

DRUK GREEN POWER CORPORATION LIMITED



**BIDDING DOCUMENTS
FOR
DESIGN, SUPPLY, INSTALLATION, TESTING AND
COMMISSIONING OF 120 MW_p JAMJEE SOLAR PV PROJECT**

VOLUME I

BIDDING PROCEDURES

JANUARY 2025

120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instructions to Bidders (ITB)
- Section 3 - Bid Data Sheet (BDS)
- Section 4 - Evaluation and Qualification Criteria (EQC)
- Section 5 - Information to Bidders (IFB)
- Section 6 - Bidding Forms (BDF)

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



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SECTION 1 – NOTICE INVITING TENDER**NIT No.: CO 002/2025****January 07, 2025**

1. Druk Green Power Corporation Limited (DGPC) has applied a loan from the European Investment Bank (EIB) toward the cost of Design, Supply, Installation, Testing and Commissioning of 120MWp Jamjee Solar PV Project.
2. DGPC having its registered office in Thimphu [*hereinafter referred to as the Employer*] invites sealed Bids from eligible Bidders for “**Design, Supply, Installation, Testing and Commissioning of 120MWp Jamjee Solar PV Project** [*hereinafter called the Works*]. The duration for execution of the Work is **540** days from date of signing of Contract Agreement.
3. Bidders may obtain further information and examine the Bidding Documents and related documents prior to submission of the Bids.
4. The Bidding procedure will be carried out in line with EIB Procurement policies, The Guide to Procurement, The EIB Sanction policy, EIB polices in Prohibited Conduct, The EIB Anti-Fraud Policy and the guidelines/polices that are available on EIB's website. <https://www.eib.org/en/publications/guide-to-procurement.htm>, <https://www.eib.org/en/publications/anti-fraud-policy>, [European Investment Bank Exclusion Policy](#)
5. Eligible Bidders with key qualifications as defined below may participate in this bidding: Experience in Design, Supply, Installation, Testing and Commissioning of Solar PV Project

Note: Detailed qualification criteria for the bidder are defined under Section 4 of the Bidding Documents.

6. Bidding documents shall be downloaded from DGPC website (www.drukgreen.bt) free of cost. Bidders downloading the documents from the website should register themselves by informing to the nodal officer of DGPC immediately after the documents are downloaded or, before the deadline for submission of the Bid and their intention to submit the Bid.
7. A Pre-bid meeting shall be conducted on **January 27, 2025** at **10.00 hrs** to clarify all enquiries from the Bidders. All enquiries from the Bidders must be submitted latest by **January 26, 2025**.
8. Bids must be delivered to the address below at or before **February 19, 2025** at **15:00 hrs** (Bhutan Standard Time). Submission of Bids through e-mail shall be permitted. However, the Bids shall be protected with password. The password shall be submitted through separate e-mail on the date of Bid opening.
9. Late Bids shall be rejected. Bids will be opened on **February 19, 2025** at **15:30 hrs** (Bhutan Standard Time) in presence of the Bidder's representatives who choose to attend in person or on-line through virtual video conference.
10. All Bids must be accompanied by a Bid Security for an amount of **BTN/INR 75.00 million (Ngultrum seventy-five million or equivalent USD at the exchange rate of 1 USD = BTN 84)** only in the form of unconditional Bank Guarantee/Demand Draft/Cash Warrant and in case of foreign institution, shall be enforceable in a [correspondent] Bank in Bhutan. The Bid Security shall be valid till **July 19, 2025**. Bids not accompanied with an acceptable Bid Security shall be rejected. In such case, Bids shall be returned to the Bidders unopened.

11. The Employer reserves the right to accept or reject Bids partly or fully or cancel the bidding process without assigning any reasons thereof and in such case no Bidder shall have any claim arising out of such action of the Employer.
12. The address referred to above is as under:

Manager,
Contracts Section, Projects and Contract Department,
Druk Green Power Corporation Limited
Post Box No: 1351
Thori Lam, Motithang
Thimphu 11001
Email: s.choden272@drukgreen.bt
[Contact No. 02-339875](tel:02-339875)

120 MW_p JAMJEE SOLAR PV PROJECT

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VOLUME V - Tender Drawings



SECTION 2- INSTRUCTIONS TO BIDDERS**TABLE OF CONTENTS**

A. GENERAL	1
1 Scope of Bid and Source of Funds	1
2 Fraud and Corruption	1
3 Eligibility of Bidders	1
4 Exclusion	2
5 Eligible Countries	3
6 Eligible Plant and Services	3
7 Joint Venture Bids	3
8 One Bid per Bidder	4
9 Responsibility of Bidders	4
B. THE BIDDING DOCUMENTS	4
10 Contents of Bidding Documents	4
11 Clarifications on Bidding Documents	5
12 Site visit and familiarization with local laws	5
13 Pre-Bid Meeting	6
14 Amendment of Bidding Documents	6
C. PREPARATION OF BIDS	6
15 Language of Bid	6
16 Cost of Bidding	6
17 Documents Comprising the Bid	6
18 Bid Prices and Discounts	7
19 Contract Price Adjustment	8
20 Currencies of Bid and Payment	8
21 Bid Validity	8
22 Bid Security	9
23 Alternative Bids	9
24 Documents establishing Eligibility and Qualifications of the Bidder	10
25 Format and Signing of Bids	10
D. SUBMISSION OF BIDS	10
26 Sealing and Marking of Bids	10
27 Deadline for Submission of Bids	11
28 Late Bids	11
29 Withdrawal, Substitution or Modification of Bids	11
E. BID OPENING AND EVALUATION	12
30 Bid Opening	12
31 Confidentiality	13
32 Clarification of Bids	13
33 Examination of Bids and Determination of Responsiveness	13



34	Technical Evaluation	14
35	Correction of Errors	14
36	Evaluation and Comparison of Bids	15
37	Abnormally Low Bids	15
38	Seriously unbalanced Bids or Front Loaded	16
39	Preference for Domestic Bidders	16
40	Subcontracting	16
41	Notice of Intention for Award of Contract	16
	F. AWARD OF CONTRACT	17
42	Award Criteria	17
43	Right to Accept or Reject Bids	17
44	Notification of Award	17
45	Debriefing by Employer	17
46	Performance Security	17
47	Signing of Contract	18
48	Performance Management System	18
49	Bidding-Related Complaints	18



A. GENERAL

1 SCOPE OF BID AND SOURCE OF FUNDS

- 1.1 The Employer as defined in Section 3-Bid Data Sheet (BDS), invites Bids for the execution of Works, as described in the BDS and Section 8-Particular Conditions of Contract (PCC). The name and identification number of the Contract is provided in the BDS and PCC.
- 1.2 The successful Bidder will be expected to complete the Works by the intended completion date specified in the BDS and PCC.
- 1.3 The Employer has provisioned a budget towards the cost of the execution of Works and intends to apply this fund to cover eligible payments under the contract for this works.
- 1.4 Unless otherwise stated, throughout this Bidding Documents, definitions and interpretations shall be as prescribed in the General Conditions of Contract (GCC).

2 FRAUD AND CORRUPTION

- 2.1 In line with the policy of the Royal Government of Bhutan (RGOB), the Employer requires that the Bidders, Contractors and their Subcontractors shall observe the highest standards of ethics during the bidding process and execution of Contracts. The terms “corrupt practice”, “fraudulent practice”, “collusive practice”, “coercive practice” and “obstructive practice” shall be as per the definition in Sub-Clause 1.1.6 of PCC. In pursuance of this policy, the Employer:
- a) will reject a Bid for award if it determines that the Bidder, recommended for award, has directly or through an agent engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing for the contract in question;
 - b) will sanction a firm or individual, including declaring them ineligible, either indefinitely or for a stated period of time, to be awarded a contract if it at any time determines that they have, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing for, or in executing contract;
 - c) will have the right to require that a provision be included in Bidding Documents and in contracts, requiring Bidders, Suppliers, Contractors and their Subcontractors to permit the Employer, any organization or person appointed by the Employer and/or any relevant RGoB agency to inspect their accounts and records and other documents relating to the Bid submission and contract performance and to have them audited by auditors appointed by the Employer;
 - d) requires that Bidders, as a condition of admission to eligibility, execute and attach to their bids an Integrity Pact Statement in the form provided in Section III, Bidding Forms. Failure to provide a duly executed Integrity Pact Statement may result in disqualification of the Bid; and
 - e) will report any case of corrupt, fraudulent, collusive, coercive or obstructive practice to the relevant RGoB agencies, including but not limited to the Anti-Corruption Commission (ACC) of Bhutan, for necessary action in accordance with the statutes and provisions of the relevant Agency
- 2.2 Furthermore, the Bidders shall be aware of the provisions stated in Sub-Clause 1.1.6 of PCC.

3 ELIGIBILITY OF BIDDERS

- 3.1 A Bidder may be a private entity, government-owned entity, subject to ITB Sub-Clause 3.6, or any combination of such entities in the form of a Joint Venture (JV) under an existing agreement or with the intent to enter into such an agreement supported by a letter of intent, subject to provisions under ITB Clause 6.
- 3.2 A Bidder may have the nationality of any country, subject to the restrictions pursuant to ITB Clause 5. A Bidder shall be deemed to have the nationality of the country if the Bidder is constituted, incorporated or registered in and operates in conformity with the provisions of the laws of that country, as evidenced by its articles of incorporation (or equivalent documents of constitution or association) and its registration document, as the case may be. This criterion also shall apply to the determination of the nationality of proposed sub-contractors or sub-consultants for any part of the Contract including related Services.

- 3.3 A Bidder shall not have conflict of interest. All Bidders found to have conflict of interest shall be disqualified. Bidders may be considered to have a conflict of interest with one or more parties in this bidding process, if:
- i) they have at least one controlling partner in common; or
 - ii) they receive or have received any direct or indirect subsidy from either party; or
 - iii) they have the same authorized legal representative for purpose of this Bid; or
 - iv) they have relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the Bid of another Bidder, or influence the decisions of the Employer regarding this bidding process; or
 - v) a Bidder participates in more than one Bid in this bidding process. Participation by a Bidder in more than one Bid shall result in the disqualification of all Bids in which such Bidder is involved. However, this does not limit the inclusion of the same sub-contractor in more than one Bid; or
 - vi) a Bidder or any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the Works that are subject of the Bid or in any other way provided consulting services in any aspect of the preparatory stages leading up to the issue of these Bidding Documents; or
 - vii) a Bidder or any of its affiliates has been hired (or is proposed to be hired) by the Employer as the Project Manager for the Contract implementation; or
 - viii) this and/or other documents to be used for the procurement of the Works to be executed pursuant to these Bidding Documents, or in any other way provided the consulting services in any aspect of the preparatory stages leading up to the issue of these Bidding Documents or hired/proposed to be hired by Employer as Project Manager for the Contract implementation;
 - ix) a Bidder or any of its affiliates employs or otherwise engages a close relative of the Employer's employee who has an authority over the Bidder or its affiliates or over the Bid. For the purpose of this sub-clause a close relative is defined as immediate family which includes father, mother, brother, sister spouse and own children.
- 3.4 A Bidder that is determined to be ineligible pursuant to any of the provisions of this Bidding Documents shall not be eligible to be awarded a Contract.
- 3.5 Government-owned enterprises in Bhutan shall be eligible only if they can establish that they (i) are legally and financially autonomous, (ii) operate under commercial law, and (iii) are not a dependent agency of the Employer.
- 3.6 Bidders shall provide such evidence of their continued eligibility satisfactory to the Employer as the Employer shall reasonably request.
- 3.7 Pursuant to the EIB's Sanctions Policy, the contract will not be awarded to or for the benefit of an individual or entity that is subject to financial sanctions imposed by the EU, either autonomously or pursuant to the financial sanctions decided by the United Nations Security Council on the basis of article 41 of the UN Charter.

4 EXCLUSION

- 4.1 A bidder shall be excluded if:
- i) he is insolvent or is in receivership or is a bankrupt or is in the process of being wound up, or has entered into an arrangement with his creditors; or
 - ii) his business affairs are being administered by a court, judicial officer or appointed liquidator; or
 - iii) he has suspended business or is in any analogous situation arising from similar procedures under the laws and regulations of his country of establishment; or
 - iv) he has been found guilty of professional misconduct by a recognized tribunal or any professional body; or

- v) he has not fulfilled his obligations with regard to the payment of taxes, social security or other payments due in accordance with the laws of the country in which he is established or of the Kingdom of Bhutan; or
- vi) he is or has been guilty of serious misrepresentation in supplying information required for any prior registration with the Employer or the Construction Development Board of Bhutan; or
- vii) he has been convicted of fraud and/or corruption by a competent authority or Anti-Corruption Commission of Bhutan
- viii) he has not fulfilled his contractual obligations with the Employer in the past; or
- ix) he has been debarred/blacklisted from participation in public procurement by any competent authority as per law.

5 ELIGIBLE COUNTRIES

- 5.1 The employer shall permit legal entities from all countries to submit their Bids for supply of Plant and Equipment under the Bidding Documents having Origin in any country.
- 5.2 As an exception, Bidders of a country, and/or Plant and Equipment manufactured/ originated in a country or provided from or by a country shall be excluded if:
 - a) as a matter of law or official regulation, the Royal Government of Bhutan (RGoB) prohibits commercial relations with that country as specified in BDS; or
 - b) RGoB prohibits any import of Plant and Equipment from a country or any payments to persons or entities in that country pursuant to a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the RGoB prohibits any import of plant and Equipment from that country or any payments to persons or entities in that country.
- 5.3 For the purposes of this Clause the term “origin” means the country where the Goods have been mined, grown, cultivated, produced, manufactured or processed; or, through manufacture, processing, or assembly, another commercially recognized article results that differs substantially in its basic characteristics from its components.

6 ELIGIBLE PLANT AND SERVICES

- 6.1 The plant and services to be supplied under the Contract shall have their origin in eligible source countries as defined in **ITB Clause 5** above and all expenditures under the Contract will be limited to such plant and services.
- 6.2 For the purpose of ITB Clause 6.1 above, “origin” means the place where the plant, or component parts thereof are mined, grown, produced or manufactured, and from which the services are provided. Plant components are produced when, through manufacturing, processing, or substantial or major assembling of components, a commercially recognized product results that is substantially in its basic characteristics or in purpose or utility from its components.

7 JOINT VENTURE BIDS

- 7.1 Bids submitted by a joint venture, if so permitted in the BDS, formed by a number of legal entities as specified in the BDS subject to the condition that the total number of legal entities shall not exceed three (3) entities, shall comply with the following requirements:
 - a) JV shall nominate a Lead Partner from amongst its members and a Representative from the Lead Partner who shall have the authority to conduct all business for and behalf of any and all members of the joint venture during the bidding process and, in the event the JV is awarded the Contract, during contract execution. This authorization shall be evidenced by submitting with the bid a power of attorney signed by legally authorized signatories of the other members;
 - b) Bids shall be signed by an authorized Representative of the joint venture so that the bids submitted by JV shall become legally binding on all members;

- c) Lead Partner shall be authorized to receive instructions for and on behalf of any and all members of the JV and the entire execution of the Contract, including payment, shall be done exclusively with the Lead Partner;
- d) All members of the joint venture shall be liable jointly and severally for the execution of the Contract in accordance with the contract terms; and
- 7.2 In order to qualify for participation in the bidding process, either the Lead Partner must meet the minimum technical qualification requirements or jointly by the JV partners, as specified in the BDS, as the case may be.
- 7.3 The financial qualification requirements, however, may be met jointly by the members of the JV subject to the condition that each member can independently meet at least the minimum financial qualification requirements as specified in the BDS. Failure to comply with this requirement will result in rejection of the Bids.

8 ONE BID PER BIDDER

- 8.1 Each Bidder shall submit only one Bid, either individually or as a partner in a JV, Consortium or Association. A Bidder who submits or participates in more than one Bid (other than as a sub-contractor or in cases of alternatives that have been permitted or requested) shall cause all the proposals with Bidder's participation to be disqualified.

9 RESPONSIBILITY OF BIDDERS

- 9.1 The Employer shall not assume any responsibility regarding information gathered, interpretations or conclusions made by the Bidder or regarding information, interpretations or deductions the Bidder may derive from the data or any report furnished by the Employer. Verbal communication or conversation with any employee of the Employer either before or after the submission of Bids shall not affect or modify any of the terms or obligations contained herein.
- 9.2 It shall be the sole responsibility of Bidders to determine and to satisfy themselves by such means as they consider necessary or desirable as to all matters pertaining to this bidding process including in particular all factors that may affect the performance of the Contract in the event of award.

B. THE BIDDING DOCUMENTS

10 CONTENTS OF BIDDING DOCUMENTS

- 10.1 The set of Bidding Documents comprises the documents listed below and addenda issued in accordance with **ITB Clause 14**

Volume I: Bidding Procedures

- Section 1: Notice Inviting Tender (NIT)
- Section 2: Instruction to Bidders (ITB)
- Section 3: Bid Data Sheet (BDS)
- Section 4: Evaluation and Qualification Criteria (EQC)
- Section 5: Information to Bidders (IFB)
- Section 6: Bidding Forms (BDF)

Volume II: Conditions of Contract and Particular Condition of Contract

- Section 7: Conditions of Contract for EPC/Turnkey Projects, FIDIC (Silver Book), First Edition 1999 (GCC)
- Section 8: Particular Conditions of Contract (PCC)
- Section 9: Contract Forms (COF)

Volume III: Technical Specifications and Employer's Requirements

- Section 10: Employer's Requirement
- Section 11: General Technical Specification (GTS)
- Section 12: Particular Technical Specification (PTS)
- Section 13: Quality Assurance Plan (QAP)
- Section 14: Supplementary Information
- Section 15: Technical Data Sheet

Volume IV: Price Schedule

Volume V: Tender Drawings

10.2 The Bidder is expected to examine all instructions, forms, terms, conditions, specifications and other information in the Bidding Documents and shall be deemed to have carefully examined the Bidding Documents and also to have satisfied himself as to the nature, character and scope of Work to be executed. Failure to furnish all information and documents required as per the Bidding Documents or submission of Bids not substantially responsive to the Bidding Documents in every respect shall be at the Bidder's risk and may result in rejection of the Bids.

11 CLARIFICATIONS ON BIDDING DOCUMENTS

- 11.1 A prospective Bidder requiring any clarifications of the Bidding Documents may notify the Employer in writing, including by facsimile, telex or electronic mail, at the Employer's address indicated in the BDS, not later than the date and time specified in BDS.
- 11.2 The Employer shall respond to any request for clarification received prior to the date specified in the BDS. Copies of the Employer's response shall be forwarded to all purchasers of the Bidding Documents, including a description of the inquiry, but without identifying its source. Alternatively, the Employer may upload the clarifications on the Employer's website. Bidders are advised to visit the website of the Employer from time to time in their own interest. All such clarifications shall form part of the Bidding Documents. Should the clarification result in changes to the essential elements of the Bidding Documents, the Employer shall amend the Bidding Document, following the procedures in **ITB Clause 14**.

12 SITE VISIT AND FAMILIARIZATION WITH LOCAL LAWS

- 12.1 The Bidder is advised to visit and examine the site and its surroundings where the plant is to be installed and obtain for itself on its own responsibility and risk, all information that may be necessary for preparing the Bids and entering into a contract for the provision of plant and services. The costs of visiting the site shall be the Bidder's own expense. The Employer shall facilitate the site visit upon receipt of advance notification from the Bidder.
- 12.2 The Bidder shall acquaint himself with the local conditions and requirements including the transportation, communication facilities, utility and labour conditions and shall not claim at any time after submission of the Bid or during the execution of the Contract that there was lack of understanding with regard to the conditions imposed in the Contract or prevailing at the site.
- 12.3 In their own interest, the Bidders are required to familiarize themselves with the Income Tax Act, prevailing labour laws including laws and regulations governing engagement of labour for employment and deployment at site and other related acts and laws prevalent in the Kingdom of Bhutan. Further, the Bidders are required to comply with these acts/laws and other relevant provisions particularly with reference to the requirement of taking insurance for the equipment during transportation, storage, erection, testing & commissioning until the **defect liability period**.
- 12.4 Foreign Bidders shall familiarize themselves especially with the rules and regulation applicable to the foreign firms for carrying out business in the Kingdom of Bhutan.
- 12.5 The Bidder and any of its personnel or agents will be granted permission by the Employer to enter upon its premises and lands for the purpose of such inspection, but only upon the express condition that the Bidder, its personnel and agents shall release and indemnify the Employer and

its personnel and agents from and against all liability in respect thereof and shall be responsible for death or personal injury (whether fatal or otherwise), loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of the inspection.

13 PRE-BID MEETING

- 13.1 A pre-bid meeting shall be conducted, if necessary, or as specified in the BDS. The Bidders shall be invited to attend the pre-bid meeting to be held on the date, time and location specified in BDS.
- 13.2 The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.
- 13.3 The Bidder is requested to submit any questions in writing or by facsimile or e-mail to reach the Employer not later than one week prior to the meeting.
- 13.4 Minutes of the meeting, including the text of the question raised (without identifying the source of inquiry) and the responses given will be transmitted without delay to all purchasers of the Bidding Documents. Any modification of the Bidding Documents as a result of the pre-bid meeting shall be made by the Employers exclusively through the issue of an Addendum pursuant to **ITC Clause 14** and not through the minutes of the pre-bid meeting.
- 13.5 Non-attendance of the pre-bid meeting will not be a cause for disqualification of the Bidder.

