave lightning impulse withstand voltage (kVp)	650	95	170	95
Chopped wave lightning impulse withstand voltage (kVp)	715	-	187	-
Switching impulse withstand voltage (kVp)	540	-	-	-
Permissible temperature rise over an ambient of 50°C (irrespective of tap)				
Top oil	50°C			
Winding	55°C			

Fault level & duration	As per system requirement			
Short-circuit withstand time (Thermal)	2 second			
Bushing Insulation Level	HV	HVN (If applicable)	LV	LVN (If applicable)
Rated voltage (kV)	145	36	36	36
One min power frequency withstand voltage (kV)	305	77	77	77
Full wave lightning impulse withstand voltage (kVp)	650	170	170	170
Switching impulse withstand voltage (kVp)	-	-	-	-
Termination	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 +/- 10%, 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 +/- 10% voltage variation of voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: i. 110% for continuous rating ii. 125% for at least one minute iii. 140% for at least five seconds The Contractor shall furnish over fluxing characteristic up to 170%			
Air clearance	As per applicable standards			
Symmetrical short circuit level current, 3 Phase RMS	40 kA, 1 sec.			
Insulating Oil	As per IS 335, IEC-60396-2020, type A, High grade.			
Special accessories	1. On line DG (multi gas) and moisture analyser 2. Insulating oil drying system(catridge type) As per IS/IEC 61850			

18.3 Tank

18.3.1 The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of adequate thickness. The tank and the tank cover shall be of welded construction. All seams and joints shall be welded and where practicable, they shall be double welded. The tank so welded shall be reinforced by stiffener of structural

steel for general rigidity.

18.3.2 The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped so that it does not retain rain water.

18.3.3 The main tank body of the transformer, excluding tap changing compartments and
radiators, shall be capable of withstanding pressure of 760mm of Hg.

18.3.4 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.

18.3.5 Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

18.3.6 All bolted connections to tank shall be fitted with suitable oil-tight gasket, which shall give satisfactory service under the operating conditions. All gaskets shall be closed design (without open ends) and shall be of one piece only. Gasket of nitrite rubber or equivalent shall be used. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.

18.3.7 Lifting lugs shall be provided on all parts of the transformer requiring independent handling during assembly or dismantling. In addition, the transformer tank shall be provided with lifting lugs and bosses properly secured to the sides of the tank for lifting the complete transformer assembly with oil either by crane or by jacks.

18.3.8 The transformer tank shall be supported on a structural steel base equipped with forged steel single flanged wheels suitable for moving the transformer completely with oil. The wheels shall be bi-directional and mounted on swivels which may be turned through 90° when the tank is jacked up and capable of being locked in position parallel to and at right angles to the longitudinal axis.

18.4 Core

18.4.1 The transformer core shall be built up with high-grade non-ageing cold rolled grain oriented (CRGO) silicon steel laminations having high permeability and low hysteresis loss. The thickness of lamination shall be 0.27 mm or less.

18.4.2 The transformer shall be so designed that the flux density in the core shall not exceed

1.9 tesla at rated voltage and rated frequency. The maximum flux density in any part of core or yoke at 10% continuous over voltage condition shall not exceed 1.9 tesla.

18.4.3 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

18.4.4 The core shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibration during operation and transportation. The clamping structure shall be designed to minimize eddy current loss.

18.4.5 The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux components at right angles to the plane of the laminations which may cause local heating.

18.4.6 The core shall be provided with lugs suitable for lifting the complete CCA of the transformer. The CCA shall be fixed with the tank so that it does not shift when transformer is moved or during short circuit.

18.4.7 The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2 kV RMS for one minute.

18.4.8 The core shall not be earthed at multiple locations. Terminal shall be brought on top of tank and earthed through link. Core and Frame terminals should be brought out on transformer top so as to enable megger.

18.5 Winding

18.5.1 The conductor for winding shall be made of electrolytic grade copper. The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs can be readily done without special equipment.

18.5.2 The coils shall be supported between adjacent sections by insulating spacers and barriers. Bracings and other insulation used in the assembly of the windings shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings.

18.5.3 The insulation paper shall be of high quality and the value of degree of polymerization shall not be less than 1200 Pv.

18.5.4 Materials used for insulation and assembly of the windings shall be insoluble, non- catalytic and chemically inactive in the hot transformer oil and shall not soften or otherwise get affected under the operating conditions.

18.5.5 All threaded connections shall be provided with locking facilities. All leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

18.5.6 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperature along the windings.

18.5.7 Windings shall be subjected to a shrinkage treatment before final assembly, so that no further shrinkage occurs during service. Adjustable device shall be provided for taking up any possible shrinkage of coils in service if required.

18.5.8 The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. The assembled core and windings shall be vacuum dried and suitably impregnated before removal from the treating tank. The copper conductors used in the coil structure shall be best suited to the requirements and all permanent current carrying joints in the windings and the locks shall be welded or brazed.

18.6 Insulating Oil

The oil for first filling together with 10% extra shall be supplied with the transformer. The oil shall comply in all respects with the provisions of the latest edition of IS 335, IEC-60396-2020 (as amended up to date). Particular attention shall be paid to deliver the oil free from moisture having uniform quality throughout in non-returnable steel drums.

18.7 On-Load Tap Changer

18.7.1 On-Load Tap Changer (OLTC) shall be designed for remote control operation from Remote Tap Change Control (RTCC) Panel in the control room in addition to being capable of local manual as well as local electrical operation. The OLTC shall include the following.

i. An oil immersed tap selector and arcing switch or arc suppressing tap selector, provided with reactor or resistor for reduction of make and break arcing voltages and short circuits.
ii. Motor driven mechanism
iii. Control and protection devices
iv. Local /Remote tap changer position indicator
v. Manual/Electrical operating device
vi. Pressure relief device

18.7.2 The OLTC shall be so designed that the contacts do not interrupt arc within the main tank of the transformer. The tap selector and arcing switch or arc suppressing selector switch shall be located in oil filled compartment. The compartment shall be provided with Oil Surge Relay. It shall be designed so as to prevent oil in the tap selector compartment from mixing with the oil in the transformer tank.

18.7.3 The contactors and associated gear for the driving motor shall be housed in a local kiosk mounted adjacent to or on the transformer. The degree of protection of the complete arrangement shall be IP 55 or better. The motor shall be suitable for operation with three phase, 415 V, 50 Hz external power supply.

18.7.4 RTCC Panel

Remote Tap Change Control (RTCC) Panel shall include, but not limited to, the following.

i. Automatic Voltage Regulator with SCADA compatibility
ii. Under voltage relay to monitor the taper changer control voltage
iii. Raise and lower push button
iv. Tap position indicator
v. Indication lamp showing tap changing in progress
vi. Alarms and Annunciation
vii. Any other accessory required for satisfactory operation or required during detail engineering

18.8 Bushing

18.8.1 The bushings shall have high factor of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable.

18.8.2 All bushings shall be equipped with terminals suitable for bimetallic connection. Each bushing shall be so coordinated with the transformer insulation that all flash over will occur outside the tank.

18.8.3 Bushings of rated voltage below 52 kV shall be porcelain insulator of oil- communicating type or OIP (non-oil communicating) or RIP type.

18.8.4 Bushings of rated voltage 52 kV and above shall be OIP condenser type (non-oil communicating) with porcelain insulator with following fittings.

i. Oil level gauge
ii. Oil filling plug and drain valve if not hermetically sealed
iii. Tap for capacitance and tan delta test

18.9 Radiators

18.9.1 Radiators provided shall have sufficient cooling surface to limit the temperature rise to the values as specified in the 'Technical Requirements'. The radiators shall be seamless and made of mild steel/CRCA with minimum thickness not less than 1.2 mm. It shall be suitably braced to protect them from mechanical shocks.

18.9.2 The radiators shall be connected to the tank by machined steel flanges with adequate gaskets to avoid oil leakage. Each radiator unit shall be provided with butterfly type or positive operated gate type oil leak proof shut-off valve which can be fastened in either closed or open position and separate oil tight flange for each tank connection for use when the radiator unit is detached. Each radiator unit shall have a lifting arrangement and oil drain at the bottom and a vent at the top.

18.9.3 It shall be possible to take out any of the radiator unit without disturbing the transformer. The radiators shall be so designed as to prevent any accumulation of water on the outer surface or formation of gas pockets when the tank is being filled.

18.10 Accessories

18.10.1 Conservator

The conservator shall have air cell type constant oil preservation system to prevent oxidation and contamination of oil due to contact with moisture. The conservator shall be provided with separate compartment for OLTC. No separate conservator tank shall be provided for OLTC. The conservator shall be fitted with oil filling hole, cap and drain valve. Prismatic toughened glass oil level gauge and 150 mm Magnetic Oil Gauge (MOG) with low oil level alarm contact shall also be provided.

18.10.2 Silica gel breather

The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel dehydrating breather with transparent enclosure. Silica gel shall be isolated from atmosphere by an oil seal. The capacity of breather should be such that it can contain minimum 5 kg silica gel for main conservator compartment and minimum 1 kg silica gel for OLTC conservator compartment. The GI pipe connecting breather with conservator should be seamless and no joint is permitted.

18.10.3 Buchholz relay

Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement shall be provided. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper or stainless-steel tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling when the transformer in service. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.

18.10.4 Pressure Relief Device

Pressure Relief Device shall be provided on main tank and OLTC for rapid release of any pressure in transformer which may endanger the equipment. The device shall operate at a static pressure of less than hydraulic test pressure of transformer tank/OLTC chamber. The terminal box of the PRD shall be water tight with protection class IP 56 or better as per IEC 60529. Electrically insulated contact shall be provided for trip signal.

18.10.5 Temperature Indicators

18.10.5.1 Oil Temperature Indicator (OTI)

150 mm dial type temperature indicator with 'Maximum' reading pointer and resetting device shall be provided. The indicator shall have adjustable, electrically independent, potential free alarm and trip contacts. A temperature sensing element suitably located in a pocket on top oil shall be provided. Accuracy class of OTI shall be 1.5% or better.

18.10.5.2 Winding Temperature Indicator (WTI)

A device for measuring the hot spot temperature of each of the winding shall be provided. It shall comprise the following.

i. Temperature sensing elements, one each on HV and LV winding.
ii. Image coil.
iii. Auxiliary CTs, if required to match the image coil.
iv. 150 mm dial type temperature indicator with 'Maximum' reading pointer and resetting device with adjustable, electrically independent, potential free alarm and trip contacts.
v. Calibration device.

The winding temperature indicator shall be responsive to the combination of top oil temperature and winding current, calibrated to follow the hottest spot temperature of the transformer winding. Accuracy class of WTI shall be 1.5% or better.

18.10.6 Marshalling Box

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. 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 or synthetic 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.

18.10.7 Valves

The transformer shall be provided with the following (but not limited to) valves.

i. Two nos. of filter valves, one at top and another at bottom on diagonally opposite corners
ii. Two nos. of sampling valves at top and bottom of the tank
iii. Drain valve on main tank
iv. Drain valves on main and OLTC compartment of conservator
v. Valves (for nitrogen injection and oil drain) as required by firefighting system All valves shall be constructed of stainless steel, brass or gun metal except of shutoff valve for radiator and cooler. For radiator and cooler, valve shall be made up of gun metal or cast iron.

17.10.8. Suitable transformer oil soak pit and burnt oil pit should be constructed as per CEAR/IS Regulations.

17.10.9. Suitable portable online DGA monitor should be fitted to Power Transformer as per Regulations and the monitoring parameters are to be displayed in SCADA monitor.

18.11 Painting

18.11.1 Before painting or filling with oil, un-galvanized parts shall be completely cleaned and free from rust, scale and grease. All external rough surfaces on casting shall be filled by metal deposition. The interior of transformer tank and other filled chambers and internal structural steel work shall be cleaned of all scale and rust by send blasting or other approved method. These surfaces shall be painted with an oil resisting varnish or paint.

18.11.2 Except for nuts, bolts and washers, all external surfaces shall receive a minimum of three coats of paint. The primary coat shall be applied immediately after cleaning. The second coat shall be of oil paint of weather resisting nature. The final coat shall be of a glossy, oil and weather resisting non-fading paint. The paint shade shall be as provided by the Employer during detailed engineering.

18.11.3 All internal surfaces of mechanism chambers and kiosk except those which have received anticorrosion treatment, shall receive three coats of paint applied to the thoroughly cleaned metal surface. The final coat shall be of light coloured anti- condensation mixture.

18.11.4 Any damage to paint work incurred during transport and erection shall be made good by thoroughly cleaning the damaged portion and by applying full number of coats of paints.

18.12 Transportation

18.12.1 Transformer tank is filled with oil or pure dry nitrogen/ air depending upon the transport weight limitations. Necessary arrangement shall be ensured to take care of pressure drop of nitrogen or dry air during transit and storage till completion of oil filling during erection. A gas pressure testing valve with necessary pressure gauge and adaptor valve shall be provided.

18.12.2 Bushings shall be crated, packed and transported as per standard guide lines of the Bushing Manufacturer. All care should be taken to avoid any damage of the porcelain due to vibration during transport.

18.12.3 Special attention shall be paid in packing the accessories & spares to avoid moisture ingress. All parts shall be adequately marked to facilitate field erection.

18.13 Warranty

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

18.14 Testing and Inspection

18.14.1 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.

18.14.1.1 Type Tests

i. Lightning impulse (Full & Chopped Wave) test on windings as per IS 2026- 3/IEC 60076-3
ii. Temperature Rise test at a tap corresponding to maximum losses as per IS 2026-2/IEC 60076-2. Dissolved Gas Analysis (DGA) shall be conducted on oil sample taken before and immediately after temperature rise test. Gas analysis shall be as per IS 9434/IEC 60567 and results will be interpreted as per IS 10593/IEC 60599.

18.14.1.2 Special Tests

i. Short circuit withstand test as per IS 2026-5/IEC 60076-5
ii. Measurement of zero-sequence impedance as per IS 2026-1/IEC 60076-1
iii. Measurement of harmonics of no-load current as per IS IEC 60076-1
iv. Measurement of acoustic noise level as per NEMA TR-1

Note: 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.

18.14.2 Routine Tests

Each completed transformer shall be subjected to following routine tests as per the 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 at 90%, 100% & 110% of rated voltage

v. Measurement of short-circuit impedance and load loss at principal and extreme taps

vi. Magnetic balance test & magnetizing current 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 and polarization index

x. Measurement of tan delta and capacitance of winding

xi. Core isolation test

xii. Marshalling box functional test

xiii. IR Measurement on wiring of marshalling box

xiv. Test on on-load tap changer

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

xvi. Jacking test followed by D.P. test

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

19 Nitrogen Injection Fire Protection System

Nitrogen Injection Fire Protection System (NIFPS) shall use nitrogen as fire quenching medium. The protection system shall prevent transformer oil tank explosion and possible fire in case of internal faults. In the event of fire by external causes such as bushing fire, OLTC fire, fire from surrounding equipment etc., it shall act as a fast and effective fire extinguisher without any manual intervention.

19.1 Standards and Codes

All the equipment of NIFPS shall comply with the latest edition of the following standards and codes including amendments.

Standard	Description
IS 10028-2	Code of practice for selection, installation and maintenance of transformers; Part 2: Installation
IS 7285-2	Refillable Seamless Steel Gas Cylinders - Specification Part 2: Quenched and Tempered Steel Cylinders With Tensile Strength Less Than 1100 MPa (112 kgf/mm^2)
CEA Technical Standards for Construction of Electrical Plants and Electric Lines Regulations, 2010 with 2015 amendment	
CEA Measures relating to Safety and Electric Supply Regulations, 2010 with 2015 amendment	
CBIP Manual on Transformers, Publication No. 317	

19.2 Technical Requirements

Parameter	Specification
Fire extinction period from commencement of nitrogen injection	30 second (maximum)
Total time duration to bring oil temperature below flash point	30 minute (maximum)
Fire detector heat sensing temperature	141°C
TCIV setting for normal operation to ensure no obstacle for transformer breathing	40 litre per minute
TCIV setting for operation during abnormal flow of oil	60 litre per minute
Capacity of nitrogen gas cylinder	10 m^3 gas at pressure of 150 kg/cm^2 for up to 60,000 litre of oil 20 m^3 gas at pressure of 150 kg/cm^2 for above 60,000 litre of oil

19.3 System Components

NIFPS shall broadly consists of the following components. However, all other components which are necessary for fast, reliable and effective working of the fire protection system shall be deemed to be included in the scope of supply. The NIFPS shall have provision for SCADA connectivity.

19.3.1 Fire Extinguishing Cubicle

The Fire Extinguishing Cubicle (FEC) shall be made of CRCA sheet of minimum 3 mm thick with Polyurethane painting. The degree of protection shall be IP55 or better.

It shall have hinged split doors fitted with high-quality tamper-proof lock. The following components shall be provided in the FEC.

i. Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer. The nitrogen gas cylinder should have been certified by Bureau of Indian Standards and approved by Chief Controller of Explosives, Government of India.
ii. Oil drain pipe with mechanical quick drain valve
iii. Control equipment for draining of oil and injecting nitrogen gas
iv. Pressure monitoring switch for backup protection for nitrogen release
v. Limit switches for monitoring of the system
vi. Butterfly valve with flanges on top of the cubicle for connecting oil drain pipe and nitrogen injection pipe
vii. Panel lighting
viii. Oil drain pipe extension of suitable sizes for connecting pipes to oil pit

19.3.2 Control Box

Control box shall be placed in the Master Control Room (MCR) for monitoring, automatic control and remote control. The rated control voltage of the control box shall be 110 VDC. The control box shall have suitable indications, alarms, switches and push buttons for complete monitoring and control of the system.

19.3.3 Transformer Conservator Isolation Valve

Transformer conservator isolation valve (TCIV) shall be fitted in the conservator pipe line between conservator and buchholz relay which shall operate for isolating the conservator during abnormal flow of oil due to rupture / explosion of tank or bursting of bushing. The valve shall not isolate conservator during normal flow of oil during filtration or filling or refilling. Locking plates shall be provided with handle for pad locking. It shall have proximity switch for remote alarm and indication glass window for visual inspection for physical checking of the status of valve. The TCIV shall be of the best quality and proven design as malfunctioning of TCIV could lead to serious consequences.