14 AMENDMENT OF BIDDING DOCUMENTS

- 14.1 Before the deadline for submission of Bids, the Employer may modify the Bidding Documents by issuing addenda/corrigenda. This may be done either on Employer's own initiative or in response to clarification requests from any of the Bidders.
- 14.2 Addenda/corrigenda thus issued shall be part of the Bidding Documents, and shall be binding on all Bidders. Addenda/corrigenda shall be communicated in writing, including by post, facsimile, or e-mail to all purchasers of the Bidding Documents. The addenda/corrigenda shall also be uploaded on the Employer's website.
- 14.3 The Employer may, at its discretion, extend the deadline for submission of Bids pursuant to **ITB Sub-Clause 27.2** to allow prospective Bidders reasonable time to take the addendum into account in preparation of their Bids. It would be in the interest of the Bidders to regularly visit the Employer website for information on any amendment or clarification to the Bidding Documents. The Employer shall in no way be responsible for any ignorance of the Bidder about the amendment to the Bidding Documents.

C. PREPARATION OF BIDS

15 LANGUAGE OF BID

- 15.1 All documents relating to the Bid shall be in English language. The documents and printed literatures provided by the Bidder as documentary evidences shall also be in English. Such documents, in other language, should be translated to English. The English translation shall prevail in the interpretation.

16 COST OF BIDDING

- 16.1 The Bidder shall bear all costs, direct or indirect, associated with the preparation and submission of his Bids (including site visits and attending pre-bid meetings). The Employer shall, in no case, be responsible or liable for these costs, regardless of the conduct or outcome of the bidding process.

17 DOCUMENTS COMPRISING THE BID

- 17.1 The Bid submitted by the Bidder shall comprise the following:
- i) Bid form (in the format indicated in Section 5: Bidding Forms);
 - ii) Bid Security in accordance with **ITB Clause 22**;
 - iii) Price Schedules – this must be submitted in paper form, signed by the duly authorized signatory of the Bidder, and also in electronic form, if required by the Employer;

- iv) Integrity Pact Statement duly executed by the Bidder as per Form: 3 of Section 6;
 - v) Power of Attorney: written confirmation authorizing the signatory of the Bid to commit the Bidder;
 - vi) Qualification: documentary evidences in accordance with **ITB Clause 24** establishing Bidder's qualification to perform the Contract if its Bid is accepted;
 - vii) Deviations Sheet in accordance with Form: 6 of Section 6. No deviation, whatsoever, shall be permitted by the Employer to the provisions of the Bidding Documents listed in the BDS;
 - viii) Alternative offers, if permitted in the BDS;
 - ix) Any other documents specified in the BDS.
- 17.2 In addition to the requirements under **ITB Sub-Clause 17.1** above, bids submitted by a Joint Venture, Consortium or Association of two or more firms as partners shall comply with the following requirements, unless otherwise stated in the BDS:
- a) the Bid shall include all information listed in the ITB Sub-Clause Error! Reference source not found. for each JV, Consortium or Association partner;
 - b) the Bid shall be signed so as to be legally binding on all partners;
 - c) all partners shall be jointly and severally liable for the execution of the Contract in accordance with the Contract terms;
 - d) one of the partners shall be nominated as the Lead Partner, authorized to incur liabilities, and receive instructions for and on behalf of any and all partners of the JV, Consortium or Association;
 - e) the execution of the entire Contract, including payment, shall be done exclusively with the Lead Partner; and
 - f) a copy of the JV/Consortium/Association Agreement entered into by the partners shall be submitted with the Bid; or a Letter of Intent to execute a JV/Consortium/Association Agreement in the event of a successful Bid shall be signed by all partners and submitted with the Bid, together with a copy of the proposed Agreement.

18 BID PRICES AND DISCOUNTS

- 18.1 Unless otherwise specified in the BDS and/or Technical Specifications, Bidders shall quote for the entire plant and services on a "single responsibility" basis such that the total Bid price covers all the Contractor's obligations mentioned in or to be reasonably inferred from the Bidding Documents in respect of the design, manufacture, including procurement and subcontracting (if any), site establishment including workshops and necessary facilities for assembling of deliveries, delivery, erection, installation, completion of the plant. This includes all requirements under the Contractor's responsibilities for testing, pre-commissioning and Commissioning of the plant and, where so required by the Bidding Documents, the acquisition of all permits, approvals and licenses, etc.; the operation, maintenance and training services and such other items and services as may be specified in the Bidding Documents, all in accordance with the requirements of the General Conditions. Items against which no price is entered by the Bidder will not be paid for by the Employer when executed and shall be deemed to be covered by the prices for other items.
- 18.2 Bidders are required to quote the price for the commercial, contractual and technical obligations outlined in the bidding document. If a Bidder wishes to make a deviation, such deviation shall be listed in the relevant form in Section 6 (Bidding Forms). The bidder shall also provide the additional price if any, for withdrawal of the deviation.
- 18.3 Prices shall be quoted in the Price Schedules included in Section 6 (Bidding Forms)
- 18.4 Bidders participating from India and supplying goods and services from India for bonafide use in the Kingdom of Bhutan shall quote the prices for items in the Price Schedule exclusive of any effect of the Integrated Goods and Service Tax (IGST) of India. The IGST on the export of goods or services or both are covered under Zero Rated Supply as per Chapter VII, 16(1) THE INTEGRATED GOODS AND SERVICES TAX ACT, 2017 of India. For the purpose of evaluation in the case of ICB, the effect of GST may be considered to have all the bidders in the

same platform since foreign bidders would be including the taxes and duties payable in their country.

- 18.5 The trade terms used in the Bidding Documents shall be governed by the rules prescribed in the current edition of Incoterms, published by The International Chamber of Commerce as specified in the BDS.
- 18.6 Bidders wishing to offer any price reduction (discount), shall specify in their Letter of Price Bid, the price reductions applicable to each item and in the manner in which the price reductions will apply. Conditional rebates/discount, if any, offered by the Bidder shall not be considered for Bid Evaluation.

19 CONTRACT PRICE ADJUSTMENT

- 19.1 The rates and prices quoted by the Bidder shall be fixed during the performance of the Contract or subjected to adjustment if provided for in the BDS, the PCC and the provisions of Sub Clause 13.8 of the General Condition of Contract. A Bid submitted with an adjustable price quotation shall be treated as non-responsive and shall be rejected pursuant to **ITB Clause 33** unless adjustable price quotations are permitted.
- 19.2 If price adjustment is provided for in the BDS and the PCC and the provisions of Sub-Clause 13.8 of the General Condition of Contract, prices quoted by the Bidder are subject to adjustment during the performance of the Contract.
- 19.3 The prices quoted by the Bidder shall reflect changes in the cost of labour, material, etc. in accordance with the procedures specified in Sub-Clause 13.8 of GCC
- 19.4 A Bid submitted with a fixed price quotation when Bids have been invited with price variation, will not be rejected, but the price adjustment will be treated as zero.
- 19.5 The estimated effect of the price adjustment provision applied over the period of execution of the Contract shall not be taken into consideration in Bid evaluation.
- 19.6 The Employer shall indicate the name, source and origin of indices along with their base values and corresponding coefficients as per PCC.

20 CURRENCIES OF BID AND PAYMENT

- 20.1 The unit rates and prices shall be quoted by the Bidder in the currencies specified in the BDS.
- 20.2 The rates of exchange shall be the selling rates prevailing on the date 30 days prior to the deadlines for submission of Bids. The selling rates posted by the Royal Monetary Authority of the Kingdom of Bhutan shall be used for the conversion of prices.
- 20.3 The payment to the Contractor shall be made in the currency of Bid Price and any banking charges related to payment shall be borne by the Contractor.

21 BID VALIDITY

- 21.1 Bids shall remain valid for the period specified in the BDS. A Bid valid for a shorter period shall be liable for rejection by the Employer as non-responsive.
- 21.2 In exceptional circumstances, prior to expiry of the Bid validity period, the Employer may request Bidders to extend the period of validity for a specific additional period. The request and the Bidder's responses shall be made in writing or by electronic mail. The Bid Security required pursuant to **ITB Clause 22** shall be extended to 30 days after the deadline of the extended Bid validity period. A Bidder may refuse the request to extend the validity of its Bid without forfeiting the Bid Security. The refusal to extend the Bid validity period will make the Bid invalid and shall not be further considered for evaluation and award. A Bidder agreeing to the request shall not be required or permitted to modify its Bid, except as provided for in **ITB Clause 29**.
- 21.3 The provision of **ITB Clause 22** regarding discharge and forfeiture of Bid Security shall continue to apply during the extended period of Bid Validity.

22 BID SECURITY

- 22.1 The Bidder shall furnish, as part of the Bid, a Bid Security as specified in the BDS.
- 22.2 The Bid Security shall be fixed amount as specified in BDS and denominated in Ngultrum (Nu/BTN) or the currency of the Bid or in any freely convertible currency, and shall:
- a) at the Bidder's option, be in any of the following forms:
 - i. an unconditional and irrevocable Bank Guarantee; or
 - ii. Banker's Cheque/Cash Warrant; or
 - iii. a Demand Draft; or
 - iv. cash deposit in the Employer's bank account (in exceptional circumstances only).
 - b) be issued by a reputable financial institution and enforceable in any Banks in Bhutan;
 - c) in case of a bank guarantee, be substantially in accordance with the form of Bid Security included in Section 6: Bidding Forms, or other form approved by the Employer prior to Bid submission;
 - d) be payable promptly upon written demand by the Employer in the case of the conditions listed in **ITB Sub-Clause 22.5** are invoked;
 - e) be submitted in its original form; copies shall not be accepted;
 - f) remain valid for period of 30 days beyond the validity period of the Bids, as extended, if applicable, in accordance with **ITB Sub-Clause 21.2**.
- 22.3 Any Bid not accompanied by a responsive Bid Security shall be rejected by the Employer as non-responsive.
- 22.4 The Bid Securities of unsuccessful Bidders shall be returned as promptly as possible upon the successful Bidder furnishing the Performance Security and in any event not later than 30 days after the expiration of the validity of the unsuccessful Bidder's Bid. In case of Single Stage– Two-Envelope and Two-Stage bidding processes, the Bid Security of non-responsive Bidders shall be returned immediately after the technical evaluation.
- 22.5 The Bid Security shall be forfeited:
- a) if a Bidder withdraws its Bid as a whole or in part during the period of Bid validity period; or
 - b) if the Bidder that submitted the lowest evaluated Bid does not accept the correction of the Bid Price pursuant to **ITB Clause 35**; or
 - c) if the Bidder has been found practicing corrupt or fraudulent or collusive or coercive practices during bidding process; or
 - d) if the successful Bidder fails to within the specified time limit to:
 - i. sign the Contract in accordance with **ITB Clause 47**; or
 - ii. furnish a Performance Security in accordance with **ITB Clause 46**.
- 22.6 The Bid Security of a JV/Consortium/Association must be in the name of JV/Consortium/Association that submits the Bid.

23 ALTERNATIVE BIDS

- 23.1 Alternative bids shall not be considered, unless specifically allowed in the BDS. If so allowed, the BDS shall specify which of the following options shall be allowed:
- a) Option One: A Bidder may submit alternative bids with his base bid and the Employer shall only consider the alternative bids offered by the Bidder whose bid for the base case was determined to be the lowest-evaluated bid, or

- b) Option Two: A Bidder may submit an alternative bid with or without a bid for the base case. All bids received for the base case, as well as alternative bids meeting the Technical Specifications, shall be evaluated on their own merits.
- 23.2 Bidders wishing to offer technical alternatives to the Employer's requirements as described in the Bidding Documents must also provide: (i) a price at which they are prepared to offer a plant meeting Employer's requirement; and (ii) all information necessary for a complete evaluation of the alternatives by the Employer, including drawings, design calculations, technical specifications, breakdown of prices, and proposed installation methodology and other relevant details. Only the technical alternatives, if any, of the lowest evaluated Bidder conforming to the basic technical requirements shall be considered by the Employer.

24 DOCUMENTS ESTABLISHING ELIGIBILITY AND QUALIFICATIONS OF THE BIDDER

- 24.1 To establish Bidder's eligibility in accordance with **ITB Clause 3**, Bidders shall complete the Letter of Tender, included in Section 10: Contract Forms.
- 24.2 In accordance with Section 3: Bid Data Sheet, to establish its qualifications to perform the Contract, the Bidder shall provide the information requested in the corresponding information sheets included in Section 6: Bidding Forms.
- 24.3 If a margin of preference applies as specified in accordance with **ITB Clause 39**, domestic Bidders, individually or in joint ventures, applying for eligibility for domestic preference shall supply all information required to satisfy the criteria for eligibility specified in accordance with **ITB Clause 39**.

25 FORMAT AND SIGNING OF BIDS

- 25.1 The Bidder shall prepare ONE Original of the Technical Bid and ONE original of the Price Bid comprising the Bid as described in **ITB Clause 17**, and clearly mark "ORIGINAL-TECHNICAL BID" and "ORIGINAL- PRICE BID". Alternative bids, if permitted in accordance with **ITB Clause 23**, shall be clearly marked "ALTERNATIVE". In addition, the Bidder shall submit copies of the Bid, in the number specified in the BDS and clearly mark each of them as "COPY". In the event of any discrepancy between the original and the copies, the original shall prevail.
- 25.2 The original and all copies of the Bid shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Bidder. This authorization shall consist of a written confirmation as specified in the BDS and shall be attached to the bid. All pages of the Bid where entries or amendments have been made shall be signed or initialed by the person signing the Bid.
- 25.3 A bid submitted by a JV shall be signed so as to be legally binding on all partners.
- 25.4 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the bid.

D. SUBMISSION OF BIDS

26 SEALING AND MARKING OF BIDS

- 26.1 Bidder may submit their Bids by hand, courier, registered post or by hand to reach the Employer at the address specified in BDS on or before the date and time specified in the BDS. The Employer shall not be responsible for any delay in receipt of the bid where sent by post or courier. When so specified in the BDS, Bidders shall have the option of submitting the Bids electronically. Bidders submitting Bids electronically shall follow the procedures specified in the BDS.
- 26.2 The Bidder shall seal the original and all copies of the Bid, including alternative Bids if permitted in accordance with **ITB Clause 23**, in separate inner envelopes contained within one out envelope. All envelopes shall be sealed with adhesive or other sealant to prevent reopening.
- 26.3 For Single-Stage-Two-Envelopes bidding process; the inner Envelope-I shall:

- a) contain technical bids signed across their seals by the person authorized to sign the Bid on behalf of the Bidder; and
- b) be marked “ORIGINAL”, “ALTERNATIVE” (if permitted) and “COPY”

Whereas, the inner Envelope-II shall:

- i) contain Financial bids and be signed across their seals by the person authorized to sign Bid on behalf of the Bidder; and
- ii) be marked “ORIGINAL”, “ALTERNATIVE” (if permitted) and “COPY”

Where bids are invited under the Single-Stage-Single-Envelope bidding process, both technical and financial bid shall be in a single inner envelope.

26.4 The outer Envelope shall:

- a) be marked “CONFIDENTIAL”;
- b) be addressed to the Employer at the address provided in the BDS;
- c) bear the name and number of the Contract as defined in the BDS and PCC; and
- d) provide a warning not to open before the time and date for Bid Opening as specified in the BDS.

26.5 In addition to the identification required in **ITB Sub-Clause 26.4**, the inner envelopes shall indicate the name and address of the bidder to enable the bid to be returned unopened in case it is declared late pursuant to **ITB Clause 28**.

26.6 If the outer envelope is not sealed and marked as above, the Employer shall assume no responsibility for the misplacement or premature opening of the Bid.

26.7 In the two-stage bidding process, Bidders shall be advised to submit only the technical bids in the first stage. In the second stage, Bidders shall be requested to submit both their technical bids as modified and agreed with the Employer and the financial bids based on the modified technical bids simultaneously in two separate sealed envelopes.

27 DEADLINE FOR SUBMISSION OF BIDS

27.1 Bids shall be delivered to the Employer at the address specified above no later than the time and date specified in the BDS. In the event, the specified date for submission of Bids is declared a holiday for the Employer, the Bids shall be received up to the specified time on the next working day. Such postponement of date shall not have any impact on the other dates specified in the Bidding Documents (i.e., bid validity and validity of Bid Security).

27.2 The Employer may, at its discretion, extend the deadline for the submission of Bids or opening of Bids by issuing an addendum in accordance with **ITB Clause 14**, in which case all rights and obligations of the Employer and the Bidders previously subject to the original deadline shall then be subject to the new deadline.

27.3 In the event when the deadline for submission of Bid has been extended by Employer, the Bidders who have already submitted their Bids within the original deadline of submission shall have the option to submit their revised Bid in substitution, either in full or in part of earlier Bid. In the absence of a revised Bid, the original Bid shall be considered for opening and subsequent evaluation. Wherever, the Bidder has submitted the revised Bid in modification of earlier Bid, the earlier Bid shall be returned unopened to the Bidder.

28 LATE BIDS

28.1 The Employer shall not consider any bid that arrives after the deadline for submission of bids, in accordance with **ITB Clause 27**. Any bid received by the Employer after the deadline for submission of bids will be declared late, rejected and returned unopened to the Bidder.

29 WITHDRAWAL, SUBSTITUTION OR MODIFICATION OF BIDS

29.1 A Bidder may withdraw, substitute, or modify its bid after it has been submitted by sending a written notice, duly signed by an authorized representative, and shall include a copy of the

authorization in accordance with **ITB Sub-Clause 25.2**, (except that withdrawal notices do not require copies). The corresponding substitution or modification of the bid must accompany the respective written notice. All notices must be:

- (a) prepared and submitted in accordance with **ITB Clause 25** and **ITB Clause 26** (except that withdrawals notices do not require copies), and in addition, the respective envelopes shall be clearly marked “Withdrawal,” “Substitution,” “Modification;” and
 - (b) received by the Employer prior to the deadline prescribed for submission of bids, in accordance with **ITB Clause 27**.
- 29.2 Bids requested to be withdrawn in accordance with **ITB Sub-Clause 29.1** shall be returned unopened to the Bidders.
- 29.3 No bid may be withdrawn, substituted, or modified in the interval between the deadline for submission of bids and the expiration of the period of bid validity specified by the Bidder on the Letter of Technical Bid or any extension thereof.

E. BID OPENING AND EVALUATION

30 BID OPENING

- 30.1 The Employer shall open the Bids, including modifications made pursuant to **ITB Clause 29**, in presence of the Bidders’ representative who choose to attend at the time and in the place specified in the BDS. Any specific electronic bid opening procedures required if electronic bidding is permitted shall be as specified in the BDS.
- 30.2 Envelopes marked “WITHDRAWAL” shall be opened and read out first. Bids for which an acceptable notice of withdrawal has been submitted pursuant to **ITB Clause 29** shall not be opened.
- 30.3 The “ORIGINAL” and “COPIES” will be opened at the bid opening. The Bidder’s names, the bid prices, the total amount of each Bid and of any alternative Bid (if alternatives have been requested or permitted), any discounts, Bid withdrawals, substitutions or modifications, the presence or absence of Bid Security (and any other details the Employer may consider appropriate), responses to any bidding documents addenda, fulfilment of any such other specific formal requirements as are prescribed in the Bidding Documents, and such other details as the Employer may consider appropriate, shall be announced by the Employer at the opening. This information also shall be written on a notice board for the public to copy. Any Bid price, discount or alternative bid price not announced and recorded shall not be taken into account in the Bid evaluation.

The Bid Form including appendices to Bid Form, Bill of Quantities, Price Schedules, Bid Securities, any discounts offered, and any other important documents shall be initialed by all members of the Tender Committee. All corrections/overwriting will be noted and recorded on each page of the Bill of Quantities. The Bid evaluation will be done using the “COPIES” while the “ORIGINAL” will be kept in safe custody. If there are any discrepancies between the “ORIGINAL” and “COPIES”, the “ORIGINAL” shall prevail.

No Bid shall be rejected at bid opening except for late bids pursuant to **ITB Clause 28**. Substitution Bids and modifications submitted pursuant to **ITB Clause 29** that are not opened and read out at bid opening shall not be considered for further evaluation regardless of their circumstances. Late, withdrawn and substituted Bids shall be returned unopened to Bidders. In the case of Single-Stage-Two-Envelopes bidding process, the technical Bids shall be opened at the bid opening. The date for opening of the Financial Bid shall be notified to the Bidders whose Bids had been found responsive in the techno-commercial evaluation.

- 30.4 The Employer shall prepare Minutes of the bid opening, including the information disclosed to those present in accordance with **ITB Sub-Clause 30.3**.
- 30.5 The number of representatives of Bidder to attend the bid opening shall be restricted to two persons. Bidders who chose to attend shall sign the record containing their name, designation, Bidders’ name and phone number or any other particulars as may be required. The omission of a Bidder’s representatives’ signature on the record shall not invalidate the contents and effect of the record. Bidders who chose to attend the opening shall not be allowed to speak on matters related

to the Bids until and unless required by the Tender Committee or by seeking permission from the Chairperson of the Tender Committee by raise of hand. Bidders who wish to lodge complain for bid opening shall submit their complain in writing under the signature of authorized signatory of the Bidder in the format provided at the bid opening.

31 CONFIDENTIALITY

- 31.1 Information relating to the evaluation of bids and recommendation of contract award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on Contract award is communicated to all Bidders.
- 31.2 Any attempt by a Bidder to influence the Employer in the evaluation of the bids or Contract award decisions may result in the rejection of its Bid.
- 31.3 Notwithstanding the above, from the time of bid opening to the time of Contract award, if any Bidder wishes to contact the Employer on any matter related to the bidding process, it should do so in writing.