19.3.4 Fire Detector

Adequate number of fire detectors shall be fitted on top cover of the transformer and OLTC with brackets. Heat sensing temperature of the fire detectors shall be 141°C.

19.3.5 Signal Box

Signal box shall be mounted way from the transformer preferably near the marshalling box for terminating the cables from TCIV & fire detectors and to further connection to control box at the MCR. The degree of protection of the signal box shall be IP 55 or better.

19.3.6 Cables

The interconnecting cables shall be Fire Retardant Low Smoke (FRLS) type. Cables passing along the top of the transformer shall be Fire Survival type.

19.3.7 Pipes

Heavy duty pipe connecting the transformer tank for oil drain and for nitrogen injection shall be provided. Pipes, complete with supports, connections, flanges, bends and tees etc. shall be supplied along with the system.

19.3.8 Other Items

i. Doors and covers of all the panels (FEC, Control box, Signal box, etc.) shall be provided with neoprene gaskets.
ii. All the panels and piping system shall be painted with enamelled paint.

19.4 Protection Philosophy

19.4.1 The NIFPS shall have the operating modes and operate on receipt of corresponding activation signals.

19.4.1.1 Auto Mode

i. Fire Prevention

The system shall operate on receipt of all the following three signals.

i. Differential relay trip
ii. Operation of Buchholz relay (OR) Pressure Relief Device (OR) Rapid Pressure Rise Relay
iii. Master trip (OR) Tripping of LV / HV circuit breaker in series

ii. Fire Extinction

The system shall operate on receipt of all the following three signals.

i. Operation of fire detector
ii. Operation of Buchholz relay (OR) Pressure Relief Device (OR) Rapid Pressure Rise Relay (OR) Oil Surge Relay
iii. Master trip (OR) Tripping of LV / HV circuit breaker in series

19.4.1.2 Remote Manual Mode

The system shall operate on receipt of both the following signals.

i. Master trip (OR) Tripping of LV / HV circuit breaker in series
ii. Operation of emergency operating switch on the control box

19.4.1.3 Local Manual Mode

In case the system fails in Auto Mode / Local Remote Mode (OR) Power Failure, the system can be operated manually from the Fire Extinguisher Cubicle.

19.4.2 On receipt of all required activating signals, the system shall drain pre-determined volume of oil from top of the tank through outlet valve to reduce tank pressure and simultaneously inject nitrogen gas at high pressure through inlet valves for stirring the oil and thus bringing the temperature of oil below flash point to extinguish the fire. Transformer conservator isolation valve shall block the flow of oil from conservator tank.

20 Control and Relay Panel

20.1 Standards and Codes

All equipment provided under Control and Relay Panel shall comply with latest editions and amendments of the relevant IEC standards and IS codes. In particular, the C&R Panel shall comply with the following standards and codes.

Standard/Code	**Description**
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 nominal voltages greater than 1000 V up to and including 300 kV
IEC 60099-4	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for A.C. systems
IS 3070-3	Lightning Arresters for Alternating Current Systems - Part 3: Metal Oxide Lightning Arresters Without Gaps
IEC 62052-11	Electricity metering equipment (A.C.) - General requirements, tests and 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

20.2 Construction

20.2.1 The control and relay panel shall be free standing, floor mounted, simplex type, metal enclosed construction. The panel enclosure shall be made of CRCA steel sheet. The thickness of load bearing members shall be minimum 3 mm and that of non-load bearing members shall be minimum 2 mm.

20.2.2 All external surface shall be painted with two coats of epoxy-based paint of colour shade RAL 7032. Internal surface shall be painted with epoxy enamel white paint. The minimum dry film thickness (DFT) shall be 100 micron.

20.2.3 Controls, indications, relays, meters and other instruments shall be flush mounted on the front of the panel. Door shall be provided at the rear of the panel. All doors and removable covers shall be provided with neoprene or synthetic rubber gasket.

20.2.4 The panel shall be dust, moisture and vermin proof with degree of protection not less than IP 4X as per IEC 60529.

20.2.5 Cable entry shall be through the bottom of the panel. Gland plate of thickness not less than 3 mm shall be provided.

20.3 Relays

20.3.1 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 front with connections from the inside.

20.3.2 Auxiliary voltage of the relays shall be 110 VDC and the relays shall be capable of operating continuously between 80 – 120% of auxiliary voltage.

20.3.3 All numerical relays shall have adequate number of freely configurable, optically isolated, Binary Inputs (BI) and potential free Binary Outputs (BO). All I/O's shall have galvanic isolation. Analog inputs shall be protected against switching surges and harmonics.

20.3.4 All numerical relays shall have sufficient number of current and voltage inputs required for all the required protection functions.

20.3.5 The numerical relay shall provide choice of ANSI/IEC/IEEE relay characteristic curves with wide protection setting ranges through a minimum of two protection setting groups.

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

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

20.3.8 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 – At least 200 events with date and time stamp.

20.3.9 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.

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

20.3.11 The numerical relay shall have two serial communication ports, one on front side for local communication with PC and another on rear side for remote communication with SCADA system as per IEC 61850.

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

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

20.3.14 Necessary software and hardware to up/down load the data to/from the relay from/to the PC shall also be provided.

20.4 Protection Scheme

The following protection schemes shall be implemented for the protection of power transformer and its feeder.

i. Biased Differential Protection with Second Harmonic Restraint
ii. Non-directional Over Current and Earth Fault Protection
iii. Restricted Earth Fault Protection
iv. Under Voltage and Over Voltage Protection
v. Buchholz Alarm and Trip
vi. OTI Alarm and Trip
vii. WTI Alarm and Trip
viii. PRV Trip
ix. MOG Alarm
x. OSR Trip

Note: The above-mentioned protection schemes are indicative only. All the protection schemes required for safe and reliable operation of power transformer and the feeder shall be provided.

20.5 Measuring Instruments

20.5.1 All measuring instruments shall be enclosed in dust proof, moisture resistant cases and flush mounted on the panel.

20.5.2 Analog Ammeter and Voltmeter with selector switch shall be provided. Accuracy class shall be 0.5 or better. Instrument dial shall be with white scale, black pointer and black numerals.

20.5.3 Digital Multi-Function Meter (MFM) of accuracy class 0.2 or better shall be provided. It shall have communication capability for integration with SCADA. MFM shall be able to measure line & phase voltages, line & phase currents, active power, reactive power, apparent power, power factor and frequency.

20.6 Control Switches

All control switches shall be rotary operated type with adequate making, carrying and breaking current ratings. The control switches shall be pistol grip type, lockable with spring return to normal position. They shall be flush mounted on the panel with shrouded terminals.

20.7 Indications

All indicating lamps shall be flush mounted LED type with supply voltage of 110 VDC. Lamp covers shall preferably be screwed type and moulded from heat resisting material. Indicating lamps shall be provided for R, Y, B PT supply, Breaker ON & OFF, Auto trip, Spring charged, Trip circuit healthy, etc.

20.8 Annunciation

Flush mounted static type annunciator with sufficient number of windows to accommodate all trip and alarm signals shall be provided. Separate audible annunciation for alarm and trip shall be provided by means of buzzer and hooter. Visual

annunciation shall be by flickering of facia. Push buttons for test, accept and reset shall also be provided.

20.9 Earthing

20.9.1 An earth bus made of copper or aluminium shall be provided throughout the length of the panel and bolted to the framework of the panel. 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 earth grid.

20.9.2 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.

20.9.3 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.

20.10 Mimic Diagram

Colored mimic diagram made of metal or plastic with symbols to facilitate exact representation of the system shall be fixed on the front of control panel. Semaphore indicators shall be incorporated in the mimic diagram for indicating position of circuit breakers, isolators and earthing switches. The rated control voltage of semaphore indicator shall be 110 / 220 VDC.

20.11 Wiring and Terminal Blocks

20.11.1 All internal wiring shall be done with 1100 V grade, 2.5 sq.mm. PVC insulated stranded flexible copper wire. For CT secondary circuits, 4 sq.mm copper wire shall be used.

20.11.2 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 wire terminations.

20.11.3 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.

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

20.11.5 All internal wiring to be connected to the external equipment shall terminate on terminal blocks. Terminal blocks shall be rated for 1100 V, 10 A and made of non- inflammable material.

20.11.6 CT and VT secondary circuits shall be terminated on stud type, non-disconnecting

terminal blocks.

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

20.11.8 Screw driver operated stud type test terminal block shall be provided.

20.12 Accessories

i. Thermostatically controlled space heater with switch for isolation

ii. 240 V, 15 A industrial socket with ON/OFF switch

iii. LED lamp controlled by door switch

20.13 Warranty

The control and relay panel unit shall be warranted for minimum of 2 (Two) years against all material/ manufacturing defects and workmanship.

20.14 Testing and Inspection

20.14.1 Type Tests

The Contractor shall submit type test report of the panel for degree of protection as required by the Technical Specifications as per IEC 60529. The test should have been conducted by NABL accredited laboratory.

20.14.2 Routine Tests

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

21 132 kV Switchyard Equipment

21.1 Standards and Codes

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

Standard/Code	Description
IS/IEC 62271-100	High Voltage Switchgear and Control gear - Part 100: AC Circuit Breakers
IEC 60376, IS 13072	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment
IS/IEC 62271-102	High Voltage Switchgear and Control gear - Part 102: AC Disconnectors and Earthing Switches
IEC 61869	Instrument Transformers
IS 2099	Bushings for alternating voltages above 1000 Volts
IS 2544	Porcelain post insulators for systems with nominal voltage greater than 1000 Volts
IS 335, IEC 60296	Insulating oil
IS/IEC 60034	Rotating electrical machines
IS 996	Single-phase AC industrial motors for general purpose

IS 3070, IEC 60099-4	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for A.C. systems
IEEE STD 80	Earthing
IEC 60694	High Voltage switchgear
IEC 60815	High Voltage Insulators
IEC 60185	Current Transformer
IEC 60045-5	Instrument Transformers – CVT
IEC 60060	High Voltage testing
IEC 60129	Disconnectors and Earth Switches
IEC 60044-1	Instrument Transformers- CT
IEC 60044-2	Instrument Transformer- VT
IEC 60044-4	Instrument Transformers- Measurement of Partial discharge
Indian Electricity Act, CBIP manual, CEA rules and guidelines	

21.2 General Technical Parameters

System Parameters	Specification
Highest system voltage	145 kV
Rated system voltage	132 kV
Rated frequency	50 Hz
Number of phases	3
One minute power frequency withstand voltage	275 kV (rms)
Full wave impulse withstand voltage (1.2 / 50 µs)	650 kV (peak)
Maximum Radio Interference Voltage between 0.5 MHz and 2.0 MHz	500 µV at 92 kV rms
Rated short-time withstand current	31.5 kA for 1 s
Rated peak withstand current	80 kAp
System neutral earthing	Effectively earthed

Minimum creepage distance	As per site pollution level
Minimum clearance (i) Phase to phase clearance (ii) Phase to earth clearance (iii) Sectional clearance (iv) Ground clearance	 1300 mm 1300 mm 4000 mm 4800 mm

21.3 Supplier Qualification Criteria

Only TGNPDCL approved components shall be used for construction of 132 kV switchyard.

21.4 Circuit breaker

21.4.1 Technical Parameters

Parameters	**Specification**
Type	Outdoor SF6, single pressure
Operating duty cycle	O – 0.3sec – CO – 3min – CO
Rated break time	60 ms
Total break time	65 ms
Total closing time	Not more than 150 ms
Re-strike performance class	C2
Mechanical endurance class	M2
First pole to clear factor	1.3
Reclosing	Three phase high speed auto reclosing
Rated terminal load	Adequate to withstand 100 kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity
Noise level	Maximum 140 dB at 50 m distance from base of circuit breaker
Seismic level	0.5 g horizontal for the site location under Zone-V as per IS 1893 0.3 g horizontal for the site location under other than Zone-V as per IS 1893
Auxiliary contacts	
No. of contacts	As required plus 10 NO and 10 NC contacts per pole as spare
Thermal rating	10 A at 220 V DC
Breaking capacity	2 A DC with circuit time constant not less than 20 ms
Rated fault current and duration	31.5 kA for 1 sec.

Rated short circuit making current	125 kA peak
Making time (closing time)	Less than 200 msec.

21.4.2 Duty Requirements

21.4.2.1 The circuit breaker shall be shall be capable of performing their duties without opening resistors. The circuit breaker shall meet the duty requirements for any type of fault or fault location and shall be suitable for line charging and dropping when

used on effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.

21.4.2.2 The circuit breaker shall be capable of breaking the steady and transient magnetizing current corresponding to power transformers of applicable rating. It shall be capable of breaking line charging currents as per IEC 62271-100 with a voltage factor of 1.4. The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC 62271-100.

21.4.2.3 The total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic/hydraulic pressure and arc extinguishing medium pressure, etc. While furnishing the proof of the total break time of complete circuit breaker, the effect of non-simultaneity between contacts within a pole or between poles shall be brought out to establish the guaranteed total break time. While furnishing particulars regarding the D.C. component of the circuit breaker, the Contractor shall note that IEC 62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation.

21.4.3 Construction

21.4.3.1 Circuit breakers shall be SF6 insulated, single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6gas on the internal insulating surfaces of the circuit breaker.

21.4.3.2 Each pole shall form an enclosure filled with SF6 gas independent of two other poles and the SF6 density of each pole shall be monitored individually.

21.4.3.3 The SF6 gas density monitor shall be adequately temperature compensated to model the density changes due to variations in ambient temperature within the bodyof circuit breaker as a whole. It shall be possible to dismantle the monitor without removal of gas. Temperature compensated SF6 pressure gauge shall be provided which will be visible from ground level.

21.4.3.4 Sufficient SF6 gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.

21.4.3.5 All making and breaking contacts shall be sealed and free from atmospheric effect. In the event of leakage of extinguishing medium to a value, which cannot withstand the dielectric stresses specified in the open position, the contacts shall preferably self- close. Main contacts shall be easily accessible for inspection and replacement. If there are no separately mounted arcing contacts, then the main contacts shall be easily accessible for inspection and replacement. Main contacts shall have ample area and contact pressure for carrying the rated current under all conditions.

21.4.3.6 All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically.

21.4.3.7 Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.

21.4.4 Operating Mechanism and Control

21.4.4.1 Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated for 3-phase reclosing operation.

21.4.4.2 The pneumatically operated mechanism shall offer unit compressor with each circuit breaker with the breaker local air receivers having a capacity for two 'CO' operations of the breaker at the lowest pressure for reclose duty without refilling.

21.4.4.3 The spring-operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-open operation shall be possible with the energy contained in the operating mechanism. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring.

21.4.4.4 The hydraulic mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto-reclose duty. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of
1.5 times maximum working pressure.

21.5 Disconnector

21.5.1 Technical Parameters

System Parameters	**Specification**
Service	Outdoor
Type	Gang operated, Double break type
Rated short-time withstand current for isolator & earth switch	31.5 kA for 1 s
Rated peak withstand current for isolator & earth switch	80 kA
Operating Mechanism	AC / DC / Universal motor operated/manual
Maximum operating time	12 s
Control Voltage	110 / 220 V DC
Auxiliary contacts	
No. of contacts for isolator	As required plus 8 NO and 8 NC contacts per pole as spare
No. of contacts for earth switch	Total 6 NO and 6 NC
Thermal rating	10 A at 220 V DC
Breaking capacity	2 A DC with circuit time constant not less than 20 ms
Mechanical endurance class a) Isolator b) Earth switch	M2 M0

21.5.2 Duty Requirements

21.5.2.1 Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open under influence of short circuit current and wind pressure together.

21.5.2.2 The earth switches, wherever provided, shall be interlocked so that the earth switches can be operated only when the isolator is open and vice versa. In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of failsafe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within stipulated variation range. The interlock coil shall be provided with adequate contacts for facilitating permissive logic for DC control scheme of the isolator as well as for AC circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energized.

21.5.2.3 The earthing switches shall be capable of discharging trapped charges of the associated lines. Isolators and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity.

21.5.2.4 The isolator shall be capable for making/breaking normal currents when no significant change in voltage occurs across the terminals of each pole of the isolator on account of making/breaking operation.

21.5.3 Construction

21.5.3.1 Contacts

i. The contacts shall be self-aligning and self-cleaning type and shall be so designed that binding cannot occur after remaining in closed position for prolonged period in a heavily polluted atmosphere.
ii. No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earthing switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.
iii. Contact springs shall not carry any current and shall not lose their characteristics due to heating effects.
iv. The moving contact of double break isolator shall preferably be turn-and- twist type or other suitable type of locking arrangement to ensure adequate contact pressure.
v. Flexible braided copper, where used, shall have corrosion resistant coating such as tinning or silvering.

21.5.3.2 Base

Each single pole of the isolator shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a standard supporting structure.

21.5.3.3 Blades

i. All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. Ferrous parts, other than stainless steel shall not be used in close proximity of main current path. All ferrous castings, if used elsewhere shall be made of malleable cast iron or cast-steel. No grey iron shall be used in the manufacture of any part of the isolator.
ii. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces. Where this is impracticable, adequate corona rings shall be provided. Corona shields are not acceptable. Corona rings shall be made up of aluminum/aluminum alloy.

iii. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism.

iv. The isolator and earth switch shall be designed such that no lubrication of any part is required except at very infrequent intervals. i.e., after every 1000 operations or after 5 years whichever is earlier.

21.5.3.4 Insulator

i. The insulator shall conform to IS / IEC 60168 and IS 16683 / IEC TS 60815.

ii. In addition to all type, routine and acceptance tests, as per IS / IEC 60168, the following additional routine/ acceptance tests shall also be carried out.

a. Bending load test in four directions at 50% of minimum bending load guaranteed on all insulators, as routine test

b. Bending load test in four directions at 100% of minimum bending load guaranteed as a sample test on each lot

c. Torsional test on sample insulator of a lot

d. Ultrasonic test as a routine test

iii. The porcelain of the insulator shall have minimum cantilever strength of 600 kg.

iv. Pressure due to the contact shall not be transferred to the insulators after the main blades are fully closed.

21.5.3.5 Earthing Switches

i. Where earthing switches are specified, these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.

ii. Earthing switches shall only be locally operated.

iii. Each earth switch shall be provided with flexible copper/aluminum braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade. The transfer of fault current through swivel connection will not be accepted.