32 CLARIFICATION OF BIDS

- 32.1 To assist in the examination, evaluation, comparison and post-qualification of the Bids, the Employer may, at Employer's discretion, ask any Bidder for a clarification of the Bidder's Bid, including justification and breakdowns of unit rates. Any clarification submitted by a Bidder that is not in response to a request by the Employer shall not be considered. Employer's request for clarification and the response thereto shall be in writing and shall be delivered by e-mail, post or hand delivery.
- 32.2 No change in the prices or substance of the Bid shall be sought, offered or permitted, except to confirm the correction of arithmetic errors discovered by Employer in the evaluation of the Bids, in accordance with **ITB Clause 35**.
- 32.3 If a Bidder does not provide clarifications of its bid by the date and time set in the Employer's request for clarification, its bid may be rejected.

33 EXAMINATION OF BIDS AND DETERMINATION OF RESPONSIVENESS

- 33.1 Prior to the detailed evaluation of Bids, the Employer shall determine to its satisfaction whether each Bidder meets the eligibility and qualifying criteria as prescribed in **ITB Clause 3** and BDS respectively. The determination shall be based upon examination of the documentary evidence of the Bidder's qualification submitted by the Bidder, pursuant to **ITB Clause 24**.
- 33.2 The Employer shall also determine whether each Bid:
- has been properly signed;
 - is accompanied by the Bid Security; and
 - is substantially responsive to the requirements of the Bidding Documents.
- 33.3 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
- which affects in any substantial way the scope, quality or performance of the Works;
 - which limits in any substantial way, inconsistent with the Bidding Documents, the Employer's rights or the Bidder's obligations under the Contract; or
 - whose rectification would affect unfairly the competitive position of other Bidders presenting substantially responsive Bids.
 - which is incomplete or does not include all the scope of Facilities covered in the technical specifications.

- 33.4 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 nonconforming deviation or reservation.

34 TECHNICAL EVALUATION

- 34.1 Employer will carry out a detailed technical evaluation of the Bids previously determined to be substantially responsive as per **ITB Clause 33** in order to determine whether the technical aspects are in accordance with the requirements set forth in the Bidding Documents. In order to reach such a determination, Employer will examine and compare the technical aspects of the bids on the basis of the information supplied by the Bidders, taking into account the following factors:

- a) overall completeness and compliance with the Technical Specifications and Drawings; deviations from the Technical Specifications as identified as per **ITB Clause 17.1** (t) to the Bid; suitability of the facilities offered in relation to the environmental and climatic conditions prevailing at the Site; and quality, function and operation of any process control concept included in the Bid. The Bid that does not meet minimum acceptable standards of completeness, consistency and detail will be rejected for non-responsiveness;
- b) type, quantity and long-term availability of mandatory and recommended spare parts and maintenance services;
- c) Other relevant factors, if any, listed in Section 4 (Evaluation and Qualification Criteria)

- 34.2 Where alternative Bid have been allowed in accordance with **ITB Clause 23**, and offered by the Bidder, Employer will make a similar evaluation of the alternatives. Where alternatives have not been allowed but have been offered, they shall be ignored.

- 34.3 At the time of award of Contract, if so desired by Employer the Bidder shall withdraw these deviations listed in Form 6 of Section 6 at the cost of withdrawal stated by the him in the Bid. In case the Bidder does not withdraw the deviations proposed by him, if any, at the cost of withdrawal stated in the Bid, his Bid will be rejected and bid security forfeited.

35 CORRECTION OF ERRORS

- 35.1 Bids determined to be substantially responsive shall be checked by the Employer for any arithmetical errors. Corrections in the bid price shall be done as per the provisions of this clause and shall be binding on the Bidders. If the Bidder does not accept the correction of errors as per the provisions of this clause, the Bid shall be rejected and the Bid Security forfeited in accordance with ITB Sub-Clause 22.5.

- 35.2 The errors shall be corrected by the Employer as follows:

- a) where there is a discrepancy between the words and figures against the unit price or amount, the expression in words shall prevail;
- b) where there is a discrepancy between the unit price and the line item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted shall prevail, unless in the opinion of the Employer there is an obviously gross misplacement of decimal point in the unit rate, in which case the line item total as quoted shall govern, and unit rate shall be corrected.
- c) Where there is discrepancy between summation of subtotals and total amount, the summation of subtotal amount shall prevail, and the total amount shall be corrected.

- 35.3 In case the Bidder has not quoted unit price against any item, the Employer shall treat the price of unquoted items as zero for the purpose of evaluation, comparison and award (if such Bidder emerges as the lowest evaluated Bidder), with the assumption that the costs have been absorbed elsewhere in the Priced Bid.

- 35.4 In case prices for any specific item is given by a Bidder as lump sum instead of unit rate as required, the Employer reserves the right to arrive at unit rate on the basis of dividing the quoted lump sum amount by the specified quantity in the Bill of Quantities. If the Bidder has quoted lump sum price for multiple items and in the event the Bidder is declared successful, the breakup of unit prices for

such items shall be discussed and agreed during the pre-award meeting. The price breakup as agreed shall form part of the Contract.

36 EVALUATION AND COMPARISON OF BIDS

- 36.1 The Employer shall evaluate and compare only the Bids determined to be substantially responsive in accordance with **ITB Clause 33**.
- 36.2 In evaluating the Bids, the Employer shall determine for each Bid the evaluated Bid Price by adjusting the Bid Price as follows:
- a) making any correction for errors pursuant to **ITB Clause 35**
 - b) excluding provisional sums and the provision (unless no rates have been asked from the Bidder), if any, for contingencies in the Bill of Quantities, but including Daywork, where priced competitively;
 - c) making an appropriate adjustment for any other acceptable variations, deviations or alternative offers submitted in accordance with **ITB Clause 23**; and
 - d) making appropriate adjustments to reflect discounts or other price modifications offered in accordance with **ITB Sub-Clause 18.6**; and
 - e) making adjustment for margin of preference for the domestic Bidders and Joint Ventures, Consortia or Association in accordance with **ITB Clause 39**.
- 36.3 The estimated effect of any price adjustment conditions under Sub-Clause 13.8 of PCC, during the period of implementation of the Contract, shall not be taken into account for bid valuation.
- 36.4 The lowest evaluated Bid shall be determined by comparing all evaluated bids of substantially responsive Bidders.

37 ABNORMALLY LOW BIDS

- 37.1 An abnormally low Bid is one where the bid price, in combination with other constituent elements of the bid, appears unreasonably low to the extent that the Bid prices raises material concerns as to the capability of the Bidder to perform the Contract for the offered bid price. Before proceeding to further analysis, the Employer shall revisit their estimate to ensure its realistic compared to the prevailing market rates.
- 37.2 Abnormally low bids shall be scrutinized by seeking written clarifications from the Bidder, including detailed price analyses of its bid price in relation to the subject matter of the contract, scope, proposed methodology, schedule, allocation of risks and responsibilities, and any other requirements of the request for Bidding Documents.
- 37.3 After evaluation of the price analyses, in the event that the Employer determines that the Bidder failed to demonstrate its capability to perform the Contract for the offered bid price, the Employer shall reject the Bid.
- 37.4 If the Employer decides to accept the abnormally low Bid after considering the detailed price analysis, the Employer shall increase the performance security to protect itself against any financial loss in the event the successful Bidder is not able to perform the Contract. The Employer shall ask the successful Bidder to deposit additional performance security, equivalent to the difference between the estimated and quoted price, in the form of cash warrant or unconditional bank guarantee in addition to the 10% performance security. However, the additional performance security shall not exceed 10% (ten percent) of the quoted price.
- 37.5 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 Employer shall not be taken into account in Bid evaluation.

38 SERIOUSLY UNBALANCED BIDS OR FRONT LOADED

- 38.1 If the Bid that is evaluated as the lowest evaluated cost is, in the Employer's opinion, seriously unbalanced or front loaded the Employer may require the Bidder to provide written clarifications. Clarifications may include detailed price analyses to demonstrate the consistency of the bid prices with the scope of works, proposed methodology, schedule and any other requirements of the Bidding Documents.
- 38.2 After the evaluation of the information and detailed price analyses presented by the Bidder, the Employer may as appropriate:
- a) accept the Bid and increase the performance security and ask the Bidder to deposit additional performance security, equivalent to the difference between the estimated and quoted price, in the form of cash warrant or unconditional bank guarantee in addition to the 10% performance security. However, the additional performance security shall not exceed 10% (ten percent) of the quoted price; or
 - b) reject the Bid.

39 PREFERENCE FOR DOMESTIC BIDDERS

- 39.1 As indicated in the BDS, domestic contractors may receive a margin of preference in Bid evaluation, for which this clause shall apply.
- 39.2 A domestic Bidder shall provide all evidence necessary to prove that it meets the following criteria to be eligible for a margin of preference in the comparison of its Bid with those Bidders who do not qualify for the preference. A domestic Bidder shall:
- a) be registered within Bhutan, constituted under and governed by the civil, commercial or public law of Bhutan, and have its statutory office, central administration or principal place of business there;
 - b) have majority ownership by nationals of Bhutan;
 - c) not subcontract more than twenty percent (20%) of the initial Contract Price, excluding provisional sums, to foreign contractors, suppliers and/or consultants.
- 39.3 Joint Ventures, Consortia and Associations of domestic firms may be eligible for the margin of preference provided that:
- a) the individual partners satisfy the criteria of eligibility of ITB Sub-Clause 39.2 (a) and (b);
 - b) the JV/C/A is registered in Bhutan;
 - c) the JV/C/A does not subcontract more than ten percent (10%) of the initial Contract Price, excluding provisional sums, to foreign firms; and
 - d) the JV/C/A satisfies any other criteria specified for the purpose of domestic preference eligibility, as specified in the BDS.
- 39.4 The procedure used to apply the margin of preference shall be as stipulated in the BDS.

40 SUBCONTRACTING

- 40.1 Unless otherwise stated in the BDS, Employer does not intend to execute any specific elements of the Works by subcontractors. If permitted, Bidders may propose subcontracting up to the percentage of total value of contracts or the volume of works as specified in the BDS.

41 NOTICE OF INTENTION FOR AWARD OF CONTRACT

- 41.1 If Standstill provisions apply as specified in the BDS, the standstill period shall be defined in the BDS to specify the duration subsequent to notification of intention for award of contract (before making the actual contract award) within which any unsuccessful bidder can challenge the proposed award.

F. AWARD OF CONTRACT**42 AWARD CRITERIA**

- 42.1 The Employer shall award the Contract to the Bidder whose offer has been determined to be the lowest evaluated bid and is substantially responsive to the Bidding Documents, provided further that the Bidder is determined to be eligible and qualified to perform the Contract satisfactorily.
- 42.2 The Employer reserves the right to accept any of the deviations submitted in accordance with **ITB Sub-Clause 18.2** by the lowest evaluated bidder, at the price shown for the deviation in the bid.

43 RIGHT TO ACCEPT OR REJECT BIDS

- 43.1 Notwithstanding **ITB Clause 42**, 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 award, 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 such action of the Employer.

44 NOTIFICATION OF AWARD

- 44.1 The Employer shall notify the concerned Bidder whose bid has been selected in accordance with **ITB Clause 42** in writing that the Employer has intention to accept its Bid and the copy of this information shall be given to all other Bidders who submitted the Bid. Such notifications should be communicated in writing, including facsimile, telex or electronic mail to all the Bidders on the same day of dispatch. The Employer shall also ensure that the same information is uploaded on their website on the same day of dispatch.
- 44.2 The concerned Bidder shall return a copy of the Letter of Intent to Award to the Employer after duly recording "Accepted Unconditionally" under the signature of the authorized signatory within seven (7) days of the date of notification.
- 44.3 The Letter of Acceptance shall constitute the formation of the Contract, subject to the Bidder furnishing the Performance Security in accordance with **ITB Clause 46** and signing of the Contract in accordance with **ITB Clause 47**. Until a formal contract is prepared and executed, the LoA shall constitute a binding contract between the successful Bidder and Employer.
- 44.4 Upon the furnishing of performance security pursuant **to ITB Clause 46** by the successful Bidder, Employer shall:
- promptly notify each unsuccessful Bidder and return their bid security; and
 - publish a notification of award on its website.

45 DEBRIEFING BY EMPLOYER

- 45.1 On receipt of the Employer's Letter of Acceptance referred to in **ITB Clause 44**, an unsuccessful Bidder has three (3) working days to make a written request to the Employer for a debriefing. The Employer shall provide a debriefing to all unsuccessful Bidders whose request is received within this deadline.
- 45.2 Where a request for debriefing is received within the deadline, Employer shall provide a debriefing within five (5) working days.
- 45.3 The Employer shall discuss only such Bid and not the bids of other competitors. The debriefing shall not include:
- point-by-point comparisons with another Bid; and
 - information that is confidential or commercially sensitive to other Bidders.
- 45.4 The purpose of debriefing is to inform the aggrieved Bidder of the reasons for lack of success, pointing out the specific shortcomings in its bid without disclosing contents of other bids.

46 PERFORMANCE SECURITY

- 46.1 Within thirty days (30) days after receipt of the Letter of Acceptance, the successful Bidder shall deliver to the Employer a Performance Security in the amount stipulated in the GCC (usually 10%

of the Contract Price) and in the form stipulated in the BDS, denominated in the type and proportions of currencies in the Letter of Acceptance and in accordance with the GCC.

- 46.2 Failure of the successful Bidder to submit the above-mentioned Performance Security or sign the Contract shall constitute sufficient grounds for cancellation of the award and forfeiture of the Bid Security.
- 46.3 Upon the successful Bidder's signing of the Contract and furnishing of the Performance Security pursuant to **ITB Sub-Clause 45.1**, the Employer shall promptly notify the name of the winning Bidder to each unsuccessful Bidder and shall discharge the Bid Securities of the unsuccessful Bidders.

47 SIGNING OF CONTRACT

- 47.1 The Contract shall incorporate all agreements between the Employer and the successful Bidder. The Contract shall be signed by the parties, upon furnishing of the Performance Security by the successful Bidder, on a date and time, and place notified by the Employer.
- 47.2 Where the Contract cannot be signed by both parties in person, the Employer shall send to the successful Bidder a complete set of Contract Documents signed by the Employer, including the Letter of Acceptance. Within the stipulated time the successful Bidder shall sign these documents and deliver it to the Employer. The Letter of Acceptance shall indicate the deadline within which the successful Bidder shall sign these documents with the date of signature and return it to the Employer.
- 47.3 The Contract shall become effective from the date of signing the Contract Documents.
- 47.4 Failure of the successful Bidder to accept the award/sign the contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security.

48 PERFORMANCE MANAGEMENT SYSTEM

- 48.1 The performance of the Contractor shall be assessed as per the Vendor Performance Management System (VPMS) available in the Employer's website for the purpose of assessing the performance of the Contractor. The Employer, at its discretion, may use any other Performance Management System.

49 BIDDING-RELATED COMPLAINTS

- 49.1 The procedures for dealing with Bidding-Related Complaints arising out of this bidding process are specified in the BDS

120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instruction to Bidders (ITB)
- **Section 3 - Bid Data Sheet (BDS)**
- Section 4 - Evaluation and Qualification Criteria (EQC)
- Section 5 - Information to Bidders (IFB)
- Section 6 - Bidding Forms (BDF)

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



SECTION 3 - BID DATA SHEET

This Section consists of provisions that are specific to procurement and supplement the information or requirements included in Section 2 – Instruction to Bidders.

ITB Clause Reference	Particulars
A. GENERAL	
1.1	The Employer is: Druk Green Power Corporation Limited (DGPC) The name and identification of the Contract are: Name of Contract: Design, Supply, Installation, Testing and Commissioning of 120 MWp Jamjee Solar PV Project Reference Number: CO 002/2025 Dated January 07, 2025
1.2	The indented Completion date of EM Equipment is: 540 days from the date of Signing of Contract Agreement.
1.3	The Source of Fund: European Investment Bank (potential) and own resources.
7.1	Joint Venture/Consortium Bids are permitted: “No”
B. BIDDING DOCUMENTS	
11.1, 11.2	The Employer’s address for clarifications is: Attention: Manager Address: Contracts Section Projects & Contract Department Druk Green Power Corporation Limited Tel No: +975-2-339875 Electronic mail: s.choden272@drukgreen.bt Bid clarification request shall be received on or before pre-bid meeting Time: 17:00 hrs (Bhutan Standard Time) Date: January 26, 2025
13.1	Pre-bid Meeting shall be held on January 27, 2025 at 10:00 hrs at the address given below: Address: Contracts Section Projects & Contract Department Druk Green Power Corporation Limited Tel No: +975-2-339875
C. PREPARATION OF BIDS	
17.1 ix)	Any additional copy of documents required to be submitted by the Bidders are: i) Latest Tax Clearance Certificate; ii) Certificate of Incorporation; iii) Valid Business/Trade License
18.5	The Incoterms edition is: [2010]
19.1	Price adjustment is not applicable
20.1	The currencies of Bid shall be: Bhutanese Ngultrum (BTN)/Indian Rupees (INR)/US dollar Any expenditure payable in Bhutan shall be paid in BTN.
21.1	The Bid shall be valid for 120 days from the deadline for submission of Bids stipulated in ITB Clause 27 (i.e. Bid shall be valid up to June 19, 2025).
22.1	The Bid Security amount is BTN/INR 75 million (BTN/INR seventy-five million or equivalent USD at the exchange rate of 1 USD = BTN 84) and shall be valid up to a period of 30 days beyond the validity period for the bids (i.e. valid up to July 19, 2025) in the form of i. an unconditional and irrevocable Bank Guarantee; or ii. Banker’s Cheque/Cash Warrant; or iii. a Demand Draft; or iv. cash deposit in the Employer’s bank account (in exceptional circumstances only).

ITB Clause Reference	Particulars
	be issued by a reputable financial institution and, in case of a foreign institution, enforceable in a [correspondent] Bank in Bhutan.
23.1	Alternative Bids shall not be permitted.
25.1	In addition to the original Bid, the number of hard copies is: 1 (one) <i>Not applicable in case of Bids submitted electronically.</i>
26.3	A Power of Attorney as per the Bidding Form under Section 6 of Volume -1 Bidding Procedures as per the resolution of Board of Directors of the Company for the specific appointment.
D. SUBMISSION OF BIDS	
26.1	Bidders may submit their Bids electronically (i.e. through e-mail): Yes <i>Description of the procedures for submission of Bids by email:</i> Bids shall be submitted in pdf format with password protection. The password shall be sent by email to the person, to whom the Bids shall be addressed, on/before the bid opening deadline specified in the ITB 30.1 of BDS.
26.1	The Employer’s address for the purpose of Bid submission is: Attention: Manager Address: Contracts Section Projects & Contract Department Druk Green Power Corporation Limited Tel No: +975-2-339875 Electronic mail: s.choden272@drukgreen.bt Date & Time (Bhutan Standard Time) up to which Bids will be received: Date: February 19, 2025 Time: 15:00 hrs
26.3	The markings of the bids shall be as follows: Single Stage Two Envelope For single -Stage-Two-Envelope bidding process, the superscript of cover envelope shall be: “CONFIDENTIAL” Bid for “Design, Supply, Installation, Testing and Commissioning of 120 MWp Jamjee Solar PV Project” bearing identification No.: CO 002/2025 Dated January 07, 2025 Name and address of Bidder: DO NOT OPEN BEFORE February 19, 2025 15:30 hrs (BST) Addressed to the Employer: Attention: Manager Address: Contracts Section Projects & Contract Department Druk Green Power Corporation Limited Tel No: +975-2-339875 Electronic mail: s.choden272@drukgreen.bt The superscript of Envelope 1 shall be: TECHNICAL BID (Contains both Bid Security and Technical Bid) Bid for “Design, Supply, Installation, Testing and Commissioning of 120 MWp Jamjee Solar PV Project” bearing identification No.: CO 002/2025 Dated January 07, 2025 Name and address of Bidder: The superscript of Envelope 2 shall be: “CONFIDENTIAL” FINANCIAL BID



ITB Clause Reference	Particulars
	Bid for “Design, Supply, Installation, Testing and Commissioning of 120 MWp Jamjee Solar PV Project” bearing identification No.: CO 002/2025 Dated January 07, 2025 <i>Name and address of Bidder:</i> DO NOT OPEN BEFORE February 19, 2025, 15:30hrs (BST)
27.1	The deadline for submission of Bids shall be before 15:00hrs on February 19, 2025
E. BID OPENING AND EVALUATION	
30.1	The Technical Bid shall be opened on: Date: February 19, 2025 Time (Bhutan Standard Time): 15:30hrs
30.3	Following the completion of the evaluation of the Technical Bids, DGPC will notify the technically qualified Bidder of the location, date and time of the public opening of Financial Bids. Any interested party who wishes to attend this public opening should contact Manager, Contracts Section, E-mail: s.choden272@drukgreen.bt and request to be notified of the location, date and time of the public opening of Financial Bids. The request should be made before the deadline for submission of Bids, stated above.
33.1	In addition to the requirements specified in ITB Clause 17.1, 24.2 and 33.1, the criteria provided in the Section 4: Evaluation and Qualification Criteria shall be used to evaluate the bids.
36.2 (e)	Margin of preference: Not Applicable
40.1	The ceiling for Sub-Contractor’s participation and conditions are: Not Applicable . For details on subcontracting, refer Sub-Clause 4.4 of PCC
41.1	Standstill provisions shall apply. The duration of standstill period will be 10 (ten) Calendar days from the date of notice of intention for award of contract. The Employer shall, at the start of the standstill period, notify in writing each Bidder that submitted a bid, of its intention to award a contract to the successful Bidder at the end of standstill period.
F. AWARD OF CONTRACT	
45.1	The Performance Security shall be provided in any one of the following forms issued by a reputable financial institution and enforceable in any Banks in Bhutan: <ol style="list-style-type: none"> i) Unconditional bank guarantee in the form provided in Section 8: Contract Forms; or ii) Demand draft; or iii) Cash warrant
49.1	The procedures for Bidding-Related Complaints are referenced in Annex 7 of Guide to Procurement for EIB Borrowers. The Bidder should submit its complaint following these procedures, in writing, to: On behalf of Promoter, For the attention: Sonam Wangdi Title/position: Director, Projects and Contract Department Employer: Druk Green Power Corporation Limited E-mail address: s.wangdi2586@drukgreen.bt OR Independent Reviewer: For the attention: Mr. Karma P. Dorji , Title/position: Director General, Department of Energy, Ministry of Energy & Natural Resources E-mail Id: kpdorji@moenr.gov.bt Copy to EIB procurementcomplaints@eib.org :

120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instructions to Bidders (ITB)
- Section 3 - Bid Data Sheet (BDS)
- **Section 4 - Evaluation and Qualification Criteria (EQC)**
- Section 5 - Information to Bidders (IFB)
- Section 6- Bidding Forms (BDF)

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



SECTION 4 - EVALUATION AND QUALIFICATION CRITERIA

This Section contains the criteria that the Employer shall use to evaluate bids and qualify Bidders. No other factors, methods or criteria shall be used other than those specified in the Bidding Documents. The Bidder shall provide all the information requested in the forms included in Section 6 - Bidding Forms.