21.5.4 Operating Mechanism and Control

21.5.4.1 The Contractor shall offer motor operated switches having padlock arrangement for both ON and OFF positions.

21.5.4.2 Limit switches for control shall be fitted on the isolator / earth switch shaft within the cabinet to sense the open and close positions of the isolators and earth switches.

21.5.4.3 It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed.

21.5.4.4 Control cabinet / operating mechanism box shall conform to requirements stipulated elsewhere in the document and IS/IEC 61439 as applicable.

21.5.5 Operation

21.5.5.1 Isolator shall be electrically/mechanically gang operated for main blades and earth switches. The operation of all the three poles shall be well synchronized and interlocked.

21.5.5.2 The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments.

21.5.5.3 The isolator and earth switches shall be provided with 'dead centre mechanism' to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

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

21.6 Surge Arrester

21.6.1 Technical Parameters

Parameter	Specification
Arrester Classification	Station Medium (SM)
Nominal discharge current (8/20 µs)	10 kA
Repetitive charge transfer rating	1.6 coulomb
Rated thermal energy rating	5 kJ/kV
Rated arrester voltage	120 kV
Continuous operating voltage at 50°C	102 kV
Maximum Residual Voltage (i) At 30/60 µs, 1 kA current (ii) At 8/20 µs, 5 kA current (iii) At 8/20 µs, 10 kA current	 280 kVp 310 kVp 330 kVp
High-current short duration test value (4/10 µs)	100 kAp
Prospective symmetrical fault current for pressure relief test (0.2 sec)	31.5 kA RMS
Partial discharge at 1.05 times the continuous operating voltage	≤ 50 pico Coulombs

21.6.2 Duty Requirements

21.6.2.1 The Surge Arresters shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines.

21.6.2.2 The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

21.6.2.3 The Surge Arresters shall be capable of withstanding meteorological and short circuit forces under site conditions.

21.6.2.4 The SAs shall protect power transformers, circuit breakers, disconnecting switches, instrument transformers, etc. with insulation levels specified in this specification.

21.6.3 Construction

21.6.3.1 Each surge arrester shall be hermetically sealed single-phase unit. The non-linear blocks shall be made of sintered metal oxide material. The surge arrester construction shall be robust with excellent mechanical and electrical properties.

21.6.3.2 Surge Arresters shall be fitted with pressure relief devices and arc diverting ports suitable for preventing shattering of polymer housing and to provide path for flow of rated fault current in the event of SA failure.

21.6.3.3 Outer insulator of surge arrester shall be made of porcelain/polymer. The outer insulator housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrester. Arresters shall not fail due to insulator contamination.

21.6.3.4 Seals shall be provided in such a way that they are always effectively maintained even when discharging rated lightning current.

21.6.3.5 The cantilever strength of the insulator shall be minimum 150 kg.

21.6.3.6 The following details shall be furnished for quality checks.

i. The heat treatment cycle details along with necessary quality checks used for individual blocks and insulation layer formed across each block.

ii. Metalizing coating thickness for reduced resistance between adjacent discs.

21.6.4 Fittings and Accessories

21.6.4.1 Surge arrester shall be complete with insulating base having provision for mounting to structure.

21.6.4.2 Grading/corona rings shall be provided on each surge arrester unit, as required.

21.6.4.3 The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.

21.6.4.4 Self-contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit along with necessary connection arrangement. Suitable leakage current meters shall also be provided in the same enclosure. The reading of ammeter and counter shall be visible through an inspection glass panel to maintenance personnel standing on ground. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The surge counter shall be provided with a potential free contact rated for 220 V DC which shall close whenever a surge is recorded by the surge monitor. Necessary arrangement shall be provided for extending the contact information to Substation Automation System/RTU.

21.7 Instrument Transformer (132 kV system)

21.7.1 Technical Parameters

Parameter	Specification
Current Transformer	
Accuracy class	Metering – 0.2S Protection – PS / 5P20
Rated VA burden	As per requirement
Insulation class	Class E
One minute power frequencywithstand voltage between secondary terminals & earth	5 kV
Rated short time thermal withstand current	31.5 kA for 1 s
Rated dynamic current	80 kAp
Partial discharge level	10 pico Coulomb (max)
No. of terminals	All terminals of control circuits wired up to marshalling box plus 20% spare
Capacitive Voltage Transformer	
Accuracy class	Metering – 0.2 Protection – 6P
Rated VA burden	As per requirement
Insulation class	Class E
Standard reference range offrequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement
High frequency capacitance forentire carrier frequency range	Within 80% to 150% of rated capacitance
Equivalent series resistance over entire carrier frequency range	< 40 ohm
One minute power frequency withstand voltage between secondary terminals & earth	
(i) Between LV (HF) terminal andearth terminal	10 kV RMS for exposed terminals 4 kV RMS for terminals enclosed in a weatherproof box
(ii) For secondary winding	3 kV RMS
Partial discharge level	10 pico Coulomb (max)
Rated voltage factor	1.2 continuous and 1.5 for 30 sec.
No. of terminals	All terminals of control circuits wired up to marshalling box plus 20% spare

21.7.2 General Requirements

21.7.2.1 Instrument transformers shall be hermetically sealed single-phase units, oil immersed, self-cooled suitable for outdoor installations and shall be supplied with common marshalling box for a set of three single phase units.

21.7.2.2 The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted with color shade as decided by the TGNPDCL during detailed engineering.

21.7.2.3 Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IS 335 / IEC-60296. Non–PCB based synthetic insulating oil conforming to IEC 60867 shall be used in the capacitor units of CVT.

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

21.7.2.5 The insulators shall have cantilever strength of more than 350 kg.

21.7.2.6 Marshaling box shall conform to all requirements given elsewhere in the document. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals.

21.7.3 Current Transformer

21.7.3.1 Current transformer shall have single primary of either ring type or hair pin type or bar type. Wound type primary is acceptable only for metering CTs of ratio less than 400/1. In case of inverted type/live tank CT, the following requirements shall be met.

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

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

(iii) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.

(iv) The insulator shall be one piece without any metallic flange joint.

21.7.3.2 Core lamination shall be of cold rolled grain-oriented silicon steel or other equivalent alloys. The cores shall produce undistorted secondary current under transient conditions at all ratios with specified parameters.

21.7.3.3 The CT shall be provided with oil filling plug, drain plug, and oil sight glass which should be clearly visible to maintenance personnel standing on ground.

21.7.3.4 The secondary terminals of CT shall be terminated to suitable number of stud type non-disconnecting and disconnecting terminal blocks as required inside the terminal box of degree of protection IP 55 at the bottom of CT.

21.7.3.5 Different ratios shall be achieved by secondary taps only; primary reconnection shall not be accepted.

21.7.3.6 The Instrument Security Factor (ISF) at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactors are used, then all parameters specified shall be met treating auxiliary CTs as an integral part of the CT. The auxiliary CTs/reactors shall preferably be in-built construction of the CT. In case these are to be mounted separately, these shall be mounted in the central marshalling box suitably wired up to the terminal blocks.

21.7.3.7 Current transformers shall be suitable for high-speed auto reclosing.

21.7.4 Capacitor Voltage Transformer

21.7.4.1 Capacitor Voltage Transformer shall consist of a capacitor divider and an electromagnetic unit housed in independent, non-oil communicating hermitically sealed compartments.

21.7.4.2 The capacitor divider shall consist of primary and secondary capacitance housed in high quality porcelain insulators filled with oil. The electromagnetic unit shall comprise of compensating reactor, intermediate transformer, protective and damping devices.

21.7.4.3 Suitable damping device shall be permanently connected to one of the secondary windings and shall be capable of suppressing ferro-resonance oscillations.

21.7.4.4 All the secondary windings of the CVT shall be protected by HRC cartridge type fuses or MCBs. In addition, fuses/MCBs shall also be provided for protection and metering windings for connection to fuse monitoring scheme.

21.7.4.5 The secondary terminals of the CVT shall be terminated to stud type non-disconnecting terminal blocks via fuses/MCBs inside the terminal box of degree of protection IP 55. It should be ensured that access to secondary terminals is without tany danger of access to high voltage circuit.

21.7.4.6 CVTs shall be suitable for High Frequency (HF) coupling required for Power Line Carrier Communication (PLCC). Carrier signals must be prevented from flowing into EMU circuit by means of RF choke/reactor over the entire frequency range of 40 to 500 kHz. HF terminal shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment. Further, earthing link with fastener to be provided for HF terminal.

21.7.4.7 A protective surge arrester/spark gap shall preferably be provided to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor, tuning reactor, RF choke, etc. due to short circuit in transformer secondary. The details of this arrangement (or alternative arrangement) shall be

furnished by Contractor for TGNPDCL review.

21.7.4.8 The accuracy of metering core shall be maintained through the entire burden range up to rated value without any adjustments during operations.

21.7.4.9 The protection cores shall not saturate at about 1.5 times the rated voltage for aminimum duration of 30s.

21.8 Warranty

All switchyard equipment shall be warranted for minimum of 2 (Two) years against all material/ manufacturing defects and workmanship.

21.9 Testing and Inspection

21.9.1 Type Tests

All switchyard equipment shall be of type tested design. Type test reports as per the relevant IEC/IS standards shall be submitted during detailed engineering. The tests should have been conducted on the similar equipment by NABL accredited laboratory. 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 TGNPDCL or its consulting agency.

21.9.2 Routine Tests

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

22 Illumination

22.1 Standards and Codes

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

Standard/Code	Description
LM79-08	Electrical and Photometric Measurements of Solid-State Lighting Products
LM 80-15	Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules

22.2 General specification

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

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

22.2.3 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, security room and main gate.

22.3 Lighting Levels

22.3.1 The average LUX level of 10 lumen is to be maintained in switchyard. However, a lux level of 20 lumen ((10+10) additional switchable on requirement only) is to be maintained in switchyard on transformer.

22.3.2 The lighting system for outdoor and indoor areas of solar power plant 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
Battery & other rooms	150
Internal	4
Transformer yard/Switchyard	20
H – pole and metering point	10

22.3.3 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 illuminance uniformity [Uo] shall be min 0.3.

22.3.4 Plant boundary/ Peripheral area shall be illuminated with chain-link/Boundary wall post mounted LED floodlights (at every 100m) for area lighting as per following specifications:

Parameter	**Specified Value**
Input Voltage	220 – 240 V AC
Frequency	50 Hz – 60 Hz
LED Power Consumption	50 W
LED Luminous Efficiency	85 lumen / W
LED Luminous Flux	4500 lumens
Lamp Efficiency	> 88 %
Colour Temperature	Cool White
Colour Rendering Index	＞75
Light Distribution	Symmetric / circular spot
Light Design	LED + Reflector
LED Junction Temperature	≤ 80°C
Working Temperature	-40°C – 55°C
IP Grade	IP 65

Mechanical Strength	IK 08
Working Life Span	30000 Hrs
Certification	CE & ROHS
Warranty	3 Years Product Replacement

22.4 LED Luminaire for Outdoor Applications (Other than Peripheral Area)

22.4.1 LED luminaires shall meet the following parameters.

Parameter	**Specified Value**
Input voltage	170 - 260 V
Input Frequency	50 Hz +/-1 Hz
Power Factor	0.90 (Minimum)
Luminaire 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)
Luminaire Casing	Powder coated metal / Aluminium.
Colour Temperature	5700 K (cool day light)
Colour Rendering Index	> 65
Moisture protection in case of casing damage	IP 65 (driver unit shall preferably be totally encapsulated)

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

22.4.3 The LED luminaire (outdoor) housing should be made of non-corrosive, high- pressure, die-cast aluminium and the housing should be power coated grey, so as to ensure good 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 luminaire is suitable for road lighting applications (wide beam distribution) and should ensure high pole to pole spacing.

22.4.4 The luminaire should be provided with in-built power unit and electronic driver.

22.4.5 The luminaire should be suitable for standard street light poles and should be suitable for side entry and bottom entry (post top).

22.4.6 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.

22.4.7 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.

22.4.8 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 armour shall be connected to earthing system at both the ends. Proper earthing of street light poles shall be ensured.

22.4.9 Junction box for lighting shall be made of fire-retardant material. The degree of protection shall be IP55 for outdoor JB.

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

22.5 LED Luminaire/Lamps for Indoor Applications

22.5.1 LED luminaire/lamps shall have minimum 3-star BEE rating.

22.5.2 All indoor LED luminaire/lamps shall be supplied with proper diffuser to avoid direct visibility of LED and suitable heat sink for longer life.

22.6 Warranty

All luminaires shall be warranted against all material/manufacturing defects and workmanship for minimum of 2 (two) years from the date of supply.

23 Weather Monitoring System

As a part of weather monitoring system, the Contractor shall provide the following measuring instruments with all necessary software and hardware required to integrate with SCADA.

23.1 Pyranometer

23.1.1 The Contractor shall provide Class-A pyranometers (ISO 9060:2018 classification) along with necessary accessories for measuring incidental solar radiation at horizontal and inclined plane of array.

23.1.2 Specification of the pyranometer shall be as follows.

Parameter	**Specification**
Spectral Response (50% points)	0.31 to 2.8 micron
Operating temperature range	0°C to +80°C
Ingress Protection	IP 67
Resolution	Minimum +/- 1W/m^2
Output	Analog output: 4 – 20 mASerial output: RS485

23.1.3 Each instrument shall be supplied with necessary cables. Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the equipment. The signal cable length shall not exceed 20m. The Contractor shall provide instrument manual in hard and soft form.

23.2 Temperature Sensor

The Contractor shall provide minimum 3 (three) temperature sensors (1 (one) for ambient temperature measurement with shielding case and 2 (two) for module temperature measurement) at each site. The temperature sensor shall be Resistance Temperature Detector (RTD)/ Semiconductor type with measurement range of 0°C to80°C. The instrument shall have valid calibration certificate.

23.3 Anemometer

Contractor shall provide minimum one no. ultrasonic wind sensor (no moving parts) for wind speed and direction monitoring.

Parameter	Specification
Velocity range with accuracy limit	0-60m/s with +/-2% accuracy @12 m/resolution: 0.01m/s
Wind direction range with accuracy limit	0 to 360º (No dead band) with +/-2º accuracy @12 m/resolution: 1º
Mounting Bracket	Anodized Aluminium bracket to reduce corrosion, all mounting bolts of SS
Protection Class	IP 66
Output	RS 485

23.4 Data logger and Data Acquisition System

Data logger for the weather monitoring station should have the following features:

23.4.1 Provision for analog, digital and counter type inputs for interfacing with various typeof sensors

i. Analog Input

- Adequate nos. for all analog sensors with redundancy
- Provision for operation in different current and voltage ranges as perconnected sensors
- Accuracy of +/-0.1% of FS

ii. Digital Inputs

- Adequate no. of Digital inputs and outputs for the application

iii. Provision for RS232 and RS485 serial outputs

iv. Built-in battery backup

v. Connectivity and Data transmission:

- RS485 MODBUS interface for data collection and storage on SCADA
- Communication protocol should support fast data transmission rates, enable operation in different Frequency bands and have an encryption- based data security layer for secure data transmission

vi. Display Settings: Graphic LCD screen which should be easily

accessible and should display relevant details like all sensor values, battery strength, network strength etc.

vii. Provision of Time synchronization from telecom time or server time

viii. Data Storage: Provision for at least 2 MB internal Flash Memory and atleast 8 GB Micro SD card (expandable)

ix. Protection level: IP65

24 CCTV Camera system

24.1 CCTV Cameras along with monitoring stations (sufficient numbers) and all other accessories required for its proper operation must be installed to have complete coverage of following areas for 24 hours.

i. Main entry: Covering all the entry/exit

ii. Along the Plant Perimeter: Covering complete perimeter of Plant Area to capture all possible intrusion

iii. Control Rooms: Covering Entry/Exit and Equipment Rooms

iv. Switchyard

24.2 Monitoring stations of the CCTV Network shall be installed in Main Control Room.

24.3 The CCTV system shall be designed as a standalone IP based network architecture. System shall use video signals from different cameras at defined locations, process the video signals for viewing on monitors at control room and simultaneously record all video streams using latest compression techniques.

24.4 Camera shall be colour, suitable for day and night surveillance (even under complete darkness) and network compatible.

24.5 It shall be possible to control all cameras i.e., PTZ auto/ manual focus, selection of pre- sets, video tour selection etc. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitor for live video.

24.6 The system shall support video analytics in respect of the following:

i. Video motion detection

ii. Object tracking

iii. Object classification

iv. Camera server shall be provided with sufficient storage space to storage recordings of all cameras at HD mode for a period of 15 days. All recordings shall have camera ID, location, date and time of recording.

25 Fire Alarm System

25.1 Standards and Codes

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

25.2 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 othe rcompetent authority in terms of fire protection.

25.3 Firefighting system for the proposed power plant 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.

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

25.5 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.

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

25.7 Contractor shall submit the plan for fire and smoke detection system for TGNPDCL approval.

26 Testing Instruments

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

26.1 Earth resistance tester

Parameter	Specification
Display	Backlit LCD or LED display
Range	Earth Resistance : up to 2000 □
	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	

26.2 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	

26.3 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	

26.4 Digital Multimeter

Parameter	Specification
Voltage Range	1500 V DC / 1000 V AC (True RMS)
Display	4 ½ digits, Backlit LCD or LED
Measuring Category	1000 V CAT III as per IEC Standard 61010-1
Additional Functions	Resistance, Temperature, Continuity, Diode, Capacitance, Frequency, Duty cycle measurement
Accessories	
Temperature Probe – 1	
Test Leads with Alligator Clips – 1 set	
Battery – 2 set	
Carry Case with sufficient space for accommodating accessories	

26.5 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	
Battery – 2 set	
Carry Case with sufficient space for accommodating accessories.	

26.6 Infra-red thermal imaging camera

Parameter	**Specification**
Spectral response	8 μm to 14 μm (LW)
Temperature-sensitivity andcalibration range	–20 °C to +120 °C
Atmospheric air temperature	-10 °C to +40 °C
Thermal sensitivity	NETD ≤ 0.1 K at 30 °C
Geometric resolution	640 x 480 pixels
Absolute error of measurement	< ± 2 K
Adjustable parameters	Emissivity, Reflected temperature
Adjustable functions	Focus, temperature level and span
Measurement functions	Measuring spot, measuring area with averageand maximum temperature
Calibration	The measuring system (Camera, lens, aperture and filter): The thermographic camera has to be traceably calibrated at least every two years. The calibration has to be documented. If the camera is not compliant (absolute temperature and/or temperature differences), it has to be readjusted by the manufacturer.
Documentation	Storing of the infrared picture with the radiometric data to be able to determine absolute temperatures

26.7 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.	