The Employer shall use the criteria and methodologies specified in this Bidding Documents to determine the most successful Bidder whose Bid has been determined to be:

- Substantially responsive to the Bidding Documents;
- Obtained minimum qualification score of 80; and
- Lowest Evaluated Bid Value.

1.0 QUALIFICATION CRITERIA

1.1. The Bidders shall be evaluated on basis of qualifying criteria stipulated in the table below. The minimum points to qualify for Financial Bid opening is 80. The bidders not meeting minimum qualifications shall be disqualified at Technical Bid evaluation stage.

SN	Criteria	Points
A	Technical Eligibility Criteria (80)	
1	General Experience	
a)	Experience in renewable energy contracts in the role of contractor, subcontractor, management contractor or developer in the last 3 years	10
2	Specific Experience	
a)	Experience in execution of ground mounted Solar PV Projects on turnkey basis including design, engineering, supply, installation and commissioning of at least two (2) grid-connected Solar PV Power Plants with capacity of 100 MW _{AC} or larger at a single project site in the last five (5) years as on the last date bid submission. The scope of works must include supply of solar modules and evacuation infrastructure including pooling substation. <i>Additional consideration will be given to bidders with experience in high altitude or variable weather environments given Bhutan's specific climate and terrain slope ($\geq 10^\circ$).</i>	40
b)	One of the Solar PV Power Plants, declared for qualification under 2 (a), must be in operation for at least two (2) years prior to the last date of bid submission.	10
c)	Experience in execution of ground mounted Solar PV Projects on turnkey basis including design, engineering, supply, installation and commissioning of grid-connected Solar PV Power Plants with cumulative capacity of 1000 MW _{AC} in the last five (5) years as on the last date of bid submission.	20
B	Financial Eligibility Criteria (20)	
3	Financial Requirements	
a)	Minimum average annual turnover during the last three (3) years shall be BTN 5,200.00 million. While computing the annual turnover, other incomes in the P&L statement shall not be considered.	15
b)	Net Worth of the Bidder for the last three (3) financial years should be positive.	5

Note:

1. The bidder should submit the Manufacturer's Authorization for the supply of PV Modules and PV Inverters
2. The bidder shall submit the documentary evidence such as signed Contract Agreement, and/or Taking-Over Certificate, Contract Completion Certificate or Performance Certificate, in sufficient detail to verify the contract name, value, and completion time. If the documents are other than in English, an accurate certified translation of these documents in English shall be provided.
3. Copies of Audited Annual Reports/Balance sheet & Profit and Loss account for the financial year 2022, 2021, 2020, 2019 and 2018. However, in case COVID 19 has impacted normal turnover for the financial year 2021 and 2020, the Employer will use the best turnover of 3 years out of the last 5 years from 2018 to 2022 for all the bidders. These criteria will apply to all the bidders.
4. In case where audited results for the last financial year as on the date of submission of the Bid is not available, the audited results of three consecutive financial years preceding the last financial year shall be considered for evaluating the financial parameters subject to submission of a Certificate signed by CEO/CFO/Partner/Proprietor of the Bidder stating that the financial results of the last financial year of the Company/firm are under audit as on the date of submission of the bid.
5. The Net-worth shall be calculated based on subscribed and paid-up Share Capital plus Share Premium plus Free Reserve plus Unallocated balance/surplus amount of Profit & Loss Accounts less (a) Expenses not written off and (b) Accumulated Loss in Profit & Loss Accounts if not reduced from Reserve & Surplus. The revaluation reserves, capital reserves and reserve on account of intangible assets like goodwill etc. will not be taken into account while calculating Net Worth.
6. In case of composite works executed (other items/works outside the similar work requirement), to arrive at the value of similar works mentioned in the Bid, the required break up shall be given by the party with notarization. In absence of work breakup from bidder, Employer shall arrive at the break up on their own and such calculation shall be final and binding on the bidder.

120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instructions to Bidders (ITB)
- Section 3 - Bid Data Sheet (BDS)
- Section 4 - Evaluation and Qualification Criteria (EQC)
- **Section 5 - Information to Bidders (IFB)**
- Section 6 - Bidding Forms (BDF)

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



SECTION 5 – INFORMATION TO BIDDERS

TABLE OF CONTENTS

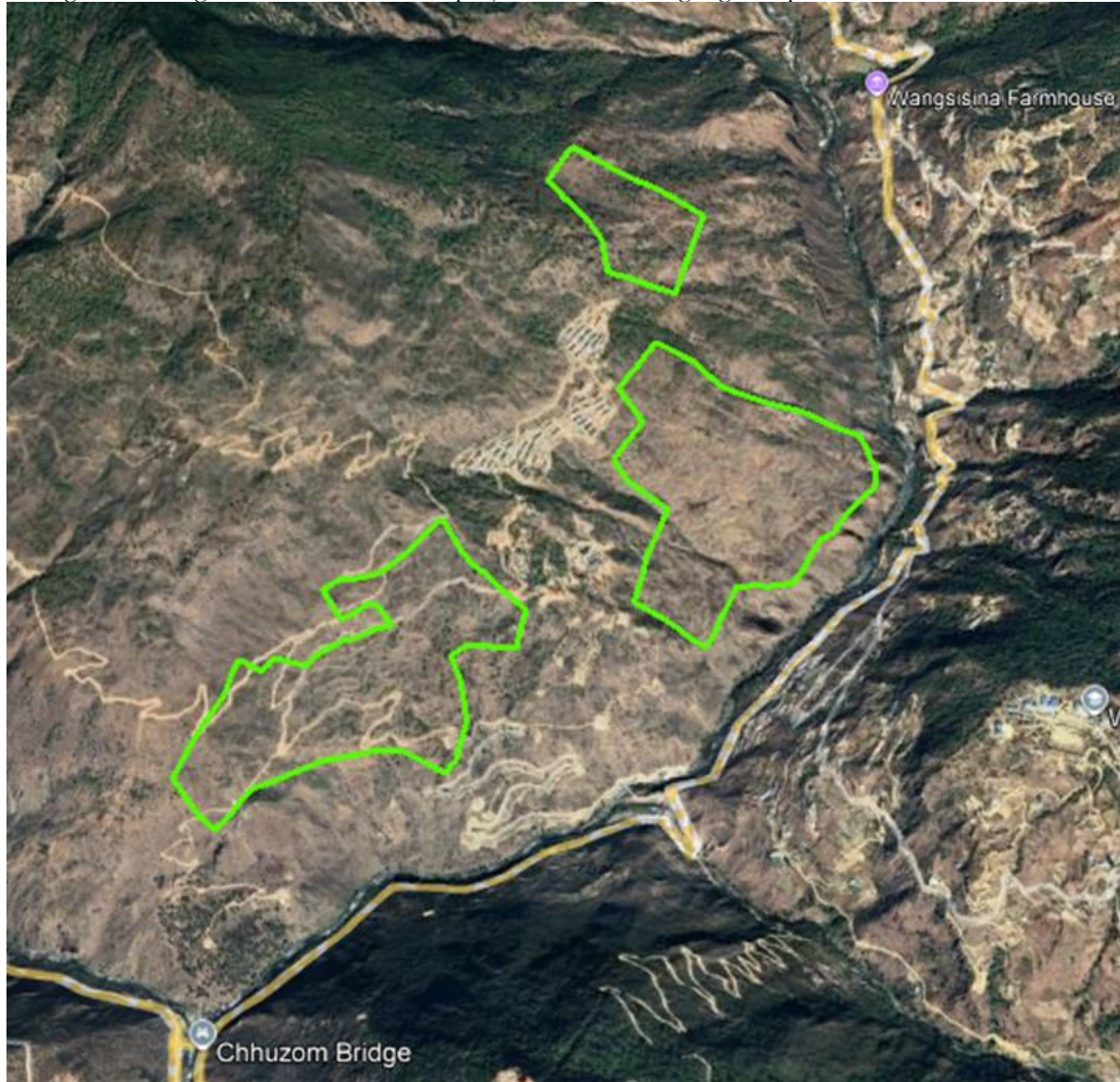
1	JAMJEE SOLAR PV PROJECT	1
1.1	Project Location and Accessibility	1
1.2	Site Specific Technical Data	2



1 JAMJEE SOLAR PV PROJECT

1.1 Project Location and Accessibility

The Jamjee Solar PV Project is located about 25 km from the capital city, under Mewang Gewog, Thimphu. The project site at Jamjee is divided into three sites totalling to about 423 acres of land. One of the three sites is connected by a bitumen-paved road from the Thimphu-Phuentsholing National Highway. The sites have a 220/66/33 kV GIS substation of Bhutan Power Corporation Limited (BPC) in their vicinity with the capacity of 3 x 80 MVA at 220/33 kV level and another 2 x 30 MVA at 220/66 kV level. About 40 % of the total land area has slopes higher than 20 degrees, 20% in between 16 to 20 degrees and 40% below 16 degrees. The figure below indicates the project location on a google map.



Key Project Data

The ground-mounted solar PV project with a minimum estimated DC capacity of 120 MW_p has a potential of generating electricity of about 197.68 GWh per annum. The power generated from the plant is to be evacuated to the national grid through the existing 220/66/33 kV substation at a suitable voltage level.

1)	Owner	:	Druk Green Power Corporation Limited (DGPC)
2)	Project title	:	120MWp Solar PV Plant, Jamjee, Bhutan
3)	Location	:	Jamjee, Sisina Chewog, Mewang Gewog, Thimphu. Coordinates: Longitude: 89°33'49.15"E Latitude: 27°20'12.62"N Altitude: 2500 M
4)	District	:	Thimphu
5)	Nearest Town	:	Thimphu (25 km)
6)	Nearest railway station	:	NA
7)	Nearest airport	:	Paro International Airport (30km)
8)	Access road	:	Phutsholing, Thimpu Highway (3 km)
9)	Wind data (as per IS: 875, part 3)		
	Basic wind speed	:	47 m/s
	Design wind speed	:	57.9 m/s
10)	Seismic data	:	As per IS: 1893 (latest revision)
	a) Zone	:	V
11)	Design ambient temperature	:	-10 °C to 35 °C
12)	Altitude	:	2500 m
13)	Languages spoken in the region:	:	Dzongkha
14)	Official language for the bidder to deal with	:	English
15)	Installation of modules	:	Ground mounted
16)	ELECTRICAL POWER EVACUATION FROM PV PLANT TO SUBSTATION	:	33 kV to 220/66/33 kV substation at Jamjee

1.2 Site Specific Technical Data

A. Solar Irradiation Data for Proposed Site (as per meteonorm)

Month	Solar Irradiation (kWhr/m ² /month)	Solar Irradiation (kWhr/m ² /daily)
January	130.5	4.2
February	119.2	4.25

March	150.8	4.86
April	149.4	4.98
May	177.4	5.72
June	161.5	5.30
July	171.2	5.52
August	160.3	5.17
September	129.3	4.31
October	148.4	4.78
November	137.9	4.59
December	135.7	4.37
Average	147.6	4.83

B. Temperature and wind data of the project location

Month	Temp (°C)	Wind Vel. (m/s)
Jan	-5.6	1.90
Feb	-4.2	2.20
Mar	-0.7	2.39
Apr	3	2.40
May	6.3	2.60
Jun	9.8	2.70
Jul	10.8	2.29
Aug	10.4	2.19
Sep	8.6	2.09
Oct	3.7	2.10
Nov	-0.6	1.80
Dec	-3.6	1.81
Average	3.2	2.21

120 MWp JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instructions to Bidders (ITB)
- Section 3 - Bid Data Sheet (BDS)
- Section 4 - Evaluation and Qualification Criteria (EQC)
- Section 5 – Information to Bidders (IFB)
- **Section 6 - Bidding Forms (BDF)**

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



SECTION 6 - BIDDING FORMS

This Section contains the forms which are to be completed by the Bidder and submitted as part of his Bid.

TABLE OF CONTENTS

1	Letter of Technical Bid	1
2	Letter of Price Bid	2
3	Integrity Pact	3
4	Covenant of Integrity	6
5	Environmental and Social Covenant	8
6	Power of Attorney	11
7	Bid Security	12
8	Deviation Schedule (if applicable)	14
9	Technical Proposal	15
9.1	Proposed Organization Set Up.....	16
9.2	Proposed Method Statement	17
9.3	Proposed Mobilization Schedule.....	18
9.4	Proposed Construction Schedule:.....	19
9.5	Proposed Key Personnel	20
9.6	Proposed Subcontractors/Manufacturers for Major Items of Plant and Services (if applicable).....	24
10	Bidder's Qualification	28
10.1	Form ELI - 1: Bidder's Information Sheet.....	28
10.2	Form ELI - 2: JV/Subcontractor Information Sheet.....	29
10.3	Form LIT - Pending Litigation.....	30
10.4	Form FIN - 1: Financial Situation and Performance.....	31
10.5	Form FIN - 2: Average Annual Turnover.....	32
10.6	Form FIN - 3: Financial Resources	33
10.7	Form FIN- 4: Current Contract Commitments (if applicable).....	34

1 Letter of Technical Bid

(To be submitted on Bidder’s letterhead)

[Location, Date]

To: [Name and address of the Employer]

Sir/Madam

We, the undersigned, declare that:

- (a) We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Bidders ITB 14;
- (b) We offer to design, supply, install, test, pre-commission and commission 120 MWp Jamjee Solar PV Project and defects therein in conformity with the Bidding Document enclosed in our bid (including this letter);
- (c) Our Bid consisting of the Technical Bid and the Price Bid shall be valid for a period of..... **days** from the date fixed for the Bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;
- (d) Our firm, including any Subcontractors, Designers, Manufacturers or Suppliers for any part of the Contract, have or will have nationalities from eligible countries in accordance with ITB 3.2;
- (e) We, including any Subcontractors, Designers, Manufacturers or Suppliers for any part of the Contract, do not have any conflict of interest in accordance with ITB 3.3;
- (f) We are not participating, as a Bidder or as a Subcontractor, in more than one bid in this bidding process in accordance with ITB 3.3, other than alternative offers submitted in accordance with ITB 23;
- (g) Our firm, its affiliates or subsidiaries, including any Subcontractors, Designers, Manufacturers, or Suppliers for any part of the Contract, has not been declared ineligible by the Employer, under the Employer's country laws or official regulations or by an act of compliance with a decision of the United Nations Security Council;

Name

In the capacity of

Signed

Duly authorized to sign the Bid for and on behalf of

Date



2 Letter of Price Bid

(To be submitted on Bidder’s letter head)

[Location, Date]

To: [Name and address of the Employer]

Sir/Madam

We, the undersigned, declare that:

- (a) We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Bidders (ITB);
- (b) We offer to design, supply, install, test, pre-commission and commission 120 MWp Jamjee Solar PV Project and defects therein in conformity with the Bidding Document enclosed in our bid (including this letter);
- (c) The total price of our Bid, excluding any discounts offered in item (d) below is the sum of: [amount of local currency in figures], [amount in words], and [amount of foreign currency in figures], [amount in words].

.....
.....

- (d) The discounts offered and the methodology for their application are:

.....
.....

- (e) Our Bid shall be valid for..... **days** from the date fixed for the bid submission deadline in accordance with the Bidding Documents, and it shall remain, binding upon us and may be accepted at any time before the expiration of that period.
- (f) If our Bid is accepted, we commit to obtain a Performance Security in accordance with the Bidding Document.
- (g) We understand that this Bid, together with your written acceptance thereof included in your notification of award, shall constitute a binding Contract between us, until a formal Contract is prepared and executed; and
- (h) We understand that you are not bound to accept the lowest evaluated Bid or any other Bid that you may receive.

Name

In the capacity of

Signed

Duly authorized to sign the Bid for and on behalf of

Date.....



3 Integrity Pact

[This agreement should be a part of the tender document, which shall be signed and submitted along with the tender document. The head of the employing agency/ or his authorized representative should be the signing authority. For the Bidders, the Bidder himself or his authorized representative must sign the integrity pact (IP). If the winning Bidder had not signed during the submission of the bid; the tender shall be rejected/ cancelled.]

1. General

Whereas [Sonam Choden, Manager, Contracts Section, Project & Contract Department, y], representing the Employer on one part, and [insert name of Bidder or his/her authorized representative, with power of attorney] representing M/s. [.....insert name of firm), hereinafter referred to as the **“Bidder”** on the other part hereby execute this agreement as follows:

2. Objectives

Whereas, the Employer and the Bidder agree to enter into this agreement, hereinafter referred to as Integrity Pact, to avoid all forms of corruption or deceptive practice by following a system that is fair, transparent and free from any influence/unprejudiced dealings prior to, during and subsequent to the currency of the Contract to be entered into, with a view to:

- 2.1 Enable the Employer to obtain the desired contract at a reasonable and competitive price in conformity to the defined specifications of the works or goods or services; and
- 2.2 Enable bidders to abstain from bribing or any corrupt practice in order to secure the contract by providing assurance to them that their competitors shall also refrain from bribing and other corrupt practices and the Employer shall commit to prevent corruption, in any form by their officials by following transparent procedures.

3. Commitments of the Employer

The Employer commits itself to the following:

The Employer hereby undertakes that no officials of the Employer, connected directly or indirectly with the contract, will demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward, favor or any material or immaterial benefit or any other advantage from the Bidder, either for themselves or for any person, organization or third party related to the Contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the Contract.

- 3.1 The Employer further confirms that its officials shall not favored any prospective Bidder in any form that could afford an undue advantage to that particular Bidder during the tendering stage, and shall further treat all Bidders alike.
- 3.2 All the officials of the Employer shall report to the Chief Executive Officer, Employer, any attempted/completed violation of clauses 3.1 and 3.2.
- 3.3 Following report on violation of clauses 3.1 and 3.2 by official (s), through any source, necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by the Employer and such a person shall be debarred from further dealings related to the Contract process. In such a case while an enquiry is being conducted by the Employer the proceedings under the Contract would not be stalled.

4. Commitments of Bidders

The Bidder commits himself/herself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of his/her bid or during any pre-contract or post-contract stage in order to secure the Contract or in furtherance to secure it and in particular commits himself/herself to the following:

- 4.1 The Bidder shall not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favor, commission, fees, brokerage, any material or immaterial benefits to any official of the Employer, connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the Contract.
- 4.2 The Bidder further undertakes that he has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, commission, fees, brokerage, any material or immaterial benefit to

any official of the Employer or otherwise in procuring the Contract or forbearing to do or having done any act in relation to the obtaining or execution of the Contract or any other contract with the Employer for showing or forbearing to show favour or disfavor to any person in relation to the Contract or any other contract with the Employer.

4.3 The Bidder shall not collude with other parties interested in the contract to preclude the competitive bid price, impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract.

4.4 The Bidder, either while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to or intends to make to officials of the Employer or their family members, agents, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.

4.5 The Bidder shall not enter into any monetary dealings or transaction, directly, with any tender committee member, and if he does so, the Employer shall be entitled forthwith to rescind the Contract and all other contracts with the Bidder.

5. Sanctions for Violation

The breach of any of the aforesaid provisions or providing false information by employers, including manipulation of information by evaluators, shall face administrative charges and penal actions as per the existing relevant rules and laws.

The breach of the Pact or providing false information by the Bidder, or any one employed by him, or acting on his behalf (whether with or without the knowledge of the Bidder), or the commission of any offence by the Bidder, or any one, employed by him, or acting on his behalf, shall be dealt with as per the provisions of the Penal Code of Bhutan, 2004, and the Anti – Corruption Act, 2006.

In the event of a breach, the Employer shall also take all or any one of the following actions, wherever required:

5.1 Immediately call off the pre-contract negotiations without giving any compensation to the Bidder. However, the proceedings with the other Bidder(s) would continue.

5.2 Immediately cancel the contract, if already awarded/signed, without giving any compensation to the Bidder.

5.3 Forfeit the Earnest Money/security deposited with the Employer.

5.4 Recover all sums already paid to the Bidder.

5.5 Encash the advance bank guarantee and performance bond /warranty bond, if furnished by the Bidder, in order to recover the payments, already made by the Employer, along with interest.

5.6 Cancel all or any other Contracts with the Bidder.

5.7 Debar the Bidder from entering into any bid from the Employer as per the Debarment Rule.

6. Examination of Books of Accounts

6.1 In case of any allegation of violation of any provisions of this integrity pact or payment of commission, the Employer/authorized persons or relevant agencies shall be entitled to examine the Books of Accounts of the Bidder and the Bidder shall provide necessary information of the relevant financial documents and shall extend all possible help for the purpose of such examination.