26.8 All testing equipment shall possess valid calibration certificate issued from approved NABL labs.

26.9 Instruments of superior rating is allowed after seeking consent of TGNPDCL.

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

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

26.12 Laptop with (advanced version) loaded with ABT energy meter software

and numerical relays software should be provided by the contractor for each plant

26.13 Standard RFID Scanner should be provided by the contractor for each plant.

26.14 Portable Transformer oil BDV tester should be provided by the EPC Firm for each plant.

26.15 Portable ONLINE DGA (Dissolved Gas Analyser) should be provided for Power Transformer.

26.16 Portable SF_6 gas leakage detector should be provided for each plant.

27 Power Evacuation System

27.1 The Contractor has to do the power evacuation and integration to and with the designated substation via either overhead transmission line or underground cables at specified grid voltage with all necessary infrastructure such as protection switchgears and metering systems as per the requirement of TGNPDCL.

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

27.3 The ROW for the TL/UG cable shall be obtained prior to the construction of the line from the concerned authorities. ROW is purely the responsibility of the EPC Firm.

27.4 All the Transmission line works are to be carried out under the supervision of supervisor having 132 KV (or above) license issued by Telangana state Electrical Inspectorate.

27.5 Overhead Transmission Line

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

Note: Installation of overhead transmission line shall be as per IS 5613. In 33 kV level,

isolators are to be provided in the overhead transmission line as per the requirement.

27.6 Underground cable

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

26.7. The ground wire on OHT line should be OPGW type cable as per TGNPDCL guidelines.

26.8. Following protection functions shall be provided:

I. For 132 kV transmission line with line length greater than 10 kMs:

a) Main : Numerical line distance relay

b) Back up: Numerical directional IDMT O/C and E/F relays.

II. For 132 kV transmission line with line length less than 10 kMs:

a) Main: Numerical line differential relay with inbuilt distance protection features with Fiber Optic Communication.

b) Back up: Numerical directional IDMT O/C and E/F relays.

Note: Test Certificates, Manuals, GA drawings, GTP etc. connected to switchyard and line must be submitted to TGNPDCL in addition to TGNPDCL.

B. Civil, Mechanical and Plumbing Works

1 General Requirement

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

1.2 Tower extensions & accessories and 33 kV transmission poles & accessories which shall be designed following latest guidelines of TSNPDCL and got approved from TGNPDCL before execution. In absence of TSNPDCL guidelines, REC (Rural electrification corporation) standards shall be followed. Poles at corner with angle > 100 shall be provided with 4- pole structure or lattice tower. Use of Pre-stressed cement concrete spun poles is not acceptable. Approved copies of these designs & drawings shall be submitted to TGNPDCL for reference and record.

1.3 Standards & Codes

1.3.1 All design and construction of civil works shall conform to relevant Indian standards such as BIS, IRC, MORTH, NBC etc.

1.3.2 Design of steel structures shall conform to IS: 800, 801 or 802 as applicable. Designof 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 review and approval, and the decision of the Engineer shall be final and binding.

1.3.3 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 plants.

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

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

1.4. 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 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.

1.5. 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.

2 Topographical Survey

2.1 The contractor shall be responsible for detailed Topographical Survey of the proposed project site. The work shall be carried out through an agency with relevant experience and qualified survey team.

2.2 The Topographical survey shall be conducted at 20m x 20m grid, or as directed by the Engineer, only with the help of digital surveying instruments like Total Station/ Auto level.

2.3 The Contractor shall carry the Bench Mark from nearest GTS Bench mark or any other established source like Railway station, Permanent PWD/ WRD structure etc. as approved by the Engineer, by fly-levelling and establish two permanent bench marks (PBM) at site. All subsequent transfer of levels shall be carried out with respect to these PBMs. The work shall also include constructing permanent reference pillars (RP) at suitable locations as directed by the Engineer. These reference pillars shall be labelled permanently with their respective coordinates and reduced levels for future use. The Permanent Bench Marks (PBM) and reference pillars (RP) shall be shown on the survey drawings.

2.4 While carrying bench mark to the project site, levels shall also be established on the permanent objects like culverts etc. at least on one object in every 1 (one) km if available along with route with adequate description about the objects. These levels shall be maintained at site & also mentioned in the survey report to facilitate locating these objects later on.

2.5 The survey work shall be carried out in UTM grid system. The contractor shall also establish the latitudes and longitudes and UTM coordinates of all the corners of the project site. At least 50m width of the adjoining plots and surrounding areas shall also be covered in the survey for correlation with adjoining plots and facilities. The grids for the survey work shall be established in N-S & E-W direction (corresponding to Geographical North or Plant North) as directed by the Engineer.

2.6 Positions, both in plan and elevation, of all natural and artificial features in the area like waterways, railway tracks, trees, cultivation, houses, fences, pucca and kutcha roads including culverts and crossings, foot tracks, other permanent objects like telephone posts and transmission towers etc. are to be established and subsequently shown on survey maps by means of conventional symbols (preferably symbols of survey of India Maps). All hills and valleys within the area/areas are to be surveyed and plotted on maps by contours. Any unusual condition or formation on the ground, locations of rockout crops (if visible on the surface) and springs/falls, sand heap/dune, possible aggregate deposits etc. shall also be noted and plotted on contour maps. The C/L coordinates of existing road & cross drainage (CD) works (culverts etc.) at intermediate points & at corners/ intersections and width of carriage way of the road shall be recorded with their position on the contour maps.

2.7 The record of measurement of all Reduced Levels (RL) shall be submitted in

digital format, (in x, y z coordinate system) along with preliminary contour plan of the site, for Engineer's review before submission of final contour map. The contour interval shall be as required for proper representation of the topography however it shall not be more than 0.5m. The Contractor shall submit survey maps of the site in 1:10,000 scale indicating grid lines and contour lines, demarcating all permanent features like roads, railways, waterways, buildings, power lines, natural streams, trees, sand dunes etc. Present use of the site i.e. mining, quarrying, agriculture etc., existing drainage pattern of the site, possibility of water logging and high flood level of the area shall also be captured in the document. The project plot boundary with coordinates of all corner points along with coordinate grid of 50m x 50m interval shall be marked on the contour map.

3 Geotechnical Investigations

3.1 The contractor shall be responsible for detailed Geotechnical investigations at the proposed project site for the purpose of foundation design for various buildings, structures, HT lines, MMS etc. and other design/ planning requirements. The investigation work shall be carried out through any Govt. approved/ NABL accredited agency. The contractor shall submit the credentials of the proposed agency along with relevant certificates in support thereof for verification/ approval of the Investigation Agency by the Engineer.

3.2. The scope of work includes execution of complete soil exploration including boring and drilling with rotary drilling rig, standard penetration test (SPT), collecting disturbed (DS) and undisturbed samples (UDS), collecting ground water samples, trial pits, electrical resistivity tests (ERT), field & laboratory CBR tests, conducting laboratory tests on collected samples of soil & ground water and preparation and submission of report. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20% met within a borehole (BH). SPT test shall be conducted at every 1.5m interval or at change of strata. The starting depth of SPT shall be 0.5m from ground level. UDS shall be collected at every 1.5m interval or at change of strata. The min. size of trial pit shall be 2.0mx2.0mx2.5m deep.

3.3 The field investigations shall mainly include drilling of min. 5 m deep BHs, conducting SPT and collecting Disturbed (DS) and Undisturbed samples (UDS), conducting in-situ CBR test for approach road to the plant, internal roads & peripheral road; Trial pits(TP) and Electrical resistivity tests (ERT). Number and location of BHs, California bearing ratio (CBR) tests, ERTs and TPs shall be decided as per the project layout, site topography and soil conditions in consultation with TGNPDCL. The proposed locations shall fairly represent the total project site to get the complete required geotechnical information. The BH near MCR and ICR shall be 10m deep. There shall be minimum 1 nos. of BH per 10 acres of the area (However, total number of bore holes shall not be less than 5), 3 nos. of Trial pits, 5 nos. of CBR test & ERT, 5 nos. of Ground water samples for laboratory investigations. The soil/ rock samples for laboratory investigations shall be collected from each borehole and trial pit in sufficient nos. (Note- In case the project plot is divided in to number of discrete blocks separated from each other, min. 3 nos. of bore holes, 2 trial pits, 2 ERT and 2 CBR tests shall be taken per such block with at least 1 No. of BHs per 5 acres as specified above).

3.4 The proposed Geotechnical investigation plan indicating proposed locations of TPs, BHs, water sample collection points, CBR test & ERT shall be submitted to the TGNPDCL for review and approval before start of work.

3.5 Laboratory tests shall be conducted on DS & UDS samples and ground water samples in sufficient no. & shall include, Soil classification, Grain size analysis including Hydrometer analysis, determination of Bulk and dry density, Specific gravity, Natural moisture content, Atterberg limits, Tri-axial shear tests (Unconsolidated Undrained – UU) on UDS, Undrained shear test, Consolidation tests, Unconfined compression tests (UCS), Free swell index, chemical analysis of soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, Organic matter and any other chemicals harmful to concrete and reinforcement/ steel. Laboratory tests on rock samples shall be carried out for Hardness, Specific Gravity, Unit Weight, Uniaxial Compressive Strength (in-situ & saturated), permeability test (in-situ, to be conducted at a depth of 750 mm), Slake Durability etc. Laboratory CBR test on soaked samples shall also be conducted on min. 5 no. of soil samples to ascertain the suitability of soil for sub- grade and requirement of any treatment of subgrade soil in case of CBR <2% as per IRC requirements.

3.6. After completion of field and laboratory work, the contractor shall submit a Geotechnical Investigation Report for Engineer's approval. All bore log details and lab test results shall be presented in the report as per provisions of relevant BIS standards indicating BH coordinates, Existing GL, Depth of water table, Method of drilling etc. The report shall include a Map showing the locations of various field tests including coordinates, calculations and recommendations for foundation type and safe bearing capacity (SBC) for various Plant buildings (ICR, MCR etc.) and Open installations, Switch Yard structures & Sub-Station (as applicable), Transformer foundation, HT lines (as applicable), MMS foundation etc. corresponding to settlement of 25mm.

3.7 The report shall include the study for "Liquefaction potential assessment of the ground and suggestions for any ground improvement measures" as required.

3.8 The report shall also include ground water analysis (water sample collected from bore well) to ascertain its suitability for construction purposes, recommendations for type of cement, grade of concrete & minimum cement content as per prevalent soil characteristics with respect to presence of aggressive chemicals and environment exposure conditions as per relevant BIS specifications. However, minimum grade of concrete shall be as specified under Cl.13.0 'Concrete Works'.

3.9 In case the contractor wishes to adopt concrete pile foundation for MMS supports the 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. 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.

3.9.1 In coastal areas and in marshy or swelling type soil, under reamed or driven precast concrete pile shall be used. In case contractor wishes to use helical piles the design, fabrication and installation shall conform to IBC (International building code).

3.9.2 The contractor shall carry out field trials for initial load test on pile to verify the pile esign 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.

3.9.3 The nos. of piles to be tested under each category shall be finalized corresponding to geotechnical characteristics at site, plot area etc. However, minimum 5 nos. of piles shall be tested {min. 3 nos. in each block (block size < 25 acre) and min. 5 nos. in each block (block size >25 acres) if the plant site is divided in discrete blocks separated from each other} under each category of load.

3.9.4 The locations of test piles shall be distributed over the plant site and to be finalized in consultation with Engineer. In case the MMS column is fixed using base plate-anchor bolt assembly, the adequacy of provided pile reinforcement in job (working) pile corresponding to the set of test loads shall be reviewed by the contractor for any additional requirement of reinforcement and the same shall be provided in the pile to be cast for initial load test.

3.9.5 In case the Contractor proposes to embed the Column leg in the pile for fixing, the test pile shall be provided with embedded column leg as per approved design and any dowels as required for application of test load. The drawing for the Test pile shall be submitted to Engineer for his approval before casting the test pile. The load test on pile shall be conducted after min. of 28 days from the date of casting. In case the contractor desires to conduct the test earlier than 28 days, he may use suitable higher-grade concrete or if there is substantial evidence from earlier cube test results on design grade concrete to demonstrate the early gain of required compressive strength prior to application of the test load.

3.9.6 However, under no circumstances the test shall be conducted before15 days of the date of casting the pile. All the dial gauges and hydraulic jack assembly shall be properly calibrated as per the requirements of relevant BIS standards and valid calibration certificate to this effect from Govt. / NABL accredited Test agency shall be submitted to the Engineer before use.

3.9.7 The contractor shall submit detailed methodology for conducting the tests in line with IS: 2911 (Part 4) for Engineer's approval before commencement of any test. 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 Engineer's approval. The pile work shall start only after approval of the final pile design duly verified/ confirmed with initial load test results.

3.10 All buildings and Plinth for Open installations (MCR, ICR etc.), Transformer yard, Switchyard and Sub-station area shall have levelled ground as detailed under Cl. No. 5 below.

4 Other Investigations

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

4.2 The contractor shall carry out Shadow Analysis at proposed site and accordingly design strings and array layout with optimum use of space, material and man power. In case of large variations in topography (3^o 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.

4.3 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 concrete grades to be used in construction of all concrete works (M25 and above) before start of construction. However, for piling M25 concrete with nominal mix of (1:1:2) may be used. For grades of concrete less than M25 to be used in PPC works, nominal mix as specified in IS:456 may be used. The concrete mix shall be designed for each source of cement and aggregates as per provisions of IS:10262 Standard and confirmed through 28 days compressive strength of concrete trial mix samples. Target mean strength of concrete for mix design shall be based on σ (standard deviation) = 5. 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, the same shall conform to IS: 4926. The Contractor shall submit the Concrete mix design proposed to be used by the RMC for review and approval by TGNPDCL. (Reports of periodic quality tests for the supply concrete batch shall be maintained by the RMC supplier as per approved Quality Plan and the same shall be submitted to TGNPDCL for review and record).

5 Area Grading and Land Development

5.1 The Finished Grade Level (FGL) of the proposed plant shall be fixed with reference to the highest flood level (HFL) and surrounding ground profile at proposed site to avoid flooding of plant site. The data regarding HFL at proposed site shall be obtained from the metrological department by the contractor. In case of absence of this data, the contractor shall assess the required information through local site reconnaissance. Thearea at and around (up to 25m beyond external wall/ area including access road & parking whichever is minimum) all buildings/ plinth for open installations (ICR, MCR etc.), transformer yard and switch-yard shall be uniformly levelled at suitable RL (i.e. FGL) to be finalized considering topography and HFL at site. The minimum plinth levelof all buildings/ open installations shall be 450mm above FGL. Module mounting structure foundation/ Pile cap or any other pedestal shall be min. 200mm above FGL. Top of transformer foundation pedestal shall be min, 500mm above the FGL.

5.2 A detailed drawing for site levelling and grading (if necessary) shall be

submitted by the contractor before commencement of construction of all buildings,plinth for open installation and transformer/switchyard 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 Plant Layout/ Array Layout drawing.

5.3 It is envisaged that the MMS are installed on natural/ existing ground without any levelling or grading of the area. Contractor shall accordingly consider the effect of the existing ground slope on the design of MMS structure as specified elsewhere in the specifications. If any ground undulations at column locations are observed the same shall be filled up with PCC (1:3:6) up to surrounding ground level immediately after pile installation before start of erection of other MMS members. In case of pile, the PCC fill shall extend min. 500mm outside pile cap all around and remaining area may be filled up with local soil properly compacted.

5.4 The contractor is responsible for making the site ready and easily approachable by clearing bushes, 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.

5.5 It shall be ensured that the land grading and levelling is done properly to

ensure for free flow of surface run-off and the grade levels shall be fixed with respect to high flood level at site, 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.

5.6 In case the filled up earth is brought from outside the plant or borrow areas (when the material inside plant 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.

6 Roads

6.1 Suitable approach road (as applicable) from nearest public road up to plant 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.

6.2 The Approach road connecting nearest public road and the Main gate shall be of 4.0mwide carriage way with 0.5m wide shoulders on either side. The access road connecting Main gate and MCR and internal access road(s) connecting MCR to various facilities/ buildings/ open Installations shall be of 3.0m wide carriage way with 0.5m wide shoulders on either side. The top of road (TOR) elevation shall be minimum 200 mm above FGL to avoid flooding of roads during rains. The roads shall be provided with alongside drains as per design requirements of drainage system for effective disposal of storm water and to avoid cross flow of storm water over the road. The roads shall be designed as per IRC SP-72 corresponding to traffic category T1 and critical field CBR value of the subgrade.

6.3 However, following minimum road section details shall be followed:

i. Topping: Surface dressing with gravel or gravel-soil mixture conforming to Cl. 402 of MORD specifications for rural roads published by IRC (MORD specs). However, for sites with average annual rainfall > 1500mm, either 2 course surface bituminous dressing conforming to Cl. 505 of MORD specs or 20 mm thick open graded pre-mix carpet + Type — B or Type –C seal coat conforming to Cl. 506 of MORD specs. shall be provided.

ii. Base course WBM (CBR>100%) conforming to Cl. 405 of MORD specs: 75mmcompacted thick, Grade III

iii. Base course WBM (CBR>100%) conforming to Cl. 405 of MORD specs: 75 mm compacted thick, Grade II

iv. Granular/ gravel sub-base course (CBR>20%), conforming to Cl. 401 of MORD specs: 175 mm compacted thick, compacted to 100% of max dry density

v. Compacted subgrade: 300mm thick below sub-base (non-expansive soil with max. dry density > 1.65 kN/m3) conforming to Cl 303 of MORD specs, compacted up to 98% of standard proctor density in layers of 150mm thickness. In case of expansive soils like black cotton soil suitable treatment as per Cl. 403 of MORD specs shall be provided before laying sub-base course.

vi. Gravel Shoulders conforming to Cl 407 of MORD specs: 150mm compacted thick, compacted to 100 % of max. dry density

6.4 Soaked CBR value of sub-grade shall not be less than 2%. Where the CBR of the sub grade is less than 2 % a capping layer of 100 mm thickness of material with a minimum CBR of 10 % is to be provided in addition to the sub-base required for CBR of 2 %. When the sub grade is silty or clayey soil and the annual rainfall of the area is more than 1000 mm, a drainage layer of 100 mm over the entire formation width should be provided conforming to the gradation given in Chapter 6 of IRC SP-20. This layer will form a part of the designed thickness of sub-base.