7. Monitoring and Arbitration

7.1 The Employer shall be responsible for monitoring and arbitration of IP as per the procurement rules.

8. Legal Actions

8.1 The actions stipulated in this integrity pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.

9. **Validity**

9.1 The validity of this integrity pact shall cover the tender process and extend until the completion of the contract to the satisfaction of both the employer and the Bidder.

9.2 Should one or any provision of this pact turn out to be invalid, the remainder of this pact remains valid. In this case, the parties shall strive to come to an agreement to their original intentions.

We, hereby declare that we have read and understood the clauses of this agreement and shall abide by it. Further, the information provided in this agreement is true and correct to the best of our knowledge and belief.

The parties here by sign this Integrity Pact at *(name and location of place)* on *(dd/mm/yy)*



EMPLOYER

(Sonam Choden)
Manager, Contracts Section

.....

BIDDER

Witness: P. Yangden

1. (Tshering Yangden)
EE, Contracts Section

Witness:

1.....



4 Covenant of Integrity

[*Name of lead tenderer*] hereby declare and covenant, on our behalf and on that of our joint venture partners, if any, for [*name of the contract*] managed by [*name of promoter*] (the “**Contract**”), that neither we nor anyone, including any of our directors, employees, agents or subcontractors for the Contract, acting on our behalf with due authority or with our knowledge or consent or facilitated by us (together, the “**Associated Entities and Persons**”), nor any of our parent, subsidiary or affiliate companies,

- (i) have engaged in any Prohibited Conduct¹⁸ in connection with the tendering process, nor will we or the Associated Entities and Persons engage in such Prohibited Conduct during the execution of the Contract;
- (ii) are listed or otherwise subject to EU/United Nations sanctions;¹⁹
- (iii) are the subject of a current decision of exclusion by the European Investment Bank;
- (iv) during the 5 (five) years immediately preceding the date of this Covenant, have been convicted in any court or sanctioned²⁰ by any authority (irrespective of whether such conviction or sanction is still in force) of any offence on grounds comparable to Prohibited Conduct in connection with a tendering process or any provision of works, goods or services; or
- (v) are excluded or subject to enforcement actions or otherwise sanctioned²¹ by the EU institutions or bodies, or any multilateral development bank,²² on grounds comparable to Prohibited Conduct, or have been under such exclusion, enforcement action or sanction the effectiveness of which ceased no more than 5 (five) years immediately preceding the date of this Covenant.

We will immediately inform you if any instance described under (i) to (v) above in respect of us or any of the Associated Entities and Persons comes to the attention of any person in our organisation having responsibility for ensuring compliance with this Covenant at any time during the tendering process and, if successful, during the Contract.

We further declare and covenant that, if successful, neither us nor any of the Associated Entities and Persons will act in contravention of EU/United Nations sanctions during the execution of the Contract.

If applicable, we provide below the details of all convictions, exclusions or other sanctions, exclusion/sanctions proceedings, and/or enforcement actions, listed above under paragraphs (i) to (v), in respect of us or any of the Associated Entities and Persons, together with details of the measures taken, or to be taken, to ensure that no Prohibited Conduct is committed in connection with the tendering process or with the execution of the Contract (*if not applicable, please indicate not applicable in the table below*):

Name of entity	Details of Disclosure	Measures taken or to be taken

¹⁸ Corruption, fraud, collusion, coercion, obstruction, theft at EIB Group premises, misuse of EIB Group resources or assets, money laundering or financing of terrorism, all as defined in the EIB Group Anti-Fraud Policy, available at <https://www.eib.org/en/publications/anti-fraud-policy> and as amended from time to time.

¹⁹ EU sanctions or restrictive measures pursuant to Chapter 2 of Title V of the EU Treaty and the objectives of the Common Foreign and Security Policy set out in Article 21 of the EU Treaty and Article 215 of the Treaty on the Functioning of the EU, either autonomously or pursuant to the sanctions decided by the United Nations Security Council on the basis of Article 41 of the United Nations Charter.

²⁰ Including a fine or any other financial penalty, irrespective of whether paid yet or not.

²¹ Including any decision having an effect similar to conditional non-exclusion, temporary suspension, letters of reprimand, or self-restraint.

²² Including the World Bank Group, the African Development Bank, the Asian Development Bank, the European Bank for Reconstruction and Development, the European Investment Bank and the Inter-American Development Bank.

We, or any of the Associated Entities and Persons, have paid, or will pay, the following commissions, gratuities or fees with respect to the tendering process or execution of the Contract *[insert complete name of each recipient, its full address, the reason for which each commission, gratuity or fee was paid, or will be paid, and the amount and currency of each such commission, gratuity or fee]*:

Name of recipient	Address	Reason	Amount

For the duration of the tendering process and, if we are successful, for the duration of the Contract, we will appoint and maintain in office an officer who shall be a person reasonably satisfactory to you and to whom you shall have full and immediate access, having the duty, and the necessary powers, to ensure compliance with this Covenant.

We grant the *[name of promoter]*, the European Investment Bank, and any persons appointed by it and/or any authority or European Union institution or body having competence under European Union law, the right to (i) visit the sites, installations and works, (ii) interview our representatives and any other relevant person and (iii) inspect and copy our books and records in connection with the tendering process or the Contract, and we shall require our Associated Entities and Persons with knowledge of the Contract to respond to questions from the European Investment Bank and to provide to it any information or documents necessary for the investigation of allegations of Prohibited Conduct.

We agree to preserve our books and records and ensure that the books and records of the Associated Entities are preserved generally in accordance with applicable law but in any case for at least 6 (six) years from the date of tender submission and, in the event we are awarded the Contract, at least 6 (six) years following the date of substantial performance of the Contract. We shall ensure that in any agreements with Associated Entities concerning the execution of the Contract provisions to the effect of this paragraph are included.

We acknowledge that any failure to comply with the obligations under this Covenant of Integrity (including any omission or misrepresentation, made knowingly or recklessly, of a past conviction, exclusion, other sanction or enforcement action), or any unauthorised amendment to the Covenant, may be considered a breach of the EIB Group Anti-Fraud Policy and thus result in the rejection of our tender for the Contract and/or cause the initiation of exclusion proceedings by the EIB against us and/or any of the Associated Entities and Persons.

SIGNED by a duly authorised representative with the requisite power and authority to sign on behalf of its company and, in the case of a joint venture, on behalf of each member thereof:

- Date:
- Name of company:
- Name of signatory:
- Position of signatory:
- Signature:

Note: This Covenant must be sent to the Bank together with the contract in the case of an international procurement procedure (as defined in section 3.3.2). In other cases, it must be kept by the promoter and be made available, upon request, to the Bank.



5 Environmental and Social Covenant

We, [*name of lead tenderer*], shall, and shall ensure that all of our joint venture members and subcontractors, if any, for [*name of the contract*] managed by [*name of the Contracting Authority*] (the “Contract”), comply with all labour and health and safety laws and regulations applicable in the country of implementation of the Contract, as well as all national legislation and regulations and any obligation in the relevant international conventions and multilateral agreements on the environment that are applicable, ratified and in force in the country of implementation of the Contract.

Labour standards

We commit to adhere to the principles of the Fundamental Conventions of the International Labour Organization,²³ and, in particular, we explicitly pledge not to employ child labour or forced labour, in line with Standard 8 of the EIB’s Environmental and Social Standards.²⁴

We will require our subcontractors not to employ child labour or forced labour [*and to cascade these requirements throughout their respective supply chains*].²⁵ We shall:

- (i) pay rates of wages and benefits and observe conditions of work (including working time) that are fair and not lower than those established for the trade or industry where the work is carried out and ensure that wages are paid promptly and regularly; and
- (ii) keep complete and accurate records of employment of workers at the site.

[for **works** contracts, insert:

“Workers relations

We shall, in line with Standard 8 of the EIB’s Environmental and Social Standards, [*insert “have in place”/“develop and implement”*] labour management policy and procedures commensurate to the size and workforce that will be applicable to the project (including a grievance mechanism in line with good international practice to address both labour and occupational health and safety considerations). We will regularly monitor and report on implementation of the grievance mechanism to [*name of the Contracting Authority*], including on any corrective measures deemed necessary.”]

Occupational and public health, and safety and security

We shall:

- comply with all applicable occupational health and safety laws in the country of implementation of the Contract;
- (ii) develop and implement the necessary health and safety management plans and systems commensurate with the project risks and impacts, in accordance with [*in the case of **goods, non-consulting services and works**, insert “the measures defined in the Project’s environmental and social management plans or equivalent and/or in the relevant studies and”*] International Labour Organization guidelines on occupational safety and management systems;²⁶
- (iii) provide workers employed in relation to the Contract access to adequate, safe and healthy facilities as well as living quarters understood by the workforce;

23 <https://www.ilo.org/global/standards/introduction-to-international-labour-standards/conventions-and-recommendations/lang--en/index.htm>.

24 <https://www.eib.org/en/publications/eib-environmental-and-social-standards>.

25 Text between brackets to be added in case the Bank’s risk assessment identifies the presence or a significant risk of child labour, forced labour or sexual exploitation or abuse at the primary supplier, or when risks are known or have been reported in lower tiers of the supply chain.

26 http://www.ilo.org/safework/info/standards-and-instruments/WCMS_107727/lang--en/index.htm.

- (v) provide qualified [emergency response/]first aid arrangements at all times;
- (vi) develop and implement a code of conduct and adopt specific measures to prevent and address inter alia gender-based violence, sexual exploitation and human trafficking for all workers, including those of our subcontractors;
- (vii) use security management arrangements that are consistent with international human rights standards and principles²⁷ where such arrangements are required for the delivery of the Contract;
- (viii) establish procedures and systems for investigating, recording and reporting any type of accident and incident (whether they happen on-site or within the Contract influence area) that occurs as a direct consequence of the implementation works or Contract activities;
- (ix) report, investigate, document and analyse any environmental and health and safety incidents, accidents or circumstances and their impact or the effect arising or likely to arise from them, including permanent disabilities, ill health or fatalities occurring in relation to the Contract, and take due actions to address and prevent any future similar event, keep the EIB informed of the ongoing implementation of these measures and, where required by national law, notify the relevant authorities of such occurrences and cooperate with them in this respect.

Protection of the environment

We shall take all reasonable steps to protect the environment, biodiversity and ecosystems on and off the site and to limit the nuisance to people and property resulting from pollution, noise, traffic and other outcomes of the operations. [*in the case of **goods, non-consulting services and works**, insert “To this end, emissions, discharges to the surface, ground and marine environments and effluent from our activities will comply with the limits, specifications or stipulations as defined in [insert name of the relevant document]*]²⁸ and the international and national legislation and regulations applicable in the country of implementation of the Contract.”]

Environmental and social performance

We shall comply with the measures prescribed to us in the Contract and any corrective or preventative actions in the annual environmental and social monitoring report or other environmental and social action plan required by the Contract, if any [*in the case of **works**, insert “and submit [insert the periodicity as indicated in the Contract, if any] environmental and social monitoring reports to [insert name of the Contracting Authority]”*]. [*in the case of **contracts above the thresholds**,*²⁹ *insert “To this end, we shall develop and implement an environmental and social management system commensurate to the size and complexity of the Contract and provide [insert name of the Contracting Authority] with the details of the (i) plans and procedures, (ii) roles and responsibilities and (iii) relevant monitoring and review reports. We further commit to fully cooperate with the staff of the supervision consultant, where applicable.”*]

Our tender price as offered for the Contract includes all costs related to our environmental and social performance obligations under the Contract. We shall:

- (i) reassess, in consultation with [insert name of the Contracting Authority], any changes that may potentially cause negative environmental or social impacts;
- (ii) provide [insert name of the Contracting Authority] with a written notice and in a timely manner of any unanticipated environmental or social risks or impacts that arise during the implementation of the Contract previously not taken into account; and

²⁷ For example, the United Nations Voluntary Principles on Security and Human Rights (<https://www.voluntaryprinciples.org/>), the United Nations Basic Principles on the Use of Force and Firearms by Law Enforcement Officials (<https://www.ohchr.org/en/professionalinterest/pages/useofforceandfirearms.aspx>), the United Nations Code of Conduct for Law Enforcement Officials (<https://www.ohchr.org/EN/ProfessionalInterest/Pages/LawEnforcementOfficials.aspx>) and the International Code of Conduct for Private Security Providers (https://www.icoca.ch/en/the_icoc).

²⁸ For instance an environmental and social impact assessment and respective permits.

²⁹ See section 3.4.1 of the guide for the thresholds.

in consultation with *[insert name of the Contracting Authority]*, adjust environmental and social monitoring and mitigation and/or compensatory and/or remedy measures as necessary to assure compliance with our environmental and social obligations.

*[in the case of goods, non-consulting services and works, insert:
“Environmental and social staff*

We shall facilitate *[insert name of the Contracting Authority]*’s ongoing monitoring and supervision of our compliance with the environmental and social obligations described above.”]

*[in the case of contracts above the thresholds for goods, non-consulting services and works, insert:
“Environmental and social management team*

For this purpose, we shall appoint and maintain in office until the completion of the Contract an environmental and social management team (scaled to the size and complexity of the Contract) that shall be reasonably satisfactory to *[insert name of the Contracting Authority]* and to whom *[insert name of the Contracting Authority]* shall have full and immediate access, having the duty and the necessary powers to ensure compliance with this Environmental and Social Covenant.”]

We accord *[insert name of the Contracting Authority]* and the EIB, and auditors appointed by either of them, the right to inspect all our accounts, records, electronic data and documents related to the environmental and social aspects of the current Contract, as well as all those of our joint venture members and subcontractors.

SIGNED by a duly authorised representative with the requisite power and authority to sign on behalf of its company and, in the case of a joint venture, on behalf of each member thereof:

Date:

Name of company:

Name of signatory:

Position of signatory:

Signature:

Note to the promoter: This Environmental and Social Covenant must be sent to the Bank together with the contract in the case of an international procurement procedure (as defined in section 3.3.2). In other cases, it must be kept by the promoter and made available, upon request, to the Bank.

6 Power of Attorney

(To be executed on non-judicial stamp paper of appropriate value)

KNOW ALL MEN BY THESE PRESENTS THAT WE, *[insert name of the Bidder]* an Employer incorporated under the *[insert relevant statute of the country of incorporation]* and having its registered office at *[insert address]*..... (hereinafter referred to as the “Bidder”) having been authorized by the Board of Directors of the Employer, inter alia, to execute contracts in the name of and for and on behalf of the Employer. I*[insert name of the person giving the power of attorney]*.....presently holding the position of *[insert designation of the person giving the power of attorney]*..... in the Employer do hereby constitute, appoint and authorize Mr..... *[insert name, designation and residential address of the person to whom the power of attorney is being given]*..... as our true and lawful attorney to do in our name and on our behalf all such acts, deeds, things necessary and incidental for submission of our Bid against NIT No., floated by the Employer. I hereby further authorize the above attorney for signing and submission of the Bid and all other documents, information related to the Bid including undertakings, letters, certificates, declarations, clarifications, acceptances, guarantees, any amendments to the Bid and such documents related to the Bid, and providing responses and representing us in all the matters before the Employer in connection with the Bid for the said NIT till the completion of the bidding.

I accordingly hereby nominate, constitute and appoint above named severally, as my lawful attorney to do all or any of the acts specifically mentioned immediately herein above.

WE do hereby agree and undertake to ratify and confirm whatever the said Attorney shall lawfully do or cause to be done under and by virtue of this power of Attorney and the Acts of Attorney to all intents and purposes are done as if I had done the same on behalf of the Employer if these presents had not been made.

IN WITNESS whereof I, have executed these presents this theday ofat

EXECUTANT

Signature:.....

Name:.....

Designation:.....

ACCEPTED:

Signature of Attorney:.....

Name:

Designation:.....

Signature of the Attorney Attested

.....

EXECUTANT

Name.....

Designation.....

Office Seal.....

Note: *The Power of Attorney should be notarised as per applicable legal provisions in the country of the Bidder*



7 Bid Security

Bank Guarantee

(To be submitted by the Contractor)

(stamped in accordance with Stamp Act if any, of the Country of the Issuing Bank)

Bank Guarantee No. Date.....

To

[Employer’s Name and Address]

Dear Sir/ Madam,

In accordance with NIT No., M/s having its Registered/Head Office at..... (here-in-after called the 'Bidder') wish to participate in the said Tender for..... [Name of Package]

As an unconditional and irrevocable bank guarantee against Bid Security for an amount of..... [insert currency and amount in words and figures*] valid up to.....[insert date@]is required to be submitted by the Bidder as a condition precedent for participation in the said Tender which amount is liable to be forfeited on the happening of any of the events mentioned in the Bidding Document.

We, the..... [Name & address of the Bank] having our Head Office at..... (#) guarantee and undertake to pay immediately on demand by the Employer or its authorized representative, the amount of..... [insert currency and amount in words and figures*] without any reservation, protest, demand and recourse. Any such demand made by the Employer shall be conclusive and binding on us irrespective of any dispute or difference raised by the Bidder.

This Guarantee shall be irrevocable and shall remain valid up to..... (@)..... If any further extension of this guarantee is required, the same shall be extended to such required period on receiving instructions from M/s..... [Bidder's Name] on whose behalf this guarantee is issued.

All rights of Employer under this Guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities there under unless a demand or claim is lodged by Employer under this Guarantee against the Bank within thirty (30) days from the above-mentioned expiry date of validity or, from that of the extended date.

In witness where of the Bank, through its authorised officer, has set its hand and stamp on this.....day of.....20.....at.....

WITNESSES: SIGNATURE OF AUTHORIZED SIGNATORY OF THE BANK

1.	1.
.....
(Signature)	(Signature)
.....
(Name)	(Name)
.....
(Official Address)	(Designation)

Authorized vide
Power of Attorney No:

Date.....

2.
.....
(Signature)

2.
.....
(Signature)

.....
(Name)

.....
(Name)

.....
(Official Address)

.....
(Designation)

Authorized vide

Power of Attorney No.....

Date.....

Note:

() Shall be as specified in the BDS.*

(@) The Bid security shall be valid till the date as specified in BDS.

(#) Complete mailing address of the Head Office and issuing branch of the Bank to be given with fax no./ telephone no. of the contact person



8 Deviation Schedule (if applicable)

NIT No.:.....

To

[Employer’s relevant official, name and address]

Sir/Madam,

The following are the deviations and variations from and exceptions to the terms, conditions and specifications of the Bidding Documents for procurement of..... *[insert brief description of works]* These deviations and variations are exhaustive. We are furnishing below the cost of withdrawal for the deviations and variations stated in this Form. We shall withdraw the deviations proposed by us in this Form at the cost of withdrawal indicated herein, failing which our Bid may be rejected and bid security forfeited.

We confirm that except for the deviations and variations stated in this Form to our Bid, the entire work shall be performed as per specifications and conditions of the Bidding Documents without any extra cost to Employer, irrespective of any mention to the contrary anywhere else in the Bid, failing which our Bid may be rejected and Bid security forfeited.

Further, we agree that additional condition, deviation, if any, found in the Bidding Documents other than those stated in this Form, save those pertaining to any rebates offered, shall not be given effect to.

Section / Clause No	Page No.	Statement of Deviations	Cost of withdrawal
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Date: (Signature).....

Place: (Name).....

(Designation).....

(Seal).....

Note: Continuation sheets of like size and format may be used and annexed to this Form if required.



9 Technical Proposal

- 9.1. Proposed Organization Set up**
- 9.2. Proposed Method Statement**
- 9.3. Proposed Mobilization Schedule**
- 9.4. Proposed Construction Schedule**
- 9.5. Proposed Key Personnel**
- 9.6. Proposed Subcontractors/Manufacturers for Major Items of Plant and Services**

9.1 Proposed Organization Set Up



9.2 Proposed Method Statement



9.3 Proposed Mobilization Schedule



9.4 Proposed Construction Schedule:



9.5 Proposed Key Personnel

Bidders must demonstrate that it has the personnel for the key position that meet the following requirements:

Sl.No	Position	Minimum Qualification	Total Requirement (Nos)	Experience in Similar Works (Years)
1	Project Manager	Bachelor's degree in Civil, electrical or Mechanical engineering	1	5
2	Project Engineer (Civil)	Bachelor's degree in Civil Engineering	1	3
3	Project Engineer (Electrical)	Bachelor's degree in Electrical Engineering	1	3
4	Site Supervisor (Civil)	Diploma in Civil Engineering	1	3
5	Site Supervisor (Electrical)	Diploma in Electrical Engineering	1	3

The bidder shall provide details of the proposed personnel and their experience records in the **7.6 and 7.7 Form PER- 1 and 2: Proposed Key Personnel** as below for each candidate.

9.5.1 Form PER – 1: Proposed Key Personnel:

1.	Title of position*
	Name
2.	Title of position*
	Name
3.	Title of position*
	Name
4.	Title of position*
	Name
5.	Title of position*
	Name
...	Title of position*
	Name
...	Title of position*
	Name
...	Title of position*
	Name

*As listed in Section 4 - Evaluation and Qualification Criteria.



9.5.2 Form PER – 2: Resume of Proposed Key Personnel:

Position		
Personnel information	Name	Date of birth
	Professional qualifications	
Present employment	Name of employer	
	Address of employer	
	Telephone	Contact (manager / personnel officer)
	Fax	E-mail
	Job title	Years with present employer

Summarize professional experience in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

Project	Role	Duration	Relevant Experience
<i>[main project details]</i>	<i>[role and responsibilities on the project]</i>	<i>[time in role]</i>	<i>[describe the experience relevant to this position]</i>

Declaration

I, the undersigned [insert “Key Personnel”], certify that to the best of my knowledge and belief, the information contained in this Form PER-2 correctly describes myself, my qualifications and my experience.