6.5 In case of no-availability of murrum in the nearby areas of the project site, suitable other screening/ blending material for WBM construction may be used conforming to provisions of IRC SP 20.

6.6 The construction of road shall conform to MORD specifications for Rural roads published by IRC.

6.7 Drain, cable or any other crossing shall be provided with RCC box or precast concrete pipe culvert. The culvert design shall conform to relevant IRC standard. The pipes for road culverts shall be of minimum class NP3 conforming to IS 458 with min. soil cover of 750mm above the pipe. In case of soil cushion less than 750mm the pipe shall be provided with 100 mm thick M20 reinforced concrete encasement with 10 dia. reinforcement rods @ 150mm c/c both ways. However, the water supply pipe for module cleaning and service/ drinking water shall be routed through Medium class GI steel pipe of required dia. conforming to IS: 1161.

6.8 Minimum dia. of casing pipe to be used at any facility like electric cable, water pipe line etc. shall be 150mm.

6.9 Maintenance pathways of min. 1.0m width shall be provided between SPV arrays for easy movement of maintenance staff, tools, equipment and machinery, washing of modules etc. The pathway area shall be generally levelled and well compacted manually/ mechanically. Areas of depression, valley zones or wherever there is noticeable change in topography, shall be levelled using well compacted good earth matching the top finished surface with ground topography/ grade to avoid accumulation of water in the region and allowing its free flow to keep the area devoid of mud/ sludge.

6.10 There shall be no peripheral road. However, about 2.5m wide corridor compacted to a depth of 300mm shall be left along inside of the plant boundary suitably maintained clean of any vegetation and shall be provided with adequate illumination for movement of security personnel. Any undulations shall be made good with locally available coarse-grained material to have fairly level passage way.

6.11 The design and drawings for approach road, all internal roads and culverts shall be submitted to the Engineer for approval before execution.

7 Surface/ Area drainage

7.1 The contractor shall design and construct storm water drainage network for smooth disposal of storm water from the plant to the nearest available drainage outlet.

7.2 The storm water drainage system shall be designed and planned to ensure no water stagnation in the plant.

7.3 The plant drainage system shall be designed for maximum hourly rainfall intensity and relevant time of concentration.

7.4 The design shall conform to the provisions of IRC SP 42 and best Industry practices. (The design rainfall shall be taken as max. hourly rainfall at 25 years return period at project site as provided in the Isopluvial map of the relevant subzone annexed with Flood Estimation Reports of Central Water Commission (CWC).

7.5 The coefficient of run-off for estimation of design discharge shall be considered as per catchment characteristics, however it shall not be less than 0.6.

7.6 The drainage scheme shall be designed considering the plant plot area and the surrounding catchment area contributing to the plant area drainage as per the topography.

7.7 The storm water drainage system shall be a network of open surface drains (with rectangular or trapezoidal cross section) and shall generally be designed to follow the natural flow of water and ground contours.

7.8 Suitable size plant peripheral drain as per design and requirement (min. 450mm wide x 450mm deep) along inside of plant boundary wall/ fence shall be provided for smooth channelization of outside storm water and to avoid flooding in the plant. The size of all internal and road side drains shall not be less than 300mm (bottom width) x 300mm (depth).

7.9 All trapezoidal drains shall have side slopes not steeper than 1:1. Unlined drains may be provided depending upon the geotechnical characteristics and drainage design in the view of the stability and erosion of drain walls. However, the drain segments near outfalls and drain crossings shall be lined. Thickness of the lining shall be minimum 115mm for brick masonry, 75mm for concrete slabs, 100mm for RR masonry and 50mm for stone slabs. The lining shall be in CM (1:4) and the joints shall be raked and pointed with CM (1:3), however the joints in lining of plant peripheral drain may be left without pointing.

7.10 In case of rectangular drain, the thickness of the wall shall be checked against structural stability under action of the design loads as specified in Cl. No. 10.0 ‘Design Loads’. However, the min. wall thickness shall be 115mm, 200mm and 100mm respectively for brick masonry, RR masonry and RCC work, except for garland drain around buildings where the min. wall thickness can be 115mm, 200mm and 100mm respectively for brick masonry, RR masonry and RCC work.

7.11 The structural design of drains shall be as per provisions of relevant BIS standards and good industry practice.

7.12 The drain outfall shall be connected to the nearest existing natural drain(s)/ water body outside plant premises and it shall be ensured that the drainage water shall not re-enter the plant nor encroach/ flood in the adjacent property/plot.

7.13 The proposed drainage scheme along with design calculations and drawings shall be submitted to the Engineer for review/ approval before start of construction.

7.14 The contractor shall provide percolation/recharge pit for harvesting of water in the MCR area. For the remaining plant facilities, the Contractor shall explore provisions for rain water harvesting system for water conservation by constructing suitable collection wells along the drains or through provision of detention ponds or percolation/recharge pit etc.

at major drainage outfalls. The scheme for rain water harvesting along with design calculations shall be submitted for approval.

8 Plant Layout

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

8.2 The Plant and SPV module layout shall be a comprehensive drawing showing various requirements of the project like, Reference coordinate grid, Geographical and Plant 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 plant, 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.

8.3 The cable corridor shall be laid through clear gap between arrays and shall not be laid below modules for easy maintenance.

8.4 All the facilities and buildings shall be presented with suitable Legend.

8.5 The drawing shall be in suitable scale to have proper representation of the information.

8.6 The Plant & SPV module layout drawing shall be submitted by the contractor for review/approval by the Engineer.

9 Design Loads

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

9.2 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	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, Chequredplate & Grating (except cable trench cover)	5.00 kN/ Sqm
5	Road culverts & allied structures overdrain & pipe crossings subjected to vehicular traffic	Design for Class – 'AA' loading (Wheeled & Tracked both) and check for Class – 'A' loading as per IRC Standard
6	Underground structures such as Sump, Pit, Trench, Drain, UG tanketc.	In addition to Earth pressure and Ground water table at FGL, a surcharge of 20kN /Sqm (10kN/Sqm for drains) shall also be considered. The structure shall be designed for following criteria – (a) Inside empty with outside fill+ surcharge and water table at GL & (b) Inside water with no fill & water table outside
7	Pre-cast and chequred 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 and critical in-field CBR

9.3 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

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

9.5 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.

9.6 Topography factor 'k3' shall be taken as 1.0 upto upwards slope of 3°. For topography with upward slope greater than 3°, the value of 'k3' shall be calculated as per Annexure-C of IS 875 (Part-3).

9.7 To calculate the design wind pressure 'pd', factors 'ka' (area averaging factor) and 'kc' (combination factor) shall be taken as 1.0. (The factor 'kd' shall be taken as 1.0 in caseof plant site within 60km of sea coast).

9.8 The Seismic Load shall be considered corresponding to Earth quake zone at site as per IS: 1893 (Part- 4) with Importance factor 1.5. Ductile detailing as per IS 13920 shall be followed in concrete structures except in case of concrete support structure upto plinth level supporting open installations of inverter transformers and control panels at ICR/LCR, wherein the detailing shall conform to IS 456 and SP 34.

9.9 Notes for MMS Design

9.9.1 WL shall be considered as detailed below for estimation of WL under primary loads:

i. WLx (downward), WLz (downward): Load due to positive pressure on design tilt angles of MMS members for wind acting in both (±X, ±Z) directions.

ii. WLx (upward), WLz (upward): Load due to negative pressure on design tilt angles of MMS members for wind acting in both (±X, ±Z) directions.

iii. WLx (member load), WLz (member load): Load due to wind action on side (exposed) face of respective MMS members (drag force) for wind acting in both(±X, ±Z) directions.

- ±WLx (member load, transverse to MMS table): Load due to wind action oncolumn, front and back bracing, longitudinal bracing
- ±WLz (member load, along length of MMS table): Load due to wind actionon column, rafter front and back bracing, longitudinal bracing

9.9.2 For estimation of design wind loads on purlins (Table 8 of IS 875- Part 3), WL (downward) and WL (upward) on modules (laid in the profile of mono slope canopy) shall be applied such that the center of pressure should be at (0.3 × length of canopy) from windward end (for simplicity, the wind load distribution may be taken as triangular with max. value at windward end). Solidity ratio (Ø) shall be taken as 0.0. **Note:** Wind tunnel studies shall be specific to the site topography as well as array layout. The wind tunnel studies shall be conducted with appropriate scale model and boundary line tunnels and must be validated from an IIT.

9.9.3 In design of MMS (for height of structures less than 10 m from ground), 20% reduction in wind pressure as per Note under Cl. 6.3 of IS 875 — Part 3 is not permitted in case of purlins (members supporting modules), which shall be designed against action of WL corresponding to full wind pressure.

9.10 Design Load combinations

9.10.1 Appropriate Load factors in LSM design for concrete structures and appropriate Factor of safety in WSM design (ASD) for all steel structures including MMS shall be considered as per relevant BIS standard. No increase in permissible stress is permitted in design of MMS.

9.10.2 Following load combinations shall be considered in design:

- For MMS Design:

i. DL+LL

ii. DL+LL + WLx (upward) ± WLx (member load)

iii. DL+LL + WLx (downward) ± WLx (member load)

iv. DL+LL + WLz (upward) ± WLz (member load)

v. DL+LL + WLz (downward) ± WLz (member load)

vi. DL+LL ± ELx

vii. DL+LL ± ELz

- For RCC and Steel structures except MMS:

i. DL+LL

ii. DL+LL ± WLx

iii. DL+LL ± WLz

iv. DL+LL ± ELx

v. DL+LL ± ELz

9.10.3 All buildings, structures and foundations shall be designed to withstand loads corresponding to worst design load combination.

10 Foundations (General)

10.1 Contractor shall design all foundations for buildings, equipment, HT line Towers, Switch yard structures, Transformer, MMS & other structures as per relevant BIS standards and recommendations of Geotechnical investigation report.

10.2 No foundation for MMS, buildings, switchyard equipment and structures, sub- stations, HT line towers, transformers, etc. shall rest on filled-up ground. However, minor structures like cable trench, cable rack, pipe pedestal, etc. may rest on filled-up soil with max. safe bearing capacity for design considerations not more than 3 T/Sqm.

10.3 Min. depth of foundation for all buildings and plinth for open installations shall be 1.5 mbelow NGL. For all other structures, min. depth of foundation shall be
1.0 m unless specified otherwise.

10.4 All foundations of a building shall be founded at same RL (Reduced level) with respect to foundation depth below lowest NGL (Natural ground level) in the building area. The Levels shall be obtained with reference to the already established TBM using digital survey instrument such as Total Station/ Auto Level.

10.5 All design & drawings shall be submitted to the Engineer for approval before execution.

11 MMS Foundation

11.1 Module mounting structure (MMS) may be supported on isolated/ strip footing or pile foundation.

11.2 Bored cast-in situ, Driven precast or under reamed Concrete pile

11.2.1 In case the contractor proposes to provide bored cast-in-situ concrete pile; the type, dia. and length of pile shall be as per recommendations of Geotechnical investigation report corresponding to prevalent soil characteristics at site. However, the min. dia of the pile shall be 300mm. When very hard strata/ rock (N>100) is encountered at a higher level, the pile shall be extended in to the hard strata minimum 1.5 times the diameter of the pile with total depth of the pile not less than 1200mm below cut-off level. A minimum clear cover of 50 mm shall be available to the steel section or reinforcement in the pile.

11.2.2 As specified above, the MMS support shall project minimum 200mm above FGL (Finished grade level) to avoid any damage to the MMS column/sub support due to direct contact of rain water/ surface run-off. This shall be ensured through either single stage construction of entire pile length including portion above FGL or by providing a collar (to be cast in second stage) which shall project min. 75mm in plan beyond the pile face and shall extend min. 250mm below GL.

11.2.3 For proper bonding, the surface of first stage concrete shall be made rough by troweling and cleaning out laitance and cement slurry by using wire brush on the surface of joint immediately after initial setting of concrete. The prepared surface should be clean watered to get saturated dry condition when fresh concrete is placed against it. The prepared surface shall be applied with a suitable bonding agent before construction of pile cap/ collar as required.

11.2.4 In case the column post/stub is supported through base plate-anchor bolt assembly, the same shall only be provided through RCC pile cap to be designed as per provisions of relevant BIS standard with min. clear overhang of 75mm. The pile shall embedded min. 50mm in the pile cap and the pile reinforcement shall be extended into the pile cap for proper anchorage.

11.2.5 In case of collapse of foundation strata during drilling of the pile bore, removable steel liner shall be used to maintain design depth and diameter of the pile for proper concreting.

11.2.6 The design & installation of piles shall conform to IS: 2911.

11.2.7 The bore shall be free from water before poring of pile concrete. For under water concreting tremie shall be used.

11.3 Helical/ Screw Pile

11.3.1 The design, manufacture, testing and installation of Helical/ Screw pile shall conform to ICB-2009 and Practice Note 28- "**Screw Piles: Guidelines for Design, Construction & Installation,** ISSN 1176-0907 October 2015 (IPENZ Engineers NewZealand)"

11.3.2 The design of pile shall be undertaken and verified by a suitably qualified geotechnical or structural Chartered Engineer with experience in the design of helical/screw piles.

11.3.3 The pile shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by installation into the ground and service loads.

11.3.4 The steel grade for pile shaft, helix plates and other accessories shall be with min. Fy350 MPa. Min. thickness (BMT) of shaft and helix plate shall be 6 mm and 8 mm respectively in case of coastal installations and soils containing aggressive chemicals and at other project sites it shall be respectively 5 mm and 6 mm. Cap plate and column base plate shall be min. 12 mm thick and of min. grade E-250 conforming to IS: 2062.

11.3.5 All materials shall be hot dip galvanized conforming to relevant BIS standard with thickness of galvanization 80 microns.

11.3.6 Wherever the pile shaft is required to be in filled with concrete grout, the same shall be of min. grade M30 (anti shrink).

11.3.7 The allowable axial design load (Direct compression & Pull out), Pa, of helical piles shall be the least of the following values:

i. Sum of the areas of the helical bearing plates times the bearing capacity of the soil or rock comprising the bearing stratum.
ii. Capacity determined from well-documented correlations with installation torque.
iii. Load capacity determined from initial load tests.
iv. Axial capacity of pile shaft.
v. Axial capacity of pile shaft couplings.
vi. Sum of the axial capacity of helical bearing plates affixed to pile.

11.3.8 The lateral allowable load capacity of the pile shall be calculated using P-Y analysis and shall be verified with field trials. The allowable design lateral load shall be equal to the min. of (i) the total lateral load producing max. lateral deflection of 5mm and (ii) 50% of the total lateral load at which the lateral displacement increases to 12mm.

11.3.9 Dimensions of the central shaft and the number, size and thickness of helical bearing plates shall be sufficient to support the design loads.

11.3.10 The Design Report shall include following details.

i. Design loads

ii. Geotechnical Strength Reduction Factors and supporting methodology

iii. List of design standards

iv. Design methodology and how specific loads such as seismic, lateral and settlement are addressed

v. Founding stratum

vi. Estimated length

vii. Connection design and details between pile shaft & pile cap plate and Col base plate

viii. Pre-production and production load testing to support design including acceptance criteria.

11.3.11 Helical piles shall be installed to specified embedment depth and torsional resistance criteria as per design. The torque applied during installation shall not exceed the maximum allowable installation torque of the helical pile

11.3.12 Special inspections shall be performed continuously during installation of helical pile foundations. The information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required.

11.3.13 The installation of piles shall be done by an agency having adequate experience in helical pile construction.

11.3.14 The method statement for pre-production load testing (initial test) and construction of Helical Pile shall be submitted for review and approval. The method statement shall comply following requirements:

11.3.14.1. <u>Helical pile pre-production load testing</u>

The Piling Contractor shall provide a method statement for the pre-production load testing. The method statement shall be submitted 2 weeks prior to pile installation for testing and shall contain the following information (as a minimum):

- Programme of the testing, detailing the timing and sequence of each load test including any additional investigations proposed
- The general arrangement of the equipment
- A method for measuring the displacement at the head and toe of each test pile
- Template for the Pile load test report
- Confirming the criteria for determining the acceptability of the compression, tension and lateral load tests
- A contingency plan in the event that a load test is deemed not acceptable

- A procedure for verifying the capacity for each individual pile, this may include correlating the installation torque for each pre-production pile with the load test results
- All pile load tests shall be supervised by suitably experienced personnel, who are competent to operate, monitor and record each test throughout its duration. Each pile load test shall be continuously monitored throughout its duration.

11.3.14.2 Helical Pile Construction

The contractor shall provide a method statement for each piling operation to be undertaken in executing the Works. The method statement shall describe all proposed equipment and detail the construction sequence. The method statement shall be submitted with the tender and shall contain the following information (as a minimum):

- Programme of the works, detailing the timing and sequence of individual portions of the works
- Full details of the installation plant to be used, including manufacturer's information and proof of servicing/recent upkeep and calibration
- Proposed phasing of excavation/filling operations such that the design stresses in the piles (and any supporting frames) are not exceeded
- The contingency plan to be adopted, to minimize disruption and delay, in the event of encountering obstructions
- Anticipated noise levels (measured in dB) and vibration levels (measured in mm/sec) arising from piling operations (if applicable)

11.3.15. The Piling Contractor shall nominate a suitably experienced, professionally qualified engineer, as the "Piling Supervisor".

11.3.16. Unless specified else were, the field trials for initial load tests on concrete and helical/screw pile shall conform to IS: 2911 (Part 4) & Practice Note- 28 (IPENZ Engineers New Zealand) as applicable. The no. and location of such tests shall be as per the provisions stipulated under Cl. No. 26.8.

11.3.17. Contractor shall also carry out routine tests on 0.5 % of the total no. of working/ job piles as per provisions of IS: 2911 (Part 4). In case of unsatisfactory results, min. Nos.of routine tests may be increased up to 2% of the total no. of working/ job piles as per the directions of the Engineer.

12 Module Mounting Structure (MMS)

12.1 The module mounting structure design shall generally follow the existing land profile. The top of the table shall be in one plane.