I confirm that I am available as certified in the following table and throughout the expected time schedule for this position as provided in the Bid:

Commitment	Details
Commitment to duration of contract:	<i>[insert period (start and end dates) for which this Key Personnel is available to work on this contract]</i>
Time commitment:	<i>[insert period (start and end dates) for which this Key Personnel is available to work on this contract]</i>



I understand that any misrepresentation or omission in this Form may:

1. be taken into consideration during Bid evaluation;
2. result in my disqualification from participating in the Bid;
3. result in my dismissal from the contract.

Name of Key Personnel: [insert name]

Signature: _____

Date: (day month year): _____

Countersignature of authorized representative of the Bidder:

Signature: _____

Date: (day month year): _____

9.6 Proposed Subcontractors/Manufacturers for Major Items of Plant and Services (if applicable)

The following Subcontractors and/or manufacturers are proposed for carrying out the item of the facilities indicated. Bidders are free to propose more than one for each item.

SN	Name of Equipment/System	Proposed manufacturer by the Bidder	Country of Origin
1	Solar Photo-Voltaic Module		
2	Grid-tied solar PV Inverter		
3	Module Mounting structure		
4	String Combiner Box		
5	Inverter Transformers		
6	Auxiliary Transformer		
7	LT Switchgear		
8	HT Switchgear		
9	DC Cables		
10	AC Cables		
11	33 kV switchyard		
12	SCADA – remote monitoring and control system		

9.6.1 Authorization by Design Firm, Subcontractor or Manufacturer

*[The Bidder shall require the proposed **Design Firm**, Subcontractor or Manufacturer for PV modules, Inverters and Module mounting structure to fill in this Form in accordance with the instructions indicated. This letter of authorization should be signed by a person with the proper authority to sign documents that are binding on the Design Firm, Subcontractor or Manufacturer. The Bidder shall include it in its bid.]*

Date: *[insert date (as day, month and year) of Bid Submission]*

Ref. No.: *[insert number of bidding process]*

To: *[insert complete name of Employer]*

WHEREAS

We *[insert complete name of Design Firm, Subcontractor or Manufacturer or Manufacturer's authorized agent]*, who are official **Design Firm, Subcontractor or Manufacturers** or agent authorized by the manufacturer of *[insert type Design Works / Goods / Manufactured]*, having factories at *[insert full address of Design Firm, Subcontractor or Manufacturer's factories]*, do hereby authorize *[insert complete name of Bidder]* to submit a bid the purpose of which is to provide the following design services or goods, manufactured by us *[insert name and or brief description of the design services or goods]*, and to subsequently negotiate and sign the Contract.

We hereby extend our full guarantee and warranty in accordance with the relevant clauses of Section 7 General Conditions of Contract and Section 8 Particular Conditions of Contract, with respect to the goods offered by the above firm.

Signed: *[insert signature(s) of authorized representative(s) of the Design Firm, Subcontractor or Manufacturer]*

Name: *[insert complete name(s) of authorized representative(s) of the Design Firm, Subcontractor or Manufacturer]*

Title: *[insert title]*

Duly authorized to sign this Authorization on behalf of: *[insert complete name of Bidder]*

Dated on _____ day of _____, _____ *[insert date of signing]*

9.6.2 Functional Guarantee of the proposed facilities

Form FUNC-1

The bidder shall quote the functional guarantee stated in the Employer's Requirement for the proposed plant and equipment.

Sl.	Functional Guarantee <i>[as required by the Employer]</i>	Functional Guarantee Value offered by the Bidder
1	Minimum DC Capacity (MWp)	
2	Minimum AC Capacity (MW)	
3	Annual Energy generation (MWhr)	
4	Minimum PR (%)	

9.6.3 Month-wise Target Generation for first yea

Form FUNC-2

Month	Solar Insolation (kWhr/m2)	Target Generation (MWhr/MWp) Quoted by Bidder#	Final Month-wise Target Generation for Bidder (MWhr)
		A	B = A x
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			
Total			

Note: Solar Insolation values and month wise target generation shall be filled by the bidder as per TS clause....

The total of Column B shall align with the functional guarantee “Minimum Annual Generation”

The employer has right to question the rationality of the month-wise quoted generation



10 Bidder’s Qualification

To establish his qualifications to perform the contract in accordance with Section 4 - Evaluation and Qualification Criteria the Bidder shall, provide the information requested in the corresponding Information Sheets included hereinafter.

10.1 Form ELI - 1: Bidder’s Information Sheet

Bidder’s Information	
Bidder’s legal name	
In case of JV, legal name of each partner	
Bidder’s country of constitution	
Bidder’s year of constitution	
Bidder’s legal address in country of constitution	
Bidder’s authorized representative (name, address, telephone numbers, fax numbers, e-mail address)	
<p>Attached are copies of the following original documents.</p> <p><input type="checkbox"/> 1. In case of single entity, articles of incorporation or constitution of the legal entity named above, in accordance with ITB 3.1 and 3.2.</p> <p><input type="checkbox"/> 2. Authorization to represent the firm or JV named in above, in accordance with ITB 25.2.</p> <p><input type="checkbox"/> 3. In case of JV, letter of intent to form JV or JV agreement, in accordance with ITB 3.1.</p> <p><input type="checkbox"/> 4. In case of a government-owned entity, any additional documents not covered under 1 above required to comply with ITB 3.5.</p>	



10.2 Form ELI - 2: JV/Subcontractor Information Sheet

Each member of a JV / Subcontractor must fill in this form

JV / Specialist Subcontractor Information	
Bidder's legal name	
JV Partner's legal name	
JV Partner's country of constitution	
JV Partner's year of constitution	
JV Partner's legal address in country of constitution	
JV Partner's authorized representative information (name, address, telephone numbers, fax numbers, e-mail address)	
<p>Attached are copies of the following original documents.</p> <p><input type="checkbox"/> 1. Articles of incorporation or constitution of the legal entity named above, in accordance with ITB 3.1 and 3.2.</p> <p><input type="checkbox"/> 2. Authorization to represent the firm named above, in accordance with ITB 25.2.</p> <p><input type="checkbox"/> 3. In the case of government-owned entity, documents establishing legal and financial autonomy and compliance with commercial law, in accordance with ITB 3.5</p>	

10.3 Form LIT - Pending Litigation

Each Bidder or member of a JV must fill in this form

Pending Litigation in accordance with Evaluation and Qualification Criteria			
<input type="checkbox"/> No pending litigation <input type="checkbox"/> Pending litigation			
Year of dispute	Amount in dispute (currency)	Contract Identification	Total Contract Amount (BTN/INR)
		Contract Identification: _____ Name of Employer: _____ Address of Employer: _____ Matter in dispute: _____ Party who initiated the dispute: _____ Status of dispute: _____	



10.4 Form FIN - 1: Financial Situation and Performance

Each Bidder or member of a JV must fill in this form

	Financial Data for Previous 3 Years [BTN/INR]				
	Year 1:	Year 2:	Year 3:	Year 4:	Year 5:
Information from Balance Sheet					
Information from Income Statement					
<input type="checkbox"/> Attached are copies of financial statements (balance sheets including all related notes, and income statements) for the last three years, as indicated above, complying with the following conditions. <ul style="list-style-type: none"> ● All such documents reflect the financial situation of the Bidder or partner to a JV, and not sister or parent companies. ● Historic financial statements must be audited by a certified accountant. ● Historic financial statements must be complete, including all notes to the financial statements. ● Historic financial statements must correspond to accounting periods already completed and audited (no statements for partial periods shall be requested or accepted). 					



10.5 Form FIN - 2: Average Annual Turnover

Each Bidder or member of a JV must fill in this form

Annual Turnover Data for the Last 3 Years			
Year	Amount Currency	Exchange Rate	BTN/INR Equivalent
Average Annual Turnover			

The information supplied should be the Annual Turnover of the Bidder or each member of a JV in terms of the amounts billed to clients for each year for contracts in progress or completed.



10.6 Form FIN - 3: Financial Resources

Specify proposed sources of financing, such as liquid assets, unencumbered real assets, lines of credit, and other financial means, net of current commitments, available to meet the total construction cash flow demands of the subject contract or contracts as indicated in Section 4 - Evaluation and Qualification Criteria

Financial Resources			
SN	Source of financing	Amount	
		BTN	INR
1			
2			
3			
4			

The bidder shall submit the documentary evidence issued by Banks for the Line of Credit

10.7 Form FIN- 4: Current Contract Commitments (if applicable)

Bidders and each partner to a JV should provide information on their current commitments on all contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued.

SN	Name of Contract	Employer's Contact Address, Tel, Fax	Value of Outstanding Work (BTN/INR/USD)	Estimated Completion Date	Average Monthly Invoicing Over Last Six Months (BTN/INR/USD)
1					
2					
3					
4					
5					
6					



DRUK GREEN POWER CORPORATION LIMITED



**BIDDING DOCUMENTS
FOR
DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF 120 MW_p
JAMJEE SOLAR PV PROJECT**

VOLUME II

GENERAL CONDITIONS OF CONTRACTS AND FORMS

JANUARY 2025



120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instruction to Bidders (ITB)
- Section 3 - Bid Data Sheet (BDS)
- Section 4 - Evaluation and Qualification Criteria (EQC)
- Section 5 - Information to Bidders (IFB)
- Section 6 - Bidding Forms (BDF)

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



120 MW_p JAMJEE SOLAR PV PROJECT

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- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



SECTION 7: GENERAL CONDITIONS OF CONTRACT

The General Conditions governing this Contract shall be the “Conditions of Contract for EPC/Turnkeys Projects”, [Silver Book] First Edition 1999, published by the Federation Internationale des Ingenieurs - Conseils (FIDIC).

These Conditions are designated as the General Conditions of Contract (GCC).

The General Conditions of Contract are linked with the Particular Conditions of the Contract (PCC) by corresponding numbering of the Clauses, so that the General and Particular Conditions together comprise the conditions governing the rights and obligations of the parties. In case of any inconsistency between the conditions contained in the General Conditions and those in Particular Conditions, the conditions contained in the Particular Conditions shall prevail over those of General Conditions.

A copy of the General Conditions of Contract is not included with the Bid Documents for the Works and reference shall therefore be made to the published FIDIC document. The Contractor shall provide 10 (ten) sets of the original FIDIC General Conditions of Contract together with the contract documents in the required format as directed by the Employer.

The copies of the FIDIC General Conditions of Contract (Silver Book, first edition 1999) can be obtained from <https://fidic.org/books/epcturnkey-contract-1st-ed-1999-silver-book> and from the address mentioned below:

FIDIC Secretariat,
P.O. Box 86,
1000 Lausanne 12,
Switzerland
Facsimile: 41 21 653 5432
Telephone: 41 21 653 5003

120 MW_p JAMJEE SOLAR PV PROJECT

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- Section 7 - General Conditions of Contract (GCC)
- **Section 8 - Particular Conditions of Contract (PCC)**
- Section 9 - Contract Forms (COF)

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



SECTION 8: PARTICULAR CONDITIONS OF CONTRACT

This section comprises Particular Conditions of Contract. The General Conditions are linked with the Particular Conditions of Contract by corresponding numbering of clauses, so that General and Particular Conditions together comprise the conditions governing the rights and obligations of the parties. In case of an inconsistency between the conditions contained in General Conditions and those in Particular Conditions, the conditions contained in Particular Conditions shall prevail over those of General Conditions.

PART A: CONTRACT DATA

Conditions	Sub-Clause	Data
Employer's name and Address	1.1.2.2 & 1.3	Druk Green Power Corporation Limited (DGPC) Post Box No: 1351 Thori Lam, Motithang Thimphu 11001, Bhutan For bidding purpose, address shall be: Attention: Manager Address: Contracts Section Projects & Contract Department Druk Green Power Corporation Limited Thimphu , Bhutan Tel No: +975-2-339875 Electronic mail: s.choden272@ drukgreen.bt
Employer's representative and Address	1.1.2.4 & 1.3	Will be nominated and intimated by the Employer after signing of Contract Agreement.
Time for Completion	1.1.3.3 & 8.2	540 days from the date of signing of Contract Agreement
Defects Notification Period (DNP)	1.1.3.7	The Defects Notification Period shall be as follows: <ol style="list-style-type: none"> 1. The mechanical structures, electrical works and overall workmanship of the Solar Power Plant must be warranted for a minimum of 2 (two) years from the date of Commissioning of Plant. 2. PV modules shall be warranted for a period of 10 (ten) years from the date of Commissioning of Plant 3. Power Conditioning Unit (PCU)/Inverter shall be warranted for the period of minimum 5 (five) years from the date of Commissioning of Plant. 4. Switchgear and transformers shall be warranted for the period of minimum 5 (five) years from the date of Commissioning of Plant.

Conditions	Sub-Clause	Data
Communications	1.3	Duly scanned copy of the notices or communications by authorized representative by electronic address (e-mail) uniquely assigned to him/her
Governing Law	1.4	Laws of the Kingdom of Bhutan
Jurisdiction	1.4	Courts of Bhutan
Ruling language	1.4	English
Language for communication	1.4	English
Time for access to the site	2.1	After the Contract Signing
Performance Security	4.2	<p>The amount of Performance Security shall be 10% (Ten percent) of the Contract Price stated in the Contract Agreement.</p> <p>The performance security shall be submitted to the Employer within 30 (Thirty) days from the issue of the Notification of Award, in the form of an unconditional and irrevocable bank guarantee issued by a bank/financial institution in Bhutan or by a foreign bank enforceable by any bank in Bhutan.</p> <p>The form of Performance Security shall be as specified in Section 10 – Contract Forms.</p>
Commencement Date	8.1	The Commencement Date of the work shall be from the date of Signing of Contract Agreement.
Delay damages for the works	8.7 & 14.15(b)	The applicable rate of Delay Damages shall be 0.1% of the final contract value, payable (per day) in such currencies.
Maximum amount of delay damages	8.7	The maximum amount of delay damages shall be 10% (Ten percent) of the Contract Price stated in the Contract Agreement.
Adjustments for Changes in Cost	13.8	Not Applicable
Advance Payment	14.2	10% (Ten percent) of Contract Price. (Details are specified in Part B- PCC)
Percentage of Retention	14.3 (c)	10% (Ten percent) of the total amount of each interim payment.
Limit of Retention Money	14.3 (c)	10% (Ten percent) of the Contract Price.

Conditions	Sub-Clause	Data
Currency/currencies of payment	14.15	Bhutanese Ngultrum (BTN)/Indian Rupees (INR)/ USD
Maximum Total Liability of the Contractor to the Employer	17.6	Contract Price
Minimum amount of third-party insurance	18.3	110 % of the Contract Price.

PART B: PARTICULAR CONDITIONS OF CONTRACT

1. General Provisions	
1.1.1 The Contract	<i>At the end of Sub-Clause 1.1.1.4, insert:</i> The word “Tender” is synonymous with “Bid”
1.1.4 Money and Payments	<i>At the end of Sub-Clause 1.1.4.5, insert:</i> The local currency of Bhutan is “Ngultrum”. Acronym for Ngultrum is “Nu” or “BTN”
1.1.5 Works and Goods	<i>At the end of Sub-Clause 1.1.5.1, insert:</i> The word “Construction Equipment” or “Equipment” are synonymous with “Contractor’s Equipment”
1.1.6 Other Definitions	<i>At the end of Sub-Clause 1.1.6.8, insert:</i> 1.1.6.9 “Integrity Pact” means the Pact signed between the Employer and Contractor committing the persons/officials of both the parties, not to exercise any corrupt influence on any aspect of the Tender/Contract. 1.1.6.10 “RGoB” means the Royal Government of Bhutan. 1.1.6.11 “DGPC” means Druk Green Power Corporation Limited hereinafter referred to as the Employer. 1.1.6.12 “Facilities” means the Plant to be supplied and installed, as well as all the Installation Services to be carried out by the Contractor under the Contract. 1.1.6.13 “Installation Services” means all those services ancillary to the supply of the Plant for the Facilities, to be provided by the Contractor under the Contract, such as transportation and provision of marine or other similar insurance, inspection, expediting, site preparation works (including the provision and use of Contractor’s Equipment and the supply of all construction materials required), installation, testing, pre-commissioning, commissioning, operations, maintenance, the provision of operations and maintenance manuals, training, etc. as the case may require. 1.1.6.14 For the purpose of fraud and corruption, the following definitions shall apply: a) “Corrupt practice” is the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party; b) “Fraudulent practice” is any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation; c) “Collusive practice” is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party; d) “Coercive practice” is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party; e) “Obstructive practice” is

	<p>i) deliberately destroying, falsifying, altering or concealing of evidence material during an investigation or making false statements to investigators in order to materially impede any investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and/or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or</p> <p>ii) acts intended materially to impede the exercise of the inspection rights of the Employer or any organization or person appointed by the Employer.</p>
1.5 Priority of Documents	<p><i>Delete the documents listed from (a) to (e) in Sub-Clause 1.5 and substitute:</i></p> <p>i) the Contract Agreement; ii) the Notification of Award; iii) Letter of Tender; iv) the Negotiation Minutes, if any; v) the Addenda to Bidding Documents, if any; vi) these Particular Conditions of Contract; vii) the General Conditions of Contract; viii) the Technical Specifications and Employer's Requirement; ix) the Tender Drawings; x) the Price Schedules; xi) the information to Bidders; xii) Contractor's Bid; and xiii) all other documents forming part of the Contract.</p>
1.12 Confidential Details	<p><i>At the end of Sub-Clause 1.12, insert:</i></p> <p>The Contractor shall not disclose any details of drawings furnished to him and information on Works, to any person(s), without the prior approval of the Engineer in writing. No photograph of the Works or any part thereof or equipment deployed thereon shall be taken or permitted by the Contractor to be taken by any of his employees or any employees of his Sub-Contractors without the prior approval of the Engineer in writing and no such photographs shall be published or otherwise circulated without the approval of the Engineer in writing.</p>
3. The Employer's Administration	
3.1 The Employer's Representative	<p>The Employer's Representative and address:</p> <p>Project Manager DGPC Thimphu, Bhutan</p> <p>Email: p.dorji785@drukgreen.bt</p>
4. The Contractor	
4.2 Performance Security	<p><i>Add in the third paragraph after the words "prior to expiry date" the words "for reasons for which the Contractor is responsible under the Contract"</i></p> <p><i>Insert the following as new penultimate paragraph:</i></p>

	<p>The Performance Security shall be valid up to 30 (Thirty) days beyond operational acceptance of the Solar PV plant.</p>
4.4 Subcontractors	<p><i>Delete Sub-Clause 4.4 and substitute:</i></p> <p>The Contractor shall not subcontract the whole of the Works.</p> <p>The Contractor shall not subcontract any portion of the Works without the approval of the Employer. Appointment of any Sub-Contractor and any subcontracting shall not relieve in any way or manner whatsoever the Contractor from any of its obligations, liabilities and responsibilities under the Contract. The Contractor shall be responsible for the acts and defaults of any Subcontractor, his agents and employees, as if they were the acts and defaults of the Contractor. Save and except as set forth hereinunder, the Contractor shall give the Engineer not less than 30 (thirty) days' notice of:</p> <p>(a) the intended appointment of the Subcontractor, with detailed particulars which shall include his relevant experience and other details considered necessary by the Employer,</p> <p>(b) the intended commencement of the Subcontractor's work</p> <p>The Contractor shall, at the time of subcontracting, propose specialized subcontractor/suppliers of specialized nature with full particulars for approval of the Engineer. Such approval by the Engineer for specialized subcontractor/suppliers shall not relieve the Contractor from any of its obligations, duties or responsibilities under the Contract.</p>
4.11 Sufficiency of the Contract Price	<p><i>At the end of Sub-Clause 4.11, add:</i></p> <p>Items of the works described in the Price Schedule/Bill of Quantities for which no rate and price has been entered in the Contract shall be considered (upto the quantities provided in Price Schedule) as included in other rates and prices in the Contract and will not be paid separately by the Employer. However, the rate for the quantities beyond the Price Schedule shall be paid at the rates worked out as per Sub-Clause 13.3 (Variation Procedure).</p>
4.16 Transport of Goods	<p><i>Add the following at the end of Sub-Clause 4.16</i></p> <p>If it is found necessary for the Contractor to move one or more oversized or overweight loads of goods over the roads, highways, bridges on which oversized and overweight items/goods are not normally allowed to be moved, the Contractor shall obtain prior permission from the concerned authorities.</p> <p>The existing road to the project site shall be used by the Contractor on "As-is-where-is-basis" for transport of goods.</p>
4.18 Protection of the Environment	<p><i>Add the following at the end of Sub-Clause 4.18:</i></p> <p>The Contractor shall comply with all applicable national and local environmental laws and regulations.</p> <p>The Contractor shall (a) establish an operational system for managing environmental impacts, (b) carry out all the monitoring and mitigation measures set forth in the Environmental Clearance from Department of Environment & Climate Change, MoENR, the Environment Impact Assessment (EIA), the Environmental</p>