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

12.3 In case of topographical variations more than 3°, the contractor shall carry out detailed study of its effect on array layout, shadow analysis and structural stability of MMS.

12.4 The structure shall be designed to allow easy replacement of any module and shall be in line with site requirements.

12.5 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 conforming to IS: 2062 and YSt 310 conforming to IS: 1608 respectively.

12.6 The contractor can also propose new light gauge structural steel or structural aluminum sections other than specified in IS: 811 subject to approval of TGNPDCL or its consulting agency. In this case the contractor shall submit his proposal stating the technical advantages of the proposed sections for TGNPDCL review along with supporting literature and sample design calculations conforming to present specifications at the time of bidding.

12.7 Aluminum-Zinc Alloy metallic coated steel strip or sheet of grade YS350 and minimum coating class AZ200 conforming to IS 15961 : 2012 may also be used for fabrication of purlin sections. In such a case, all the sections of the base metal exposed after cutting of members and punching of holes shall be provided with sprayed aluminium and zinc coating conforming to IS 5905.

12.8 The minimum thickness excluding anti corrosive treatment, Base Metal Thickness (BMT) of various elements of MMS structure shall be as following:

Members	Referencecode	Yield strength, min, M Pa	Non Coastal*	
			Coating, Reference code	BMT (mm)
Coulumns/ Vertical Post	IS 2062 / IS 1079	250		2.0
Bracing/ Rafter/ Beam/ Purlin				2.0
			70	
Steel Tubes in all sections	IS 1161	240	Micron (IS	2.0
			4759)	
			(Min)	
Hollow Steel in all sections	IS 4923	240		2.0
Splice/ SagAngle	IS 2062	250		2.0
		Yield strength, MPa	Coating Class Designation	

Rafter/ Beam/ Purlin(Pre-Galvanizedsteel sections)	ASTMA 653M /IS1079	255-380	Z600 (ASTM A653M/ IS 277)	1.6
Note	**A.** Minimum elongation % shall be as per relevant Standard and Code. **B.** Materials shall be fabricated in the shop. **C.** Minimum coating & BMT requirement mentioned above in the table. **D.** All structural calculations of cold formed steel section for checking the adequacy for strength and deflection criteria is to be done taking into consideration the maximum permissible negative tolerance over specified BMT i.e. the lower limit of BMT is to be considered. **E.** The tolerance on Base Metal thickness(BMT) of steel shall be asgiven in IS 1852.			

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

12.10. Vertical Deflection and Horizontal Sway limits:

Limiting Deflection: The limiting permissible vertical deflection for structural steel members shall be as mentioned below:

- Maximum Lateral deflection in Column post – Height / 240
- Maximum Vertical deflection in Purlin – Span / 180
- Maximum Vertical deflection in Rafter (cantilever span) – Span/180

12.11. 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.

12.12. 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

12.13. Lateral restraint to compression flange if any due to PV panels is not permitted in purlin design.

12.14. The vertical diagonal bracing shall be provided in end spans and every alternate span of each unit (table) of MMS.

12.15. MMS shall support SPV modules at a given orientation & tilt and shall absorb and transfer the mechanical loads to the ground properly.

12.16. Welding of structure at site shall not be allowed and only bolted connections shall be used.

12.17. The MMS structure shall be hot dip galvanized with minimum GSM 610 kg/ sq.m and/or minimum coating thickness of 80 microns for protection against corrosion. Galvanization shall conform to IS-2629, 4759 & 4736 as applicable.

12.18. 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.

12.19. The bidder shall ensure that inner side is also provided with galvanization coating.

12.20. The galvanization shall be done after fabrication of members and cutting of holes to ensure galvanization of all cut/ exposed edges.

12.21. In case the proposed section is made up of Aluminum, anodized coating shall be Gr. AC25 and shall conform to IS: 1868.

12.22. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels at the same time.

12.23. Two numbers of anti-theft fasteners of stainless steel on two diagonally opposite 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.

12.24. In case of seasonal tilt, fasteners and washers to be used for erection of mounting structures shall be of stainless steel grade SS 304. In case of fixed tilt, HDG fasteners with minimum coating thickness of 80 microns IS-2629, 4759 & 4736, as applicable. may be used. Those for fixing module over MMS shall be of SS 316 with property class A2-70 conforming to relevant ISO standard and must sustain the adverse climatic conditions to ensure the life of the structure for 25 years. Min. diameter of bolt for MMS connections shall be 10mm (12 mm in case of single bolt connection 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.

12.25. 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 active part of a module.

12.26. The MMS foundation shall be designed as per Cl. No. 12.

12.27. 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.

12.28. 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 plants 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)

12.29. The array structure shall be grounded properly using maintenance free earthing kit.

12.30. The bidder/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagram and drawings.

12.31. The Bidder should design the structure height considering highest flood level at the site 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 and (ii) 1000 mm, as applicable

12.32. The length of one unit (Table) of MMS is as per existing solar industry practice

12.33. The MMS shall be designed to optimize tilt angle and elevation to minimize self-shading

12.34. The EPC Firm shall submit the detailed design calculations and drawings for MMS structure, bill of materials and their specifications/ standards to TGNPDCL for approval before start of fabrication work as per the engineering work program (L2 schedule) as finalized during kick-off meeting.

12.35. The length of any cold formed section (CFS) shall not be more than 5.5 m.

12.36. 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.

12.37. 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.

12.38. The purlin splice shall comprise of flange and web splice plates and splice design shall conform to Annexure-F of BIS:800. For simplicity in fabrication, the splice member maybe of CFS channel section without lips (CU).

12.39. For same member type, same section shall be used.

12.40. 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.

13 Concrete Works

13.1 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.

13.2 The min. grade of concrete shall be M25 (M30 in coastal areas/marshy soil) for all RCC works except liquid retaining structures like underground water tank, septic tank, etc. where minimum grade of concrete shall be M30 (M35 in coastal areas/marshy soil).

13.3 Cement 53 Grade with IS specifications shall be used.

13.4 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 levelling course which shall be of grade M7.5 (nominal mix 1:4:8).

13.5 Reinforcement steel shall be of high strength TMT bars of grade Fe500 D conforming to IS: 1786.

13.6 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/mm^2 at 28 days.

14 Miscellaneous Steel Works

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

14.2 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.

15 Buildings and Plinth for Open Installations

15.1 General Requirement

15.1.1 Plant 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 Photovoltaic Solar Power Plant. Security room at main gate & Security cabin(s) (at strategic locations) shall also be provided to secure the plant from any theft/ burglary/unauthorized entry.

15.1.2 Unless otherwise specified elsewhere, all buildings and plinth for open installations except Security room/ cabin shall have RCC framed structure. Masonry partition walls shall be provided for Kitchen, Pantry, Battery room and Toilet units. For other rooms AL Glass partitions shall be provided. The plinth for open installations and equipment area shall be designed with OEM requirements. The security room/ cabin(s) shall beof prefabricated structure.

15.1.3 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).

15.1.4 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 clea r 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. However, chajja for rolling shutter shall be 750mm wide.

15.2 Functional requirements

15.2.1 MCR Building

- MCR building(s) shall be provided as per drawing titled 'MCR Building: Plan, Elevation, Sections and Finishing Details' furnished under Annexure-E.
- Number of MCR buildings shall be same as the number of pooling sub stations.

15.2.2 LCR/ ICR

- Inverter and associated equipment shall be installed on plinth as open installations. They shall generally comprise of data loggers, battery, inverter, electrical panels, etc. as per requirements and as per approved system drawings.
- There shall be suitable provision for easy/smooth passage of O&M personnel, cable trench, operating area, etc.
- The plinth supporting the ICR/LCR equipment shall have RCC framed structure with foundations, columns and beams up to plinth level (FFL).
- The size and clear head room (below soffit of beam) for LCR/ICR shall be provided as per system/O&M requirements.
- In case of indoor installation of inverters, MCR and LCR/ICR building shall not be clubbed together unless specified otherwise.
- However, when LCR/ICR and MCR building facilities are clubbed in one single building, the Equipment area (inverter room) and Office cum Control room area shall be separated by a brick wall with provision of internal entry door.
- MCR building shall have separate main entry to office area plus a provision of fire exit door.
- The size of inverter/HT panel room shall be provided as per system requirements.

15.2.3 Security Room/ Cabin

15.2.3.1. Contractor shall provide required number of pre-fabricated security cabins at strategic locations & at corners of the plot and 1 nos. security room at Main entry gate.

15.2.3.2. The Security room shall be of min. size 3m x 3m x 2.75m height. The Security cabin shall be of min. size 1.2 x 1.8m x 2.5m height.

15.2.3.3. Security room/ cabin shall be a pre-engineered & pre-fabricated structure. The walls and roof of the building shall be fabricated with double skin insulated sandwiched Al-Zn alloy coated high tensile steel metal panels (BMT- 0.5mm, Al-Zn alloy coating-150 GSM total on both sides). The insulation shall be of PUF with min. density 40 kg/ cum and adequate thickness. Roof shall be provided with suitable slope, not less than 10° to the horizontal (approx. 1V:6H) for proper drainage of rain water and shall project 300mm beyond the walls. The make and (color) shade of pre- coated metal panels shall be subject to approval by the Engineer. Min. thickness of color coating shall be 20 micron (DFT) excluding prime coat 5 micron (DFT). The coating system shall confirm to IS: 15965.

15.2.3.4. The Main security room shall be provided with one Aluminum (AL) glazed door (0.75m wide x 2.1m height) on one face and AL glazed sliding windows (1.2m width x 1.0 m height) with AL grill on remaining three sides. Security cabin shall have one AL glazed door (0.75m widex2.1m height) and 1 no. AL sliding window (0.8m width x 1.0 m height) with AL (anodized) grill on one side. All glazing shall be of clear float glass with thickness of 4mm for window and 6 mm for door panel.

15.2.3.5. The door and windows shall be provided with all necessary fitting and fixtures like handles, tower bolts, mortise lock for door, stays, door stopper etc. All AL sections for doors and windows shall be anodized (min. average thickness 25 microns) or polyester powder coated (min. DFT 50 microns) with approved color shade for protection against weather.

15.2.3.6. Specially coated/ SS self-drilling screws/ fasteners conforming to class 3 as per ASTM: 3566.1 and 3566.2 shall only be used for all connections.

15.2.3.7. Anchor/ foundation bolts shall conform to IS: 5624 and IS 800.

15.2.3.8. The Security Cabin may be installed on concrete M20 skid platform (min. 250 mm thick, over 250 mm thick compacted rubble soling with interstices filled with sand). The top of skid shall be 200 mm above FGL. The concrete skid shall be provided with shrinkage reinforcement (8 dia @ 200 c/c both ways) near top surface. The concrete skid shall project 200mm beyond the walls.

15.2.3.9. The Security Room shall be supported on RCC framed structure with columns supported on foundations. The Finished Floor Level shall be 450mm high above FGL.

15.3. The Design and drawings shall be submitted for approval prior to fabrication and installation.

16 Flooring, Skirting and Dado

16.1 Store area, Equipment Area

40 mm thick Cement concrete (IPS) flooring (1:2:4), aggregate size 10 mm down, conforming to IS 2571 with 2mm thick Heavy-duty epoxy coating (Industrial grade) of approved make on top as per manufacturer specifications and 10mm thick matching skirting of 100mm height.

16.2 SCADA Room, Control cum Office Room, Supervisor Room and Lobby

1200 mm X 1200 mm thick Heavy duty vitrified tile (8mm thick or more) flooring with matching skirting of 100mm height.

16.3 Battery Area/Room

Acid/ Alkali resistant tile flooring and 2100 height dado, Floor and dado tiles - 20mm and 12 mm thick respectively. However, in case of maintenance free batteries, vitrified tile (8mm thick) flooring and dado shall be provided.

16.4 Toilet

- 40 mm thick Ceramic tile (8mm thick) flooring and glazed tile (6mm thick) 2100 height dado.
- 20mm thick Granite stone finish over platform for wash basin.

16.5 Pantry

40 mm thick heavy duty vitrified tile (8 mm thick) flooring and glazed tile (6mm thick) 2100 mm height dado, 20mm thick Granite stone finish over service platform.

16.6 Passage/ Corridor

40 mm thick Heavy duty vitrified tile (8mm thick) flooring with matching skirting of100mm height.

16.7 Steps

Kota stone (20 thick) or 50 thick cement concrete (IPS) flooring conforming to IS 2571.

16.8 All items shall be of reputed make. Only Items with approved samples by TGNPDCL shall be used.

17 Doors and Windows

17.1 Doors, windows, louvers and ventilators shall be made of AL sections (minimum average thickness 2.5mm), industrial grade, anodized (grade AC25, min. thickness 25 micron conforming to IS: 1868) or with polyester powder coating (Total DFT 50 microns conforming to IS: 13871) and shall be of approved make & colour shade. All sections,

fittings and fixtures shall be anodized (min. thickness of coating 20 micron). The window and door shutters shall be of clear float/ wired/ ground glass as per design/ functional requirements. The doors in toile area shall be of steel frame with solid core (MDF) flush shutter, 35mm thick, with laminated finish on both sides conforming to IS: 2202.

17.2 AL Louvers, duct/ ventilation openings shall be provided as per functional requirement.

17.3 All doors, windows and ventilators shall be provided with all necessary fittings and fixtures like handles, tower bolts, wind stays, hinges etc. of heavy duty anodized AL. All doors shall be provided with hydraulic door closure of required capacity.

17.4 All windows shall be provided with suitable AL grill of anodized sections with adequatethickness for security purposes.

17.5 Clear float glass for window and door shutter shall be of min 4mm and 6mm thickness respectively. Wired/ ground glass where provided shall be of min thickness 6mm.

17.6 Entrance door and door in passage shall be min. 1.5m wide (double leaf) x 2.1 m height while door for Conference room and Store room shall be min. 1.2m wide x 2.1m height. All other doors shall be min. 1.0m widex2.1m height except for WC which may be of 0.8m width.

17.7 Rolling shutters shall be of required size and shall be made of cold rolled steel strips with adequate gauge thickness (min. 18 gauge) and shall conform to IS 6248. Rolling shutter shall be provided with all fixture, accessories, paintings etc. all complete and shall be mechanically operated type.

18 Roofing

18.1 The roof of all buildings shall be provided with min. slope of 1:100 for effective drainage of rain water. The slope shall be achieved either by application of screed concrete of grade 1:2:4 (with 12.5mm down coarse aggregate) with min. 25mm thick CM 1:4 layer on top to achieve smooth surface to facilitate application of water proofing treatment.

18.2 The water proofing treatment shall be in situ five course water proofing treatment withAPP (Atactic Polypropylene) modified Polymeric membrane over roof consisting of first coat of bitumen primer @ 0.40Kg per sqm, 2nd & 4th courses of bonding material @

1.20 kg/sqm, which shall consist of blown type bitumen of grade 85/25 conforming to IS : 702, 3rd layer of roofing membrane APP modified Polymeric membrane 2.0 mm thick of 3.00 Kg/sqm weight consisting of five layers prefabricated with center core as

100 micron HMHDPE film sandwiched on both sides with polymeric mix and the polymeric mix is protected on both sides with 20 micron HMHDPE film. The top most layer (5th layer) shall be finished with brick tiles of class designation 10 grouted with

cement mortar 1:3 (1 cement: 3 fine sand) mixed with 2% integral water proofing compound by weight of cement over a 12 mm layer of cement mortar 1:3 (1 cement: 3fine sand) and finished neat. The water proofing treatment shall be extended over golla/fillet and inner face of the parapet up to 450mm height.

18.3 The corners at parapet wall and slab shall be provided with 50 thick fillet/ golla in CM 1:3 with neat finish.

18.4 Required no. of rain water down take pipes min. 100mm dia. PVC pipes (UV resistant), with 450x450mmx15mm deep khurra and MS grill at inlet shall be provided for rain water disposal.

19 Plinth protection and drain

19.1 750mm wide plinth protection with min. 75mm thickness of PCC (1:3:6) over 75 mm thick bed of dry brick ballast, 40mm nominal size well rammed and consolidated and grouted with fine sand, shall be provided around all the buildings.

19.2 A peripheral drain (except for Security room/ cabin) of min. internal size 250mm x 250mm with brick walls in CM 1:6 over 75mm thick PCC (1:3:6) bedding with 12mm thick plaster in CM 1:5 and 25thk PCC (1:3:6) coping at top shall be provided along the periphery of the plinth protection for collection and disposal of rain water from building roof.

20 Plinth filling for buildings

Plinth beam, when provided, shall be taken minimum 200mm below FGL. The plinth filling below Ground floor (GF) for all buildings shall be provided with following specifications.

i. Well compacted sub-grade

ii. Well compacted boulder soling with interstices filled with sand over compacted sub-grade.

iii. 75mm thick PCC 1:3:6 over ii.

iv. 100mm thick PCC 1:2:4 over iii.

v. 40mm thick floor finish over iv.

21 Anti- termite Treatment

In case of presence of termites at the project site, an anti-termite treatment shall be provided for all foundation pits and building plinth in MCR building conforming to IS: 6313 to control entry of termites

22 Plumbing & Sanitary Works

22.1 Toilet block shall have following min. fittings:

- Wall mounted WC (Western type) 390 mm high with toilet paper roll holder, lowheight flushing tank and all fittings
- A set of 2 wall mounted Urinals (430 x 260 x 350 mm size) with flushing tank andall fittings (Gent's wash room only)
- Wash basin (550 x 400 mm) over concrete platform with all fittings including 2-pillarcocks
- Wall mirror (600 x 450 x 6 mm thick clear float glass) with hard board backing
- CP brass towel rail (600 x 20 mm) with C.P. brass brackets – one each in common area and bathroom (bathroom if applicable)
- Soap holder and liquid soap dispenser one each in common area and bathroom(bathroom if applicable)
- Shower and mixer for hot and cold water in bathroom (if applicable)
- Ventilators – Mechanical exhaust facility of adequate capacity
- Overhead PVC water storage tank – Capacity 1000 litres (common for both washrooms) (2000 litres in case bathroom is to be provided)

22.2 Pantry room shall be provided with kitchen sink cum drain board and provision for installation of Water Cooler.

22.3 One toilet room with provision of WC and Wash basin shall be provided at Security Room near main gate.

22.4 Necessary plumbing lines for MCR building and Security Room near main gate.

22.5 All sanitary ware, fittings and fixtures shall be of reputed Make and Type and approved by TGNPDCL. All fittings, fastener, grating shall be of CP brass conforming to relevant BIS standards.

23 Painting & Other Finishes

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

Internal Walls except toilets& battery room	Acrylic emulsion (for MCR) & Oil bound distemper (forLCR/ Security Room)
Battery room	Acid/ Alkali resistant tiled dado of 2100 mm height &Acid resistant resin-based epoxy paint above dado (Vitrified tile flooring and dado with oil bound distemper in case of maintenance free batteries)
Toilet	Oil bound distemper
External Walls	All weather proof cement based acrylic emulsion paint,exterior grade
MMS foundations/ Earthpit 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

24 Air conditioning & Ventilation for MCR and Other Buildings

24.1 All buildings shall be equipped with appropriate numbers of fans for effective heat dissipation.

24.2 In MCR building, the supervisor room, Conference room and SCADA room shall have split type air conditioning units.

25 Fire Extinguishers

25.1 All buildings shall be installed with required no. of fire extinguishers as per relevant BIS standard and NBC. Liquefied CO2/ foam/ ABC type fire extinguisher shall be upright type of capacity 10kg conforming to IS: 2171, IS: 10658.

25.2 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.

26 Sand buckets

26.1 Sand buckets shall be wall mounted made from at least 24SWG sheet with bracket fixing on wall conforming to IS: 2546.

26.2 All buildings shall be provided with required no. of sand buckets as per relevant BIS standard and NBC. 4 No. of Bucket stands with four buckets on each stand shall be provided in the Transformer Yard.

27 Sign Boards and Danger Boards

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

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

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

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

28 Masonry Work

28.1 The masonry work shall be of bricks, laterite blocks (as per site conditions) or concrete blocks.

28.2 All external walls of buildings shall be 230mm and internal walls shall be 230mm or115mm as per requirements.

28.3 All concrete block masonry walls shall be min. 200mm thick.

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

28.5 Unless otherwise specified elsewhere, Bricks shall be of class designation 7.5conforming to IS: 1077, IS: 2212 & IS: 3495.

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

28.7 The laterite blocks shall conform to IS: 3620.

28.8 All buildings shall be provided with suitable damp-proof course (DPC). The DPC shall be with PCC (1:2:4) using 6 down coarse aggregate and water proofing admixture. The min. thickness of DPC shall be 40mm.

28.9 The construction of brick masonry shall conform to IS: 2212. Construction of Concrete block masonry shall conform to IS: 2572.

29 Plastering, Pointing & Coping Works

29.1 All brick masonry work shall be provided with plaster.

29.2 Wall and ceiling plaster shall be in cement mortar (CM) 1:6 and 1:3 respectively.

29.3 Thickness of plaster shall be 18mm and 12mm respectively for rough and smooth surface of the masonry wall. The ceiling plaster shall be 6mm thick.

29.4 All joints in stone masonry shall be raked and pointed in cement mortar (CM) 1:3 except specified otherwise.

29.5 Exposed top surface of brick or stone masonry shall be provided with 25 mm thick plain cement concrete (PCC) coping (1:2:4) with trawl finish. All exposed coping shall be provided with suitable slope and projection for easy drainage of water.

29.6 All door and window chajja shall be provided with 10mm wide drip course.

30 Building Water Supply & Plumbing Works

30.1 C-PVC pipes shall be used for all internal building water supply works while all external water supply pipes shall be uPVC conforming to relevant BIS standard.

30.2 Rain water pipe shall be of PVC conforming to relevant BIS standard.

30.3 All sewerage, waste water and ventilation pipes shall be of HDPE conforming to relevant BIS standard.

30.4 MCR building and Security room shall be connected to Sewage treatment facility including all associated works like Manholes etc.

31 Sewage Treatment facility

The Contractor shall design & provide soak pit and septic tank for treatment of sewage and waste water from MCR building and Security room. The design of the septic tank shall conform to IS 2470 (Part 1). However, in case of ground water within 1.5m of finished grade level or the soil strata being of low permeability (permeability $\leq$ 10-6 m/s) where septic tank and soak pit arrangement is not effective, suitable packaged sewage treatment plant of reputed make/manufacture shall be provided. The sewage treatment facility shall be of required capacity and of proven design suitable for total of 15 people.

32 Pipe & Cable Trenches

32.1 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.

32.2 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.

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

32.4 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.

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

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

32.7 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 rainwater from the trench.

32.8 The cables shall be laid over ground on GI cable trays with proper support & accessories as per IS 1255.

33 Transformer Yard Civil Works

33.1 Transformer and equipment foundations shall be founded on piles/isolated spread footings or block foundation depending on the final geotechnical investigation report and functional requirements.

33.2 In case of transformer oil tank capacity ≥ 2000 litres, the transformer foundation shall have its own soak pit which would cover the area of the transformer and cooler banks, so as to collect any spillage of oil in case of emergency. The retention capacity of the soak pit shall be equal to volume of the transformer oil (excluding free space above gravel) and it shall be filled with granite stone gravel of size 40mm, uniformly graded, with 200 mm free space above gravel fill.

33.3 In case of transformer oil tank capacity more ≥ 20000 litres, the soak pit shall be connected to a separate burnt oil pit through discharge pipe (300 mm dia) and shall be suitably sized to accommodate full oil volume (excluding free board above inlet pipe) of the transformer connected to it, without backflow. In this case the capacity of the soak pit may be reduced to min. 1/3rd of the total transformer oil volume. The burnt oil pit shall be further connected to oily water drainage system. The water shall be discharged into the nearest drain by gravity flow or pumping after suitable

treatment as per statutory and code provisions.

33.4 Both, the transformer soak including side walls and the burnt oil pit shall be of RCC and shall be provided with sump (min. 500 mm x 500 mm x 400mm deep) and slope of 1:50 in concrete screed of 1:1 — ½:3 to the floor slab towards the sump pit. The oil collection

pit shall be provided with 20mm dia. MS rung ladder with 2 coats of epoxy paint over 2coats of primer, a manhole & removable RCC cover. The inside of oil collection pit shall be plastered with 6 mm thick CM 1:6 and painted with 2 coats of epoxy paint over 2 coats of primer.

33.5 The area around the transformer and equipment shall be covered with uniformly graded granite stone gravel of size 40mm.

33.6 The area shall be provided with galvanized chain link fence of height min 1.8m with 3.5m wide gate. The specifications for fencing shall be similar to those specified under Cl. No. 31.3 except fence post which shall be of MS angle (ISA 65x65x6) spaced at 2.5m c/c.

33.7 The Gate of size 3.5m shall be of MS pipe (medium class conforming to IS: 1161) frame with hard drawn steel wire fabric mesh (50x50mmx3mm thick conforming to IS: 1566) including all accessories and fittings. MS angle posts shall conform to IS 2062.

33.8 In addition to main gate a wicket gate of MS pipe (medium class conforming to IS: 1161) frame with 1.0 m width with hard drawn steel wire fabric (50x50x3mm thick conforming to IS: 1566) shall be provided for man entry for maintenance purpose.

33.9 The transformer yard fencing work shall conform to CEIG requirements.

33.10 The requirement of fire barrier wall between transformers shall be as per Electricity Rules and IS: 1646 recommendations. Minimum wall thickness shall be 230mm for RCC wall and 300mm for masonry wall.

34 PV Module Cleaning System – Wet or Dry Type Wet type Cleaning System

34.1 The contractor shall design and install the effective module cleaning system.

34.2 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 entire O&M period.

34.3 The Contractor shall estimate the water requirements for cleaning the photovoltaic modules at least once in two week or at closer frequency as per the soiling conditions prevailing at site, in order to operate the plant at its guaranteed plant performance. 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 of SPV module shall be considered in estimation of required quantity of water storage.

34.4 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.

34.5 If required, for settlement of any grit/ unacceptable suspended particles in the water a settling tank shall be installed before the inlet of the storage tank. Suitable arrangement for discharge/ disposal of sediment/ slush shall be provided in silting chamber by gravity disposal in surface drain or with provision of sludge sump and pump of adequate capacity.

34.6 The module cleaning system shall include construction of RCC tank or supply and installation of Ground mounted PVC tank (s) of required storage capacity, pumps (including 1 No. standby pump), water supply mains and flexible hose pipes, taps, valves (NRV, Butterfly valve, Ball valve, Gate valve, PRV, scour valve etc.), Water hammer arrester(s), pressure gauge, flow meter etc. as per the planning & design.

34.7 In case of over ground water storage tank, the contractor shall check its effect on plant performance through shadow analysis. The PVC storage tank shall conform to IS: 12701. The valves shall conform to IS: 778. A suitable metal sheet canopy for protection from direct sunlight shall be provided over the tank area.

34.8 The water supply mains could be either of GI, uPVC or HDPE, however, the vertical pipe connecting supply main to the discharge point shall be of GI.

34.9 Masonry chamber shall be provided for Main gate valve at pump end. Whereas, as per requirements, at other locations either a masonry or GI/ HDPE pipe chamber may be provided.

34.10 Module cleaning procedure and pressure requirement at discharge point shall be as per the recommendation of PV module manufacturer. However, discharge pressure at outlet shall not be less than 50kg/cm2 (5 MPa)

34.11 All the pipes thus laid shall be buried in ground at least 150mm below FGL or laid above ground clamping on suitable concrete support blocks. In case of above ground piping only GI pipes shall be used.

Dry Cleaning System

34.12 Alternate to Wet type Module Cleaning System as stipulated in the above Clauses, the Contractor may propose Robotic type dry Cleaning system with micro-fibre based brushes to avoid scratches on the PV Module. The Contractor shall also ensure following considerations during design:

34.12.1 The necessary design considerations for the mounting the robotic system shall be incorporated in the Module Mounting Structure design, foundation design as well as PV array layout, in addition to the specifications provided elsewhere in this Section.

34.12.2 The system shall be designed for operation under the climatic conditions at site.

34.12.3 The Robotic Cleaning system shall be self-powered, with battery backup (no external supply). The battery shall be compliant with IEC 62133: Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications.

34.12.4 The Robotic Cleaning system shall be integrated with the Plant SCADA.

35 Underground Liquid Retaining RCC Structures

35.1 The top of the UG tank shall be 250 mm above FGL.

35.2 The tank shall have clear free board of 300mm above MWL.

35.3 The tank bottom shall have a slope of 1:100 towards drainage sump (500x500x500 mmdeep). The slope shall be provided either in structural slab or in screed concrete (1:2:4) trawl finished. 1000x1000 mm size Manhole in roof slab and 20 mm MS rung ladder shall be provided for easy access to the storage tank and silting chamber for periodic cleaning. The manhole shall be covered with RCC precast cover. 50x50x6 mm MS angle with lugs shall be provided around precast cover and tank slab opening for edge protection. Rungs shall be painted with 2 coats of epoxy paint over 2 coats of primer.

35.4 The underground RCC tank shall be designed for following load conditions:

- External earth pressure + hydrostatic pressure due to ground water table (to be considered at FGL for design purposes) + Surcharge of 20 kN/ Sqm and Tank Empty.
- Tank full up to MWL and no external loads

35.5 The design shall conform to IS: 3370 with maximum crack width of 0.1mm for wall, bottom slab and roof slab. Min. grade of concrete shall be M30 (M35 in coastal areas, marshy and saturated soils) conforming to IS: 456. Suitable construction joints shall be provided as per provisions of IS: 3370 (Part 1). Water proofing admixture conforming to relevant BIS standard and of approved make shall be added to concrete as per manufacturer's recommendations.

35.6 The underground water tank shall be tested for water tightness as per the provisions of IS 3370 (Part-4). In case any leakage is noticed the same shall be repaired by injection of cement grout installing suitable nozzles around affected areas. Outside face of water tank in contact with water and soil and underside of roof slab shall be painted with 2 coats of epoxy paint.

36 Transmission Line Structures

36.1 132 kV or 33 kV transmission poles, towers & accessories shall be designed following latest guidelines of respective STU (State transmission utility) and get approved from them before execution. In absence of SEB/ STU guidelines REC (Rural Electrification Corporation) standards may be followed. Support at corner with angle > 100 shall be provided with a 4 -pole structure or a lattice tower structure. Use of PCC spun pole and RCC pole is not acceptable.

36.2 Approved copies of these designs & drawings shall be submitted to TGNPDCL for reference and record.

37 Miscellaneous structures

37.1 Support structure for weather monitoring device

37.1.1 Weather monitoring device shall be mounted on tubular steel pole of required height.

The pole shall conform to IS: 2713.

37.1.2 The pole shall be secured to an independent RCC foundation structure through Base plate and Anchor bolt assembly.

37.1.3 200 long 20 dia. rods shall be welded to the pole at 300 mm C/c for access to the device for maintenance purpose.

37.1.4 The support structure shall be hot dip galvanized.

37.2 Support structures for SMB

When supported independently, the SMB shall be mounted on a structural steel supporting frame of galvanized ISMC 75.

37.2.1 Column post and bracings shall be supported with 300 mm (min.) diameter and 850 mm (min.) deep below GL piles in cement concrete (nominal mix 1:z1:2). The column post and bracings shall be extended into the piles upto 800 mm with 50mm cover at the bottom.

37.2.2 The pile shall project 200 mm above GL.

37.2.3 The support structure shall hot-dip galvanized and of adequate height to ensure min. ground clearance of .8 m to SCB unit.

37.3 LA Mast and Foundation

37.3.1 The LA mast shall be a self-supporting structure with GI tubular pole of required height. The pole shall confirm to IS: 2713.

37.3.2 The pole shall be supported on RCC pedestal and foundation structure through Base plate & Anchor bolt assembly.

37.3.3 200 mm long, 20 dia rods shall be welded to the pole at 300 mm c/c for access to the device for maintenance purposes.

37.3.4 The support structure shall be hot-dip galvanized. The minimum depth of foundation shall be 1000 mm below GL.

C Quality Assurance and Inspection of Civil Works

1 Introduction

1.1 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.

1.2 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.

1.3 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.

1.4 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.

1.5 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 TGNPDCL.

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

2 QA and QC Manpower

2.1 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.

2.2 All correspondence related to Quality Assurance shall be addressed by the contractor's QA coordinator to the Engineer.

2.3 TGNPDCL / 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.

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

2.5 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.

3 Laboratory and Field Testing

3.1 The contractor shall make necessary provisions to provide all facilities required for QA& QC activities by setting up a field laboratory for QA and QC activities in line with the indicative field QA & QC laboratory set-up.

3.2 The Laboratory building shall be constructed and installed with adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples.

3.3 The quality plan shall identify the testing equipment/ instrument, which the contractor shall deploy and equip the field quality laboratory for meeting the field quality plan requirements.

3.4 The contractor shall furnish a comprehensive list of testing equipment/ instrument required to meet the planned/scheduled tests for the execution of works for TGNPDCL acceptance/ approval.

3.5 The contractor shall mobilize the requisite laboratory equipment and QA & QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.

3.6 In case contractor desires to hire the services of any established laboratory nearby for any field tests then he shall ensure that the subject laboratory is well equipped with all requisite testing facilities and qualified QA & QC staff and this shall not affect in anyway the work progress.

3.7 All equipment and instruments in the laboratory/ field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by TGNPDCL. The calibration certificates shall specify the fitness of the equipment and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipment and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to Engineer.

3.8 The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute. This includes selected IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by Engineer. Test report along with the recommendations shall be obtained from the laboratories without delay and submitted to TGNPDCL.

3.9 Based on the schedule of work agreed with the TGNPDCL and the approved FQP, the contractor shall prepare a schedule of tests and submit them to TGNPDCL and organize to carry out the tests as scheduled/agreed.

4 Sampling and Testing of Construction Materials

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

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

4.3 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.

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

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

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

5 Purchase and Service

5.1 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, plant, testing facilities etc.

5.2 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.

5.3 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 test 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.

5.4 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.

6 Field Quality Plan

6.1 Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans to TGNPDCL 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 site.

6.2 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 site.

6.3 An Indicative Field & Manufacturing Quality Plan for civil, structural and MMS works is enclosed with this specification for reference as Annexure-B.

7 General QA Requirements

7.1 The contractor shall ensure that the works, BOIs and services under the scope of Contract, whether manufactured or performed within contractor's works or at his subcontractor's premises or at the project site or at any other place of work, are in accordance with Technical specification, applicable standards / codes, approved drawings / data sheets / quality plans and BOQ. All the works, BOIs and services shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer.

Equipment	UOM	Approx. Qty.
Cube moulds for cement testing	nos.	4
Sieve shaker	nos.	1
Sieve for sand, coarse and fine aggregate	set	1
Sieve for coarse aggregate	set	1
Slump testing equipment	nos.	6
Oven	nos.	2
Physical balance	nos.	1
Thermometer	nos.	4
Burret	nos.	2
Measuring cylinder	nos.	9
Measuring flask	nos.	3
Compression testing machine	set	1
Cube mould for concrete	nos.	10
Mechanical weighing machine	nos.	1 (100kg capacity)
Drum type concrete mixer (for trial mixes)	nos.	1
Proctor testing equipment	set	1

7.2 Notes

- The equipment listed above is indicative and minimum required. Additional equipment, if any, required for successful completion of work shall be provided / arranged by the contractor.
- All test reports/ inspection reports shall be submitted in soft copy also and shall be available at site for easy access to the Engineer.
- Based on the schedule (L2/L3 Network), Quality control & Quality Assurance Work plan shall be finalized by the contractor and the same shall be submitted to TGNPDCL for acceptance/approval.