	<p>Management Plan (EMP), and (c) allocate the budget required to ensure that such measures are carried out. The Contractor shall submit to the Employer, quarterly reports on the carrying out of such measures. Cost on account of the above shall be deemed to have been included by the Contractor in the Price for the relevant item of work.</p> <p>On completion of the project construction, the Contractor shall dismantle and remove from site all their sheds and surplus materials, demolish all concrete blocks into pieces and carry out re-vegetation to restore all the area occupied by them to an original pre-constructions stage to the satisfaction of the Employer. The Contractor shall then obtain the No Objection Clearance from the Department of Environment & Climate Change and only on approval of Contractor's restoration works by the Department of Environment & Climate Change, the final payment shall be released.</p>
<p>4.19 Electricity, Water and Gas</p>	<p><i>At the end of Sub-Clause 4.19, add:</i></p> <p>“The construction power for the Project shall be arranged and provided to the Contractor by the Employer at identified locations/construction sites. Distribution arrangement is to be made by the Contractor at its own cost.</p> <p>Contractor shall, along with its Bid, submit the construction power requirements for the site after carrying out the site visit and assessment. Arrangements for further distribution of power to the Contractor's Site from the point of supply shall be made by the Contractor at his own cost. The electrical installation plan shall be submitted for approval of the Engineer.</p> <p>Before the release of grid connection, the Contractor shall make all applicable advances/ fees/deposits at prevalent rates as per rules of RGoB to the Employer/ Bhutan Power Corporation (BPC), as the case may be.</p> <p>The domestic electricity tariff rate and miscellaneous charges are available on the website https://www.bpc.bt/electricity-tariff/</p> <p>Contractor shall also make necessary back-up arrangements of construction power by installing a sufficient number of diesel generating (DG) sets & lines and operate these sets for his requirements of power at no cost to the Employer. Permission for installation of DG sets shall be taken by the Contractor at his own cost as per applicable rules from concerned authorities in Bhutan.</p> <p>The Contractor shall comply with all the conditions of power supply rules and regulations prevalent in Bhutan.</p> <p>The Contractor shall pay the applicable energy charges to the BPC from time to time. Any variation in power tariff as may be applicable during execution of Works, shall be borne by the Contractor and shall not be paid by the Employer separately under clause 13.7 of GCC (Adjustment for Changes in Legislation).</p> <p>No claims shall be entertained by the Employer on account of non-availability or inadequate quality of construction power.</p> <p>The Contractor shall ensure effective enforcement of the provisions under the Electricity Act of Bhutan 2001 and other relevant acts.</p>

<p>4.21 Progress Reports</p>	<p>At the end of Sub-Clause 4.21, insert:</p> <ul style="list-style-type: none"> i. list of all insurance claims lodged with the insurance companies showing details viz. nature and amount of claim lodged, status of settlement, reasons for delay in settlement of claim(s) (if any), amount settled and paid by insurance company, amount of settled claim paid or to be paid to the Employer (where the Employer has interest in the claim) etc. j. the Contractor/Engineer is required to maintain Hindrance Register(s) for reporting hindrances if any, while executing the work in respect of design, engineering, procurement, supply and site work related issues. The Contractor shall record hindrances in the Hindrance Register(s) and the Contractor shall bring each hindrance to the notice of the Engineer not later than 7 days of the happening of the hindrance failing which the same shall not be considered or taken into account for any purpose whatsoever. The Contractor shall submit in the monthly progress report up to date hindrance record in the format as mentioned in the hindrance register. k. in case of any hindrance, if the Contractor’s resources are idle, the Contractor shall get the same verified from the Engineer on regular basis. Up to date duly verified idling of manpower and equipment shall be submitted by the Contractor in the format acceptable to the Engineer and other supplementary formats as approved by the Engineer. The Contractor shall submit the above details along with reasons for such idling. l. date-wise receipt of the major construction equipment and machinery and other key construction materials, and their stock positions and consumption during the month. m. list of all the claims submitted by the Contractor. n. list of the construction equipment brought at site during the period with purchase invoices. <p>Refer Scope of Work & Technical Specification for detailed list of progress reports to be furnished.</p>
	<p>Insert new Sub-Clauses 4.25 as under:</p>
<p>4.25 Land</p>	<p>The Employer shall make available land free of cost, for construction of Contractor’s construction facilities like temporary houses for staff and labour, field offices, workshop, stores, fabrication shops, etc. required for execution of the Contract. Levelling and dressing of the land for contractor’s construction facilities mentioned above as per plan approved by the engineer shall be done by the contractor at his own cost. Additional land, if required by the Contractor for construction facilities shall be arranged by him at his own cost. The Contractor shall obtain the environment clearances from concerned authorities as per provisions of the Environment Assessment Act, 2000 and its Regulations 2002 for setting up his construction facilities at his own cost. The Employer shall extend all necessary assistance to the Contractor to obtain required environment clearances.</p> <p>The Final payment Certificate shall not be issued, until and unless the Contractor has handed over the possession of land allotted to him in good condition after obtaining clearances from the relevant agencies of RGoB and free from all encumbrances.</p>

	<p>The use or occupation of the land by the Contractor shall not confer on him any right of tenancy or possession thereof. The Contractor shall vacate the land immediately upon one month's notice of the Engineer.</p>
<p>5. Design</p>	
<p>5.1 General Design Obligations</p>	<p><i>Delete Sub-Clause 5.1 and substitute by the following paragraphs:</i></p> <p>“The Contractor shall carry out, and be responsible for, the design of the Works consistent with Best Industry Practices. Design shall be prepared by qualified, experienced and competent designers who are engineers or other professionals who comply with the criteria (if any) stated in the Technical Specifications.</p> <p>The Contractor shall at his own expense carry out all investigations, model studies, design and preparation of specifications, construction, working, shop drawings and all other things as necessary for the performance of the Works. The design and drawings shall be accompanied by detailed calculations, including design philosophy, references (if any) and standards, and shall be submitted to the Engineer, in accordance with Sub-Clause 5.2 [<i>Contractor’s Documents</i>] and the Technical Specifications, for approval, before commencement of the Works.</p> <p>The Contractor shall warrant that his designers have the experience, capability and competence necessary for the design. The Contractor shall undertake that the designers shall be available to attend discussions with the Engineer at all reasonable times (on or off the Site), until the issue of the Performance Certificate.</p> <p>Upon receiving notice under Sub-Clause 8.1 [<i>Commencement of Works</i>], the Contractor shall scrutinise the Technical Specifications (including design criteria and calculations, (if any) and the items of reference mentioned in Sub-Clause 4.7 [<i>Setting Out</i>]. Within the period stated in the Contract Data, calculated from the Commencement Date, the Contractor shall give notice to the Engineer of any error, fault or other defect found in the Technical Specifications or these items of reference.</p> <p>After receiving this notice, the Engineer shall determine whether Clause 13 [<i>Variations and Adjustments</i>] shall be applied, and shall give notice to the Contractor accordingly. If and to the extent that (taking account of cost and time) an experienced contractor exercising due care would have discovered the error, fault or other defect when examining the Site and the Technical Specifications before submitting the Tender, the Time for Completion shall not be extended and the Contract Price shall not be adjusted.”</p>
<p>5.2 Contractor’s Document</p>	<p><i>Amend paragraph 4 (a) with:</i></p> <p>Execution of such part of works once reviewed and accepted by the Employer, the contractor shall commence the work immediately.</p>

<p>5.4 Technical Standards and Regulations</p>	<p><i>In the first paragraph delete "the Country's technical standards" and replace with:</i></p> <p>“those technical standards referred to in the Technical Specifications or the International Standards approved by the Employer/the Engineer where no technical standards are referred to in the Technical Specifications,”</p> <p><i>The following shall be added at the end of first paragraph</i></p> <p>The work shall comply with the latest issue of internationally acceptable standards. The Contractor shall identify the standards he intends to use and shall submit copies of latest editions of relevant standards to the Employer. By definition, such international acceptable standards comprise organizations such as the International Electrotechnical Commission (IEC), Institution of Electrical and Electronics Engineers (IEEE), BIS (Bureau of Indian Standards), ASTM (American Society for Testing and Materials), ISO (International Organization for Standardization), DIN (German Code), BS (British Standard), AWS (American Welding Society), SS (Swedish Standards), EN (European Standard), American National Standards Institute (ANSI), National Fire Protection Association (NFPA), etc.</p> <p>Should the Contractor request alternatives to the above standards, other relevant standards may not be used without the Employer's approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Employer for review and approval.</p> <p>The latest editions of the standards and codes, including amendments thereof, shall be used by the Contractor.</p> <p>An English translation shall be submitted if the standards and codes proposed by the Contractor are in a language other than English.</p>
<p>5.6 As-Built Records</p>	<p><i>Insert the following at the end of this Sub-Clause 5.6:</i></p> <p>“The Contractor shall supply the Employer with two (2) hard copies and two (2) electronic copies (out of which one electronic copy shall be in source format/software in editable form) of each As-Built Records”</p>
<p>6 Staff and Labour</p>	
<p>6.1 Engagement of Staff and Labour</p>	<p>Add the following to the Sub-Clause 6.1</p> <p>The Employer may impose restrictions on the Contractors to deploy expatriate staff and labour as per the Laws of the Country. The Contractor shall arrange permits for the labour/staff for their entry into Bhutan, at his own cost.</p> <p>The Contractor shall not employ any person who has not completed 18 years of age.</p> <p><u>Forced Labour in Solar photovoltaic (PV) supply chain</u> Regarding the issue of forced labour in the Solar PV supply chain the Contractor will:</p> <p>(a) develop (or update the existing) and implement an adequate human rights or environmental and social policy or equivalent (e.g. within existing code of ethics or similar instrument), addressing the</p>

	<p>Contractor's commitment on forced labour and further environmental and social risks stemming from suppliers and supply chain.</p> <p>(b) ensure that references on compliance with human rights, forced labour, occupational health and safety standards and guidance are included in the policy (incl. references to ILO fundamental instruments).</p> <p>(c) For each Scheme, make reasonable efforts to assess and address the labour risks associated with of the PV panels of the project, including throughout the supply chain, and aim to ensure that its suppliers apply the requirements of the Environmental and Social Standards. For this purpose, Contractor to submit a corresponding risk assessment and management approach, requirement for the successful bidder to deliver at design stage a satisfactory supply chain mapping down to polysilicon level. In case any party or production site raises forced labour concerns, the contractor will be required to present further mitigation measures (e.g. labour audits). Should this be unsatisfactory, the contractor would be asked to change the supplier.</p>
6.3 Persons in Service of Others	<p><i>At the end of Sub-Clause 6.3, insert:</i></p> <p>and personnel of other Contractors working at the Project.</p>
6.5 Working Hours	<p><i>Delete Sub-Clause 6.5 and substitute:</i></p> <p>Subject to any provision contained in the Contract, the Contractor shall have the option to work continuously and on locally recognized holidays or days of rest, without any additional cost to the Employer.</p>
	<p><i>Insert new Sub-Clauses 6.12 and 6.13 as under:</i></p>
6.12 Foreign Staff and Labour	<p>The Contractor may import any personnel who are necessary for the execution of the Works as permitted by the laws, rules and regulations of the Kingdom of Bhutan. The Contractor must ensure that these personnel are provided with the required residence visas and work permits at his own cost. However, the Employer shall assist in obtaining the permits/visas.</p> <p>The Contractor shall be responsible for their return to their domicile. In the event of death in the Country of any of these personnel or members of their families, the Contractor shall similarly be responsible for making the appropriate arrangements for their return or for last rites, including any claims related to death.</p>
6.13 Engagement of Staff of the Employer	<p>The contractor and its subcontractor shall mandatorily and practically engage Employer's relevant staff for installation, testing and commissioning of the Solar PV Project. The Employer's personnel shall act only and in compliance with the instructions and orders given by the Contractor or its Subcontractors. The contractor shall not be liable for any loss and damage resulting from any non-compliance with the Contractors or its Subcontractors instructions and orders or any actions not covered by such instructions.</p>
7 Plant, Materials and Workmanship	
7.1 Manner of Execution	<p><i>Insert the following paragraphs at the end of this Sub-Clause:</i></p> <p>"All Materials and Plant that are intended to be or will be incorporated in the Permanent Works shall be new, unless specified otherwise, and</p>

	<p>shall conform to the Technical Specifications. Such Materials and Plant shall not have been used in Temporary Works or for any other prior purpose whatsoever.</p> <p>The Contractor shall warrant that all Materials used by them in carrying out the Works shall be free from defects, of the best quality available and fit for their intended purpose, taking into account local climatic conditions at the Site.”</p>
7.5 Rejection	<p><i>Amend the first sentence after the word “Contract” as follows:</i></p> <p>“Prior to taking over, the Employer may reject the defective items of the Plant, Materials, design or workmanship by giving notice to the Contractor in writing, with reasons. The Contractor shall then promptly make good the defect and ensure that the rejected item complies with the Contract.”</p>
8 Commencement, Delays and Suspension	
8.1 Commencement of Works	<p><i>Delete the first paragraph and the subparagraphs (a) and (b) and substitute:</i></p> <p>The Commencement Date shall be from the date of issue of the Notification of Award by the Employer.</p>
8.2 Time for Completion	<p><i>Add the following at the end of this Sub-Clause</i></p> <p>The Whole of the Works shall be completed within 540 days from the date of signing of Contract Agreement.</p>
8.3 Programme	<p><i>Replace 1st line of Sub-Clause 8.3 with the following:</i></p> <p>“The Contractor shall submit a detailed work schedule to the Engineer within 28 days from the date of signing of Contract Agreement made in the form of critical path method (CPM), the Program Evaluation and Review Technique (PERT) network, using a latest project management software Primavera Professional 6 and showing the sequence in which, it proposes to design, manufacture, transport, assemble, install and pre-commission the facilities. The schedule shall identify the critical path activities and shall have capabilities of predicting completion date of the Works with periodic progress updates during the execution of contract.”</p> <p><i>At the end of the Sub Clause-8.3, add the following:</i></p> <p>“Submittal of detailed programme is a condition precedent to the release of first Interim Payment Certificate.”</p>

<p>8.4 Extension of Time for Completion</p>	<p><i>At the end of sub-clause 8.4(c), add Sub-Clause 8.4 (d) as:</i></p> <p>“road conditions in the Country, which prevents the Contractor from timely transport of Plants, Equipment and Materials to the Site”</p> <p><i>At the end of Sub-Clause 8.4, insert:</i></p> <p>The Contractor shall submit application for extension of time with supporting documents within 28 days at the end of each quarter failing which it would be construed that there was no hindrance (even though the hindrance has been brought to the notice of Engineer as per Sub-Clause 4.21) during the quarter requiring extension of Time for Completion and Contractor shall forfeit his claim for extension of Time for Completion.</p> <p>In case, hindrances resulting from interface activities with other agencies working at the project are brought to the notice of the Engineer, the Employer shall determine the duration of such interface activities as per the schedule of interface activities formulated jointly by Contractors and Employer during the course of execution.</p>
<p>8.7 Delay Damages</p>	<p><i>At the end of first paragraph of Sub-Clause 8.7, insert:</i></p> <p>The applicable rate of Delay Damages shall be 0.1% of the final contract value, payable (per day) in such currencies.</p> <p>The maximum amount of delay damages shall be ten percent (10%) of the Contract Price stated in the Contract Agreement. Once the "Maximum" is reached, the Employer may consider termination of the Contract, pursuant to Sub-Clause 15.2 [<i>Termination by Employer</i>].</p> <p>However, the payment of delayed damages shall not in any way relieve the Contractor from any of its obligations to complete the Facilities or from any other obligations and liabilities of the Contractor under the Contract.</p> <p>No bonus will be given for earlier Completion of the Facilities or part thereof.</p>
<p>9 Test on Completion</p>	
<p>9.1 Contractor's Obligations</p>	<p><i>Delete first paragraph of Sub-Clause 9.1 and replace with:</i></p> <p>“The Contractor shall carry out the Tests on Completion in accordance with this Clause, Sub-Clause 4.9 [<i>Quality Assurance</i>] and Sub-Clause 7.4 [<i>Testing</i>], after providing the required documents in accordance with the Technical Specification, including those referred to in Sub-Clause 5.6 [<i>As-Built Documents</i>] and Sub-Clause 5.7 [<i>Operation and Maintenance Manuals</i>].”</p> <p><i>At the beginning of the third paragraph delete “Unless otherwise stated in the Particular Conditions” and replace with:</i></p> <p>“The Tests on Completion shall be carried out in the sequence and in accordance with the requirements set out in the Technical Specifications. Where no sequence is set out in the Technical Specifications, the Test on Completion shall be carried out in the following sequence”:</p> <p><i>Insert the following paragraph between fourth and fifth paragraph:</i></p> <p>“The duration of the Trial Operation Period shall be 30 days”.</p>

	<p><i>Insert the following additional Sub-Clauses after 9.1. (c)</i></p> <p>(d) if required by the Engineer, Tests shall be carried out in the presence of any other person nominated by the Engineer; and</p> <p>(e) shall be coordinated with, or carried out in conjunction with the Contractor(s) of other packages."</p> <p><i>Insert the following at the end of this Sub-Clauses:</i></p> <p>a) Performance Guarantee Test</p> <p>Operation Acceptance Test shall be carried out as indicated in Employer's Requirement.</p> <p>b) Performance Test Report</p> <p>On completion of the Performance Test the Contractor shall submit a report ("Performance Test Report") setting forth the results thereof calculated in accordance with agreed Test code, procedures, criteria as set forth in the Technical Specification. The Employer shall confirm:</p> <p>a) the Performance Test was, performed in accordance with the procedures and protocol set forth in this Contract</p> <p>b) the Performance Guarantees are satisfied; and</p> <p>c) The Performance Test Report is correct and complete</p>
	<p><i>Insert new Sub clause 9.5 as follows</i></p>
<p>9.5 Performance Guarantees</p>	<p>If the Contractor fails to comply with the Performance Guarantees set out in the Employer's Requirements, the Contractor shall be subject to Sub-Clause 2.5 [<i>Employer's Claims</i>] pay Performance Damages to the Employer for this default. The Liquidated Damages for Failure to meet these Performance Guarantees shall be calculated as provide under Employer's Requirement.</p> <p>The Performance Damages shall be over and above any other damages that the Contractor is liable for in accordance with the Contract. These damages shall not relieve the Contractor from his obligation to complete the Works, or from any other duties, obligations or responsibilities which he may have under the Contract.</p> <p>The Contractor acknowledges that the amount of Performance Damages is an agreed and genuine pre-estimate of the loss and damage which the Employer may incur in the event of the Contractor's failure to meet the Guaranteed Performance Levels as set out in Technical Specification. The Contractor shall not raise by way of defense or claim, in relation to the Employer's right to deduct Performance Damages, any argument that the amount of performance is a penalty or otherwise unenforceable.</p> <p>If the Contractor's obligation to pay Performance Damages is found for any reason to be void, invalid or otherwise inoperative (other than through the Employer asserting that the performance damages should not be applied) so as to disentitle the Employer from claiming Performance Damages, the Employer shall be entitled to a claim against the Contractor for such damages at Law, resulting from the Contractor's breach of its obligations under the Guaranteed Performance Levels as set out in Technical Specification, provided</p>

	that the Contractor's liability for such Performance Damages shall not exceed the sum stated in Technical Specification.
10 Employer's Taking Over	
10.3 Interference with tests on Completion	<i>Delete in penultimate paragraph sub-paragraph (b)</i>
	Add new Sub-Clause 10.4 with the heading "Storage"
10.4 Storage	If the Contractor is prevented from supplying any part of the Plant, the Contractor shall be entitled to store such part of the Plant in any warehouse reasonably selected by the Contractor. If such prevention is attributable to the Employer, the cost for storage shall be borne by the Employer.
11 Defects Liability	
11.3 Extension of Defects Notification Period	<p><i>Add the following as new third paragraph:</i></p> <p>The Defects Notification Period shall be extended for that part.</p> <ol style="list-style-type: none"> 1. The mechanical structures, electrical works and overall workmanship of the Solar Power Plant must be warranted for a minimum of 2 (two) years from the date of Commissioning of Plant. 2. PV modules shall be warranted for a period of 10 (ten) years from the date of Commissioning of Plant 3. Power Conditioning Unit (PCU)/Inverter shall be warranted for the period of minimum 5 (five) years from the date of Commissioning of Plant. 4. Switchgear and transformers shall be warranted for the period of minimum 5 (five) years from the date of Commissioning of Plant. <p>If only part of the Work is affected, the Defects Notification Period shall be extended for that part.</p>
12 Tests after Completion	
12.1 Procedure for Tests after Completion	<p><i>Delete Sub-paragraph (a) and replace with:</i></p> <p>(a) The Contractor shall be responsible for the provision of all electricity, fuel and materials for the tests.</p> <p><i>Delete Sub-clause (b) and replace with:</i></p> <p>"(b) The Contractor shall provide adequately qualified personnel, sufficient supply of all testing equipment and other materials as required, and shall perform all the works and services of whatsoever nature required to properly carry out the Tests and Commissioning."</p>
13 Variations and Adjustments	