D Performance Measurement Procedure

1 Performance Ratio (PR)

The Performance Ratio (PR) of the PV Plant is calculated as follows (according to IEC 61724 Ed.2).

$$PR = \frac{E_{out}}{\sum_k \left\{ \frac{(C_k \times Po) \times (G_{i,k} \times \tau_k)}{C_{i,ref}} \right\}}$$

PR Temperature Corrected Performance Ratio

E_{out} Cumulative AC energy measured at the injection point (ABT meter) over the duration of reporting period (kWh)

τ_k Duration of the k^{th} recording interval, i.e.(1/60)hour

$\sum_k$ Summation over all recording intervals in the reporting period, (1/4) hour

C_k Power rating temperature adjustment factor and can be calculated as below $Ck = 1 + \gamma \times (T_{avg\_mod,k} - T_{ref})$

γ Temperature coefficient of power with negative sign($°C^{-1}$)

$T_{avg\_mod,k}$ Average PV Module temperature measured at the commencement of time interval'τ_k'

(°C)

T_{ref} PV Module temperature at which P_o is determined, i.e.25°C

P_o Installed nominal peak power of PV modules, i.e. Nameplate rating at STC(kW_p)

$G_{i,k}$ Average irradiance measured at the Plane of Array (POA) at the commencement of time interval τ_k(kW/m^2)

$G_{i,ref}$ Irradiance value at which P_o is determined, i.e. $1kW/m^2$

2 Capacity Utilization Factor (CUF)

Capacity Utilization Factor of the plant shall be calculated as per the procedure.

$$\textbf{CUF} = \frac{\textbf{Eac}}{\textbf{8760 x Pac x (1-DF x (N-1) x RCF}}$$

Where,

Eac is number of units recorded in the plant end ABT meter excluding auxiliary consumption during the operation year, kWh

8760 refers to the number of hours non-leap year. It shall be replaced by 8784 hours during leap year

Pac is the plant AC capacity, kW

DF is module degradation factor, 0.7% per year

N is the number of year of operation after operational acceptance of the plant

RCF is the Radiation Correction Factor: RDC = $\frac{\text{Measured Irradiation}}{\text{Reference Irradiation}}$

Where Reference Irradiation (GHI_{ref}) = 1862 kWh/m^2 and Irradiation (GHI_{mes}) shall be recorded from the Pyranometer installed in horizontal plane at the site location. The radiation data of the Pyranometer shall be compared with the Reference Irradiation mentioned above. The radiation date from the Plant Pyranometer shall be used for computation of CUF , except in case of any discrepancy (i.e. more than $\pm$ 10% variation from the Reference Resource Assessment (SRRA) station data will be used for computation of CUF . Missing data (GHI_{mes}) from the Plant Pyranometer shll be substituted by average of GHI measured for the same period in the past three (3) days. The plant Pyranometer has to be under CCTV coverage

CUF shall be calculated on annual basis from the date of operational acceptance of the plant till the end of O&M period. Module degradation factor will not be considered for first year CUF calculation. It is the Contractor's responsibility to envisage and install extra DC capacity to accommodate any degradation during first year. 0.7% per year will be considered from second year of operation.

Grid outage hours shall be subtracted from total number of hours in a year. The Contractor shall submit grid outage certification from competent authority of TGNPDCL.

ADDITIONAL TECHNICAL CONDITIONS

1.1 The Contractor is advised to inspect the site and study the nature of soil, topography and other conditions to decide the extent of scope of area grading, ground compaction, and foundation system to be provided before submission of the Bid. TGNPDCL shall not be responsible for any variations in soil characteristics and other conditions, between those observed during preliminary site visit and detailed investigations to be carried out by the Contractor during contract execution and there shall be no compensation what so ever in the contract price on this account.

1.2 The Contractor is advised to ascertain the availability of good quality ground water at site for construction, drinking and module cleaning purpose. In case of non-availability of ground water source, the contractor shall explore the option of supply of water through water tankers. In case the water quality is not suitable for drinking or module cleaning purpose, the Contractor shall install suitable water treatment facilities.

1.3 Power Conditioning Units (Clause 4)

1.3.1 Power Conditioning Unit shall be outdoor type.

1.4 HT Switchgear (Clause 6)

1.4.1 HT Switchgear shall be Outdoor Type.

1.5 MMS Design

1.5.1 MMS shall be designed optimally for Seasonal Tilts.

1.5.2 Purlins shall be designed for loads coming due to full design wind pressure.

1.5.3 Triangular load distribution shall be considered for evaluating the wind load on the purlins.

1.5.4 For wind attack in both the directions transverse to the table length (say, +Z and -Z direction), loading coming due to both pressure (acting towards the table) and suction (acting away from the table) forces shall be considered as primary loads, and the both shall be considered separately in load combinations for a given direction of wind attack.

1.5.5 For wind attack in both the directions longitudinal to the table length (+X and –X direction when the transverse direction is defined as in 1.3), in addition to the wind load acting directly on the framing members, the loading coming on the purlins due to both pressure and suction forces on the table shall also be considered as primary loads, and the both shall be considered separately in load combinations along with wind load on framing members for a given direction of wind attack.

1.5.6 In case of seasonal tilt, the bracings shall be connected to the rafters and columns through connection (gusset) plates, such that one end of the plate is connected to the bracing and the other to the rafter/column. Bracings shall not be connected directly to the column or rafter.

1.5.7 To avoid bowing defects, the length of the purlins shall preferably be kept below 5 m and in no case shall exceed 6 m.

1.5.8 The location of purlin splices shall be near the zone of contra-flexure of the purlin, i.e. within a distance of 0.15L to 0.25L from the support, where L is the particular span within which splicing is taking place.

1.5.9 C-channel type splice piece shall be used for splicing of purlins. In addition to the web connections, both the tension and compression flanges of the purlins should be connected to the corresponding flanges of the splice piece for full moment transfer across the joint.

SECTION 6

QUALITY ASSURANCE PLAN

QUALATIY ASSURANCE PLAN

1. To ensure that the equipments are in accordance with the specifications, the contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programme shall be out lined by the contractor and shall be finally accepted by owner/ authorized representative after discussions before the award of contract. The QA programme shall be generally in line with ISO-9000/IS-14000. A quality assurance programme of the contractor shall generally cover the following:

i) His organization structure for the management and implementation of the proposed quality assurance program.
ii) Quality system manual.
iii) Design control system.
iv) Documentation control system
v) Qualification data for bidder's key personnel.
vi) The procedure for purchase of material, parts, components and selection of sub vendors service including vendor analysis, source inspection, incoming raw material inspection, verification of materials purchased etc.,
vii) System for shop manufacturing control including process controls, fabrication and assembly controls.
viii) Control of non conforming items and systems for corrective actions.
ix) Inspection and test procedure.
x) Control of calibration and testing of measuring and testing equipment.
xi) System for indication and appraisal of inspection status.
xii) System for quality audit
xiii) System for authorizing release of manufactured product to owner.
xiv) System for maintenance of records
xv) System for handling storage and delivery
xvi) All the plant standard/ written down practices followed by the manufacturer/ contractor against the manufacturing activities in their works will be submitted in electronic media preferably in at least one set of compact discs.

2. GENERAL REQUIREMENTS – QUALITY ASSURANCE

2.1 All materials, components and equipment covered under this specification shall be procedure manufactured and tested at all the stages, as per a comprehensive quality programme. An indicative programme of inspection/ tests to be carried out by the contractor for some of the major items is given in this specification. This is however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Owner. The detailed quality plans for the manufacturing activities should be drawn up by the bidder, and will be submitted to Owner for approval. Schedule for finalization of such quality plans will be finalized before award.

2.2 Manufacturing quality plan shall detail out for all the components and equipments, various tests, inspection, to be carried out as per the requirements to this specification and standards mentioned therein and quality practices and procedures followed by contractor's Quality Control Organization, the relevant reference documents and standards acceptance

norms, inspection documents raised etc., during all stages of material procurement, manufacture, assembly and final testing/ performance testing.

2.3 The bidder shall also furnish copies of the reference documents/ plant standard / acceptance norms/ test and inspection procedure etc., as referred in Quality Plan along with Quality Plans.

2.4 The Quality Plans and reference documents/ standards etc., will be subject to Owner's approval and will form a part of the contract. In these approved Quality Plan, Owner shall identify customer hold points (CHP) which shall be carried out in presence of the Owner's Project Manager and beyond which work shall not proceed without, written consent of Owner's Project Manager/ authorized representative in writing. All deviation to this specifications, approved quality plans and applicable standard must be documented and referred to Owner along with technical justification for approval and dispositioning.

2.5 No material shall be despatched from the manufacture's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/ inspections by Owner's Project Manager/authorized representative, and duly authorized for despatch issuance of MDCC.

2.6 All materials used and supplied shall be accompanied by valid and approved materials certificates and tests and inspection reports. These certificates and reports shall indicate the heat numbers or other such acceptance identical numbers of the material. The material certified shall also have the identification details stamped on it.

2.7 All materials used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/ standard. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and / or agreed details.

2.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME section-IX/ BS-4870 or other international equivalent standard acceptance to the Owner.

2.9 All welding/ brazing procedure shall be submitted to the Owner or its authorized representative for approval prior to carrying out the welding/ brazing.

2.10 All brazers, welders and welding operators, employed on any part of the contract either in contracts / his sub-contractors works or at site elsewhere shall be qualified as per ASME section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.

2.11 Test results of qualification tests and specimen testing shall be furnished to the Owner for approval. However where required by the Owner, tests shall be conducted in presence of Owner/ authorized representative.

2.12 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

2.13 Results of all non-destructive testing shall be recorded on certificates.

2.14 All the sub-vendors proposed by the contractor for procurement of major bought out item including castings, forgings, semi-finalized and finished components/ equipment, list of which shall be drawn up by the contractor and finalized with the Owner shall be subject to Owner's approval. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC Systems followed, experience list etc. along with his own technical evaluation and shall be submitted to the Owner for approval prior to any procurement. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

2.15 For components/ equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the contractor's purchase specifications and enquiries shall call for quality plans to be submitted by the suppliers along with their proposals. The quality plans called for from the vendors shall set out, during the various stages of manufacture, the quality practices and procedures followed by the vendor's quality control organization, the relevant reference documents/ standards used, acceptance level, inspection of documentation raised etc.,

2.16 Such quality plans of the successful vendors shall be finalized with the Owner and such approved quality plans shall from a part of the purchase order/ contracts between the contractor and the vendor, within three weeks of the release of the purchase order/ contract for such bought out items/ components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Owner by the contractor.

2.17 The purchase specifications for the major bought out items, list of which shall be drawn up by the contractor and finalized with the Owner shall be furnished to the Owner for comments and subsequent approval before orders are placed.

2.18 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the contractor's or their sub-vendor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

2.19 The contractor shall carry out an inspection and testing programme.

2.20 Quality audit/ surveillance/ approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with specification when installed or does not comply with the specification in service and the above shall in no way limit the liabilities and responsibilities of the contractor in ensuring complete conformance of the materials/ equipment supplied to relevant specification, standard, data sheet, drawings etc.,

2.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

2.22 Repair/ rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorized representative.

3. QUALITY ASSURANCE DOCUMENTS

3.1 The contractor shall be required to submit two sets of compact discs of the following Quality Assurance Documents within three weeks after despatch of the equipment.

i) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

ii) Factory tests results for testing required as per applicable codes and standard referred in the specification.

iii) Inspection reports duly signed by QA personnel of the Owner and contractor for the agreed inspection hold points. During the course of inspection, the following will also be recorded.

   a) When some important repair work is involved to make the job acceptable; and

   b) The repair work remains part of the accepted product quality.

iv) All the accepted deviations shall be included with complete technical details.

SECTION 7

BILL OF QUANTITIES

Sl.No.	Description of item	Qty	Unit	Rate		Amount
				In figures	In words	

* With brief specification and ref to Book of spn.

Note:

1) Item for which no rate or price has been entered in will not be paid for by the Employer when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities (refer; ITB Clause 13.2 and GCC Clause 43.1)

2) Unit rates and prices shall be quoted by the bidder in Indian rupee (ITB Clause 14.1)

3) Where there is a discrepancy between the rate in figures and words, the rates in words will govern. [ITB Clause 27.1 (a)]

4) Where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by quantity, the unit rate quoted shall govern [ITB Clause 27.1 (b)]

SECTION 8

FORMS OF SECURITIES

FORMS OF SECURITIES

Acceptable forms of securities are annexed. Bidders should not complete the Performance forms at this time. Only the successful Bidder will be required to provide Performance Securities in accordance with one of the forms, or in a similar form acceptable to the Employer.

Annex A: **Bid Security**

Annex B: **Performance Bank Guarantee**

ANNEXURE – A
BID SECURITY (BANK GUARANTEE)

In the shape of DD:
Bid Security payable at Warangal in favour of **Pay Officer/TGNPDCL/Warangal** in the form of **MICR DD / Pay Order** on any Nationalized/ Scheduled Bank.

(OR)

In the shape of BG:
Whereas _____ (name of Bidder)(here in after called "the Bidder") has submitted his bid dated _____ (date) for the construction of _____ (name of Contract) hereinafter called "the Bid").

Know all people by these presents that We _____ (name of bank) of _____ (name of country) having our registered office at _____ (hereinafter called "the Bank" are bound unto _____ (name of Employer) (hereinafter called "the employer") in the sum of ` _____ for which payment well and truly to be made to the said Employer the Bank binds itself, his successors and assigns by these presents.

SEALED with the Commission Seal of the said Bank this _____ day of 2_____.

The conditions of this obligation are:

1) If after Bid opening the Bidder withdraws his bid during the period of Bid validity specified in the Form of Bid.
2) If the Bidder having been notified of the acceptance of his bid by the Employer during the period of Bid Validity.
   a. Fails or refuses to execute the Form of Agreement in accordance with the instructions to Bidders, if required or
   b. Fails or refuses to furnish the Performance Security, in accordance with the Instruction to Bidders; or
   c. Does not accept the correction of the Bid Price pursuant to Clause 27 of ITB.

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the Employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him owing to the occurrence of one or both of the two conditions specifying the occurred condition or conditions.

This Guarantee will remain in force up to and including the date _____ 2 days after the deadline for submission of Bids as such deadline is stated in the Instructions to Bidders or as it may be extended by the Employer, notice of which extension(s) to the Bank is hereby waived. Any demand in respect of this guarantee should reach the Bank not later than the above date.

Date _____ Signature of the Bank _____
Witness _____ Seal _____

(Signature, name and address)

1. The Bidder should insert the amount of the guarantee in words and figures denominated in Indian Rupees. This figure should be the same as shown in Clause 16.1 of the Instructions of Bidders.
2. 45 days after the end of the validity period of the Bid. Date should be inserted by the Employer before the Bidding documents are issued.

ANNEXURE – B

PERFORMANCE BANK GUARANTEE

Whereas _____ (Name and address of Contractor) (hereinafter called "the Contractor") has undertaken, in pursuance of Contract No. ___ dated _____ to execute _____ (name of Contract and brief description of works) (hereinafter called "the Contractor").

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for the sum specified therein as security for compliance with his obligations in accordance with the Contract.

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee:

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Contractor, up to a total of ` _____ (amount of guarantee) 1 _____ (in words), such sum being payable in the payable in the types and proportions of currencies in which the Contract Price is payable, and we undertake to pay you, upon your first written demand and without cavel or argument, any sum or sums within the limits of ` _____ (amount) of guarantee) 1 as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us with the demand.

We further agree that no change or addition to or other modification of the terms of the Contractor or of the Works to be performed there under or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

This guarantee shall be valid until 28 days from the date of expiry of the Defects Liability Period.

Signature and seal of the Guarantor _____
Name of the Bank _____
Address _____
Date _____

1. An amount shall be inserted by the Guarantor, representing the percentage of the Contract Price specified in the Contract including additional security for unbalanced Bids, if any and denominated in Indian Rupees.

PRICE BID

SECTION 9

SCHEDULE OF QUANTITIES AND PRICES

SECTION 9

SCHEDULE OF QUANTITIES AND PRICES

A. PREAMBLE

1. The Bill of Quantities shall be read in conjunction with the Instructions to Bidders, General and Special Conditions of Contract, Technical Specifications and Drawings.

2. The quantities and items given in the Bill of Quantities are estimated and provisional, and are given to provide a common basis for bidding. The basis of payment will be the actual quantities and items of work ordered and carried out, as measured by the Contractor and verified by the Engineer and valued at the rates and prices tendered in the priced Bill of Quantities, where applicable and otherwise at such rates and prices of the Engineer may fix within the terms of the Contract.

3. The rates and prices tendered in the priced Bills of quantities shall, except in so far as it is otherwise provided under the Contract, include all constructional plant, labour, supervision, materials, erection maintenance, insurance, profit, taxes and duties, together with all general risk, liabilities land obligations set out or implied in the contract.

4. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Bill of Quantities, and where no items are provided the cost shall be deemed to be distributed among the rates and prices entered for the related items of work.

5. General directions and descriptions of work and materials are not necessarily repeated nor summarized in the Bill of Quantities. References to the relevant sections of the contract documentation shall be made before entering prices against each item in the price Bill of Quantities.

6. The method of measurement of completed work of payment shall be in accordance with relevant ISS codes.

7. Rock is defined as all materials which, in the opinion of the Engineer require blasting, or the use of metal wedges and sledge hammers, or, the use of compressed air, drilling for its removal, and which cannot be extracted by ripping with a tractor at least with 150 brake HP with a single rear mounted heavy duty ripper.

B. SCHEDULES ABSTRACT

Bid No: II-106/2024-25/CE/Proj/CESS/Sircilla

Name of Work :	Establishment of Ground Mounted Solar Photo Voltaic power plant capacity 2 MW(AC) at CESS BOINAPALLY of SIRICILLA District in TGNPDCL.

Quoted value of the contractor : `

I/We M/s…….... do here by express my/our willingness to execute the aforesaid work as per the conditions, standards, specifications, rules and regulations etc., stipulated in the tender schedule

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Signature of the tenderer

Sl.No.	**Name of Work**	**Qty.**	**Amount in Crs**
1	Survey, design, supply, installation, testing, commissioning, Operation & Maintenance of Solar Photo Voltaic Power Plant of 2MW capacity (without Batteries) including hot dip galvanized module mounting structure, invertors, junction boxes, data logger and remote monitoring system and cabling etc., as required on 100% turnkey and Build, Operate, Maintain & Transfer (BOMT) basis at CESS Boinapally of SIRICILLA District in TGNPDCL.	**1**	
2	Annual maintenance of 2MW capacity solar power plant along with spares when ever required for 5 years period.		
Total agreement amount:			

* The bidder should quote separate rates for materials, labour, transportation with loading , un-loading and CMC charges.

Certified that:

1. Above rates are in accordance with the all the specifications, various terms, conditions and requirements mentioned in this tender document, to perform the work satisfactorily.

2. The rates are inclusive of all taxes and duties what so ever. The applicable taxes with rates may be mentioned in the remarks column.

(Signature of Tenderer)
Seal