<p>13.1 Right to Vary</p>	<p><i>Replace second sentence of this sub clause as under:</i></p> <p>“Other than as stated under Sub-clause 11.4 [<i>Failure to Remedy Defects</i>] and in the event of a variation omitting part of the Works, the Contractor shall have no claim against the Employer (including claim for profit) except in relation to those Costs already incurred by the Contractor in anticipation of carrying out that part of the Works”</p> <p><i>Insert the following paragraph at the end of this Sub-clause</i></p> <p>“However, any works identified by the Employer as being necessary to amend the Contractor’s Design to make the Works fit for the purposes intended, as described in the Technical Specifications, shall not be considered a Variation.”</p>
<p>13.2 Value Engineering</p>	<p><i>Add the following after Sub-Clause 13.2</i></p> <p>“Similarly, Employer may, at any time, ask the Contractor to study and evaluate a proposal suggested by the Employer, which (in the Employer’s opinion) will, if adopted, (i) accelerate completion, (ii) reduce the cost to the Employer for executing, maintaining or operating the Works, (iii) improve the efficiency or value to the Employer of the completed Works, or (iv) otherwise be of benefit to the Employer without resulting in reductions in quality, anticipated life or operational efficiencies.</p> <p>The contractor shall study and evaluate at its own cost and respond to the proposal from the Employer in writing within 28 (Twenty-Eight) days regarding the suitability of the proposal. If such a proposal as suggested by the Employer and is agreed by the Contractor, the proposal shall be prepared at the cost of the Contractor and shall include the items listed in Sub-Clause 13.3 [<i>Variation Procedure</i>].”</p> <p>Both parties (Employer and Contractor) shall also agree for adjustment in the Contract Price, if any, resulting from the change.</p> <p>The overall responsibilities, safety and suitability of the Works shall be of the contractor, if such proposal as requested by the Employer is agreed by the Contractor.”</p>
<p>13.5 Provisional Sums</p>	<p><i>Sub-Clause 13.5 is not applicable</i></p>
<p>13.6 Daywork</p>	<p><i>Sub-Clause 13.6 is not applicable</i></p>
<p>13.7 Adjustments for Changes in Laws</p>	<p><i>At the end of Sub-Clause 13.7, add:</i></p> <p>“Notwithstanding the foregoing, such additional or reduced cost shall not be separately paid or credited if the same shall already have taken into account in the indexing or any inputs to the Price Adjustment Formulae in accordance with the provisions of Sub Clauses 13.8.</p> <p>Provided always that any variations resulting from the changes in legislation, in respect of wages of the labour and staff of the Contractor, shall be deemed to be included in the Adjustment for Changes in Cost (price adjustment formula) included in sub-clause 13.8 hereof and shall not be paid separately by the Employer under this sub-clause 13.8.</p>

	Any variation in power tariff as may be applicable during execution of works shall be borne by the Contractor and shall not be paid by the Employer separately under this sub-clause 13.8.”
14 Contract Price and payment	
14.1 The Contract Price	<p><i>After subparagraph (b) in Sub-Clause 14.1, add the following:</i></p> <p>c) If direct payment of taxes, duties etc. which are the liability of and are to be borne by the Contractor as above, is not permitted by applicable laws or regulations and/or if any deduction or withholding in respect of such taxes, duties etc. shall be required to be made, the Employer shall pay the sums due to the Contractor after making such deductions or withholding as may be required as per the applicable laws/regulations and the Contractor shall receive only the net sum payable after such deduction/withholdings. The sums so deducted/withheld shall be deposited by the Employer with the relevant authorities on behalf of the Contractor, as per applicable laws/regulations. Immediately thereafter, the Employer shall inform the Contractor of the detailed calculations of such deductions and shall provide the Contractor with the corresponding receipts from the tax authorities.</p> <p>d) The Contractor and all his personnel shall be responsible for the timely and prompt filing of all returns, documents, estimates, accounts, information and details complete and accurate as may be required under the applicable laws/regulations to the appropriate authorities. In case the Contractor or any of its personnel do not comply with the above requirements, which results in any penalty, interest or other liability, the same shall be borne and be the liability of the Contractor.</p> <p>e) Each party hereby agrees to indemnify and keep indemnified and saved harmless at all the times the other party against any claims, action, proceedings, loss, cost, expenses or damage suffered or incurred by it by reason of the party which has failed to pay taxes, duties, levies etc. which it is obliged to pay pursuant to the provisions of this clause and/or applicable laws and/or arising out of its failure to comply with its obligations under such provisions and/or applicable laws.</p> <p>f) The Contractor shall abide by the Sales Tax, Custom & Excise Act 2000, Income Tax Act 2001, Tax Act, 2012 & 2014 etc. of Kingdom of Bhutan and amendments thereof.</p> <p>g) The Contractor shall also adhere to the stipulated provisions/procedures of the IGST Act, 2017 and subsequent amendments thereof.</p>
14.2 Advance Payment	<p><i>Delete Sub-Clause 14.2, except the last paragraph and substitute:</i></p> <p>The Employer shall make 10% of the Contract Price as an advance payment, as an interest free loan when the Contractor submits an unconditional and irrevocable bank guarantee issued by a</p>

	<p>bank/financial institution in Bhutan or by a foreign bank enforceable by any bank in Bhutan.</p> <p>In accordance with this Sub-Clause, BG shall be valid up to 18 months initially and if required further extended till successful completion of works.</p>
<p>14.4 Schedule of Payments</p>	<p><i>Delete last paragraph of Sub-Clause and add the following:</i></p> <p>The Employer shall pay the Contractor in the following manner and time, on the basis of the Price Breakdown given in section of Price Schedules. Payment will be made in the currencies quoted by the bidder unless otherwise agreed between the parties. Applications for payment in respect of part deliveries may be made on a pro-rata basis as work proceeds in accordance with the Terms and Procedures as defined herein.</p> <p>(A) Terms of Payment and Procedure</p> <p>Schedule No.1 - Supply and Delivery of Plant and Mandatory Spares quoted on DAP Value:</p> <p>In respect of supplies of Plant and Equipment and Mandatory Spares Parts the following payments shall be made:</p> <ul style="list-style-type: none"> ● Ten percent (10%) of the total quoted DAP value as an advance payment against the receipt of advance payment security for the equivalent amount made in favour of advance payment. ● Seventy percent (70%) of total quoted DAP value (including Mandatory Spares) on receipt of equipment at site or pro rata basis and after physical verification and certification by the Engineer/Employer including all admissible taxes and duties. ● Ten percent (10%) of total quoted DAP value upon issuance of the Completion Certificate. ● Ten percent (10%) of total quoted DAP value upon issuance of the Operational Acceptance Certificate. <p>Schedule No.2 - Design Services</p> <p>In respect of design services for both the foreign currency and the local currency portions, the following payments shall be made:</p> <ul style="list-style-type: none"> ● Ten percent (10%) of the total design services amount as an advance payment against receipt of invoice and an irrevocable advance payment security for the equivalent amount made out in favour of the Employer. ● Ninety percent (90%) of the total or pro rata design services amount upon acceptance of design by the Engineer within 45 days after receipt of invoice. <p>Schedule No. 3 - Installation and Other Services</p> <p>In respect of installation and other services for both the foreign currency and the local currency portions, the following payments shall be made:</p>

- **Eighty Percent (80%)** of the total installation and other services of contract price shall be paid on pro-rata basis against progressive erection of the identified equipment on certification by the Engineer/Employer for the quantum of work completed.
- **Ten percent (10%)** of the total installation and other services value or pro rata basis upon issuance of the Completion Certificate.
- **Ten percent (10%)** of total installation and other services value or pro rata basis upon issuance of the Operational Acceptance Certificate.

Notes:

- a) The release of first progressive payment for Installation services shall also be subject to submission of documentary evidence by the Contractor towards having taken the insurance policy(ies) in terms of relevant provisions of GCC/PCC-Part B: Special Provisions and acceptance of the same by the Employer.

Taxes & Duties

- i) The Contractor shall bear and pay all taxes, duties, levies and charges assessed on the Contractor, its Subcontractors or their employees by all municipal, state or national government authorities (in and outside of the country) in connection with the Facilities.
- ii) Notwithstanding the above clause, the Employer shall bear and pay all taxes and customs duties as well as other local taxes, imposed by the law of the country where the site is located on the Plant specified in Price Schedule 1 and that are to be incorporated into the Facilities.
- iii) If any tax exemptions, reductions, allowances or privileges may be available to the Contractor in the country where the Site is located, the Employer shall use its best endeavours to enable the Contractor to benefit from any such tax savings to the maximum allowable extent.

(B): Payment Procedure**(i) Goods supplied from Bhutan and India**

The following documents shall be furnished for goods supplied from Bhutan and India:

- (1) Within twenty-four (24) hours of shipment, the Contractor shall notify the Employer and the insurance company by electronically the full details of the dispatch/shipment (for bought out items) including contact number, description of goods, quantity, wagon/vessel number, railway receipt number and date & consignee/the bill of lading number, port of loading, date of shipment etc. The contractor shall mail the following documents to the Employer with the copy to the insurance company:
 - (a) Four (4) copies of Contractor's invoice showing goods description, quantity, unit price and total amount. To facilitate declaration for settlement of Integrated Goods and Service

	<p>Tax (IGST) at the Border Land Customs Point prior to entry of Consignments into Bhutan, the tax invoice shall align to GST Tax Invoice along with the Letter of Undertaking (LUT) containing the following details:</p> <ol style="list-style-type: none"> i) Bank Name and Account Number, ii) Authorized Dealer (AD) Code, iii) Goods and Services Tax Identification Number (GSTIN), iv) Indian Financial System Code (IFSC), v) Import and Export Code (IEC), etc. <ol style="list-style-type: none"> (b) Original and four (4) copies of the negotiable, clean on-board bill of lading marked freight prepaid and four (4) copies of non-negotiable bill of lading for Bought out Items only. (c) Railway receipt/acknowledgement of receipt of goods from the supplier. (d) Four (4) copies of the packing list identifying the contents of each package. (e) Insurance certificate. (f) Manufacturers/suppliers guarantee certificates. (g) Inspection certificate, issued by the nominated inspection agency/Employer and the supplier's factory inspection report. (h) Certificate of approval of Test Reports issued by the Employer and Material Dispatch Clearance Certificates issued by Employer. (i) Certificate of confirmation of make of equipment as agreed between Employer and the Contractor and (j) Four (4) copies of certificate of origin. (k) Any other certificates as mutually agreed between Employer and the Contractor <p>(ii) Goods supplied from country other than Bhutan and India</p> <ol style="list-style-type: none"> (1) Within twenty-four (24) hours of shipment, the Contractor shall notify the Employer and the insurance company by electronically the full details of the dispatch/shipment (for bought out items) including contact number, description of goods, quantity, wagon/vessel number, railway receipt number and date & consignee/the bill of lading number, port of loading, date of shipment etc. The contractor shall mail the following documents to the Employer with the copy to the insurance company: <ol style="list-style-type: none"> (a) Four (4) copies of Contractor's invoice showing goods description, quantity, unit price and total amount. (b) Original and four (4) copies of the negotiable, clean on-board bill of lading marked freight prepaid and four (4) copies of non-negotiable bill of lading. (c) Four (4) copies of the packing list identifying contents of each package.
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	<p>(d) Insurance certificate.</p> <p>(e) Manufacturers/suppliers guarantee certificates.</p> <p>(f) Inspection certificate, issued by the nominated inspection agency/Employer and the supplier’s factory inspection report.</p> <p>(g) Certificate of approval of Test Reports issued by the Employer and Material Dispatch Clearance Certificates issued by Employer.</p> <p>(h) Certificate of confirmation of make of equipment as agreed between Employer and the Contractor and</p> <p>(i) Four (4) copies of certificate of origin.</p> <p>(j) Any other certificates as mutually agreed between Employer and the Contractor</p> <p>The above documents shall be received by the Employer and their representative at site before arrival of the goods (except where the goods have been delivered directly to the consignee with all documents) and if not received the Contractor will be responsible for any consequent expenses.</p> <p>(1) Subject to the fulfilment of requirements mentioned under Terms of Payment and Procedure, all payments shall be arranged as per the following procedure:</p> <p>(a) The initial 10% advance payment in currency other than Employer Country’s currency shall be arranged through remittance to the Contractor’ bank. The Contractor shall provide details of his bank account along with routing details to the Employer.</p> <p>(b) Any payments in the Employer country’s currency shall be arranged through Account Payee Cheque. The Contractor shall open a bank account in Bhutan in which the Contractor desires to receive Employer Country’s currency payments. Contractor shall arrange all permits/permissions, etc. to open such an account and shall submit a copy of the same to the Employer.</p> <p>(c) Other payments to be made against the submission of proof of dispatch documents.</p>
<p>14.6 Interim Payments</p>	<p><i>Replace first sentence of the first paragraph as:</i></p> <p>“The first Interim Payment will be paid to the Contractor after the Employer receives the Performance Security, proof of payment of insurance premium as per the requirement of the Contract and the detailed programme in accordance with Sub-clause 8.3 of PCC.”</p>
<p>14.8 Delayed Payment</p>	<p><i>The clause is replaced with the following:</i></p> <p>Omissions on the part of the Engineer to pay the amount due upon measurement or otherwise shall neither vitiate nor make the Contract void. Further, no claim for interest or damages will be entertained or payable by the Employer upon i) any Bank Guarantee or ii) payments in arrears or iii) any balance which may become due on final</p>

	settlement/reconciliation of the account or iv) payments withheld by the Employer owing to any dispute or difference between the parties.
14.9 Payment of Retention Money	<p><i>Add the following new paragraph at the beginning of this Sub-Clause:</i></p> <p>The percentage for Retention Money is 10% (Ten percent) of the total amount of each Interim Payment Certificate.</p> <p>The limit of Retention Money is 10% (Ten percent) of the Contract Price as stipulated in the Contract Agreement.</p> <p>The Contractor may substitute the Retention Money with a bank guarantee in the form, and from a source, acceptable to the Employer valid till 30 days beyond Defects Notification Period.</p> <p>A Bank Guarantee issued by a bank/financial institution in Bhutan or by a foreign bank enforceable by any bank in Bhutan shall be acceptable.</p>
15 Termination by Employer	
15.2 Termination by Employer	<p><i>Add sub-paragraph (g) after sub-paragraph (f) in Sub-Clause 15.2:</i></p> <p>(g) If in the judgement of the Employer, the Contractor has engaged in fraudulent or corrupt or collusive or coercive practices, in competing for or in executing the Contract or defaults commitments under Integrity Pact.</p>
16 Suspension and Termination by Contractor	
16.4 Payment on Termination	<i>Delete Sub-Clause 16.4 (c)</i>
17 Risk and Responsibility	
17.5 Intellectual and Industrial Property Rights	<p><i>Add the following as new last paragraph of the Sub-Clause:</i></p> <p>The intellectual property rights in software included in the Works shall remain the property of the Contractor.</p> <p>The Employer shall have the right to use the software in connection with the related Plant for the purpose of operating and maintaining the Works. Software shall not, without the Contractor's written consent or authorized by applicable mandatory copyright law, be used, modified, reengineered or reproduced for other purposes, except for making a copy for backup or archival purposes in accordance with the related software documentation.</p> <p>The Bidders participating in a tender procedure or a contract shall not violate or have violated any intellectual property rights.</p>
18 Insurance	
18.1 General Requirements for Insurance	<p><i>Delete the first paragraph of Sub-Clause 18.1 and substitute:</i></p> <p>"In this Clause, "Insuring Party", means the Contractor for each type of insurance, at his own expense, responsible for effecting and maintaining the insurance specified in the relevant Sub-Clause."</p>

<p>18.2 Insurance for Works and Contractor's Equipment</p>	<p><i>Delete first sentence of Sub-Clause 18.2 and substitute:</i></p> <p>“The insuring party shall insure the Works and Contractor's Documents, together with Materials and Plant for incorporation in the Works (All Risk Insurance Policy, Cargo Insurance during Transport and other policies as may be required) shall be insured for not less than 110% of Contract Price in the joint name with Employer as principal insurer and the Contractor. The policies are to be reviewed periodically to maintain them at not less than full replacement cost. In addition to above, policy(ies) shall cover the cost of demolition, removal of debris, professional fees, escalation. Insurance policy shall have an express provision to the effect that the insurer shall necessarily obtain a prior ‘no objection’ certificate from the Engineer before payment of insurance claim under the insurance policy.”</p> <p><i>Delete last paragraph of Sub-Clause 18.2.</i></p> <p><i>At the end of Sub-Clause 18.2, insert:</i></p> <p>If the Contractor receives instructions from the Employer to insure against any risk listed in sub-paragraph (a) to (e) listed in Sub-Clause 17.3 [Employer's Risks], such insurance if available shall be affected, at the cost of the Employer, with an Insurance Company acceptable to the Employer and shall be in the joint names of the Contractor and the Employer.</p> <p>The insurance policies required under the Contract shall be availed by the Contractor from the insurance companies registered under laws of Bhutan.</p>
<p>19 Force Majeure</p>	
<p>19.1 Definition of Force Majeure</p>	<p><i>Add the following as new sub-paragraph (vi):</i></p> <p>(vi) landslide, inclement weather condition (inclement weather condition shall either be in winter or monsoon season which results in stoppage of work and such stoppage of work is duly recorded in hindrance record maintained by the Employer for each contract, provided where for the period of monsoon, the completion time has already been excluded), epidemics, quarantine.</p>
<p>19.4 Consequences of Force Majeure</p>	<p><i>Delete sub-para (b) of Sub-clause 19.4 and substitute:</i></p> <p>“(b) if the Exceptional Event is of the kind described in sub-paragraphs (a) to (e) of Sub-clause 19.1 [Exceptional Events] and, in the case of sub-paragraphs (i) to (vi) of that Sub-clause, occurs in the Country, payment of 75% of such Cost”.</p>
<p>20 Claims, Disputes and Arbitration</p>	
<p>20 Dispute Settlement</p>	<p><i>Delete all Sub-Clauses under Clause 20 and substitute:</i></p> <p>The Parties will endeavour to resolve by mutual negotiation any dispute, differences, controversy or claims arising out of or in relation to this Contract, including the scope, validity, existence and the interpretation hereof, the activities performed hereunder, or for the breach hereof, arising between them in connection with this Contract. If the dispute or difference cannot be resolved in this manner within sixty (60) days of the notice by either Party of a dispute having arisen,</p>

the Parties shall arrange a meeting between appropriate senior executives designated by each Party, who shall have an additional thirty (30) days to resolve the dispute or difference.

Subject to the above, any and all disputes, differences, controversies or Claims arising out of or in relation to this Contract, including the scope, validity, existence and the interpretation hereof, the activities performed hereunder, or for the breach hereof, which cannot be satisfactorily resolved by mutual negotiation within the said period of ninety (90) days, shall be finally settled by arbitration as per clause (i) and (ii) below:

- i) Any dispute arising out of or in connection with this Contract, including any question regarding its existence, validity or termination, shall be referred to and finally resolved by arbitration administered by the International Chambers of Commerce (“ICC”) in accordance with the arbitration rules of the International Chambers of Commerce (“ICC Rules”) for the time being in force, which rules are deemed to be incorporated by reference to this Article.
- ii) The seat and venue of arbitration shall be Bhutan. The tribunal shall consist of three arbitrators. The language of the arbitration shall be English.

Notwithstanding the existence of any dispute or difference referred to adjudication or arbitration as per GCC 20 of the SCC, the Parties shall continue to perform their respective obligations under this Agreement.

120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instruction to Bidders (ITB)
- Section 3 - Bid Data Sheet (BDS)
- Section 4 - Evaluation and Qualification Criteria (EQC)
- Section 5 - Information to Bidders (IFB)
- Section 6 - Bidding Forms (BDF)

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- **Section 9 - Contract Forms (COF)**

VOLUME III – Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



SECTION 9 - CONTRACT FORMS

TABLE OF FORMS

- 1. NOTIFICATION OF AWARD..... 1
- 2. CONTRACT AGREEMENT..... 2
- 3. FORM OF BANK GUARANTEE FOR PERFORMANCE SECURITY 4
- 4. FORM OF BANK GUARANTEE FOR ADVANCE PAYMENT SECURITY 6
- 5. FORM OF COMPLETION CERTIFICATE..... 8
- 6. FORM OF OPERATIONAL ACCEPTANCE CERTIFICATE 9

1. NOTIFICATION OF AWARD

[Employer's letterhead]

Letter of Acceptance

[date]

To: [Name and address of the Contractor]

This is to notify you that your Bid consisting of the Technical and Price Bids dated [date] for execution of the *[name of the Contract and identification number, as given in the Contract Data]* for the Contract Price in the aggregate of *[amounts in numbers and words] [name of currency]*, as corrected and modified in accordance with the Instructions to Bidders is hereby accepted by our Agency.

This letter is being issued to you in duplicate. Please retain one copy for your record and return the other copy to us after recording "Accepted Unconditionally" under the signature of the authorized signatory.

Please report to this office to sign the formal Contract Agreement within (fifteen) days of the date of this Notification of Award.

Prior to the signing of Contract Agreement, you are requested to furnish the Contract Performance Security in the form of a Bank Guarantee/demand draft/cash warrant, using for that purpose one of the Performance Security Forms included in Section 10 - Contract Forms of the Bidding Document. The Performance Security may be submitted in advance or at the time of signing of the Contract Agreement. The bank guarantee/demand draft/cash warrant shall be in favour of *[insert appropriate name and designation]*.

Kindly acknowledge the receipt of this letter.

Authorized Signature

Name and Title of Signatory

Name of Agency

2. CONTRACT AGREEMENT

THIS AGREEMENT made on _____ day of _____ between the _____, registered and existing under the Laws of _____ and having its registered Office at _____ (hereinafter referred to as the “Employer” which expression shall unless repugnant to the context or meaning thereof include its successors and assigns), of the one part, and M/s _____ registered under the _____ Act and having its principal/registered office at _____ (herein after called the “Contractor” which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns), of the other part:

WHEREAS the Employer desires that the Contractor executes the Works known as _____ and DGPC has accepted a Bid submitted by the Contractor for the execution and completion of these Works and the remedying of any defects therein, for Accepted Contract Amount of _____ (Currency _____).

The Employer and the Contractor agree as follows:

1. In this Agreement, words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract Documents.
 - i. the Contract Agreement;
 - ii. the Notification of Award;
 - iii. Letter of Tender;
 - iv. the Negotiation Minutes, if any;
 - v. the Addenda to Bidding Documents, if any;
 - vi. these Particular Conditions of Contract;
 - vii. the General Conditions of Contract;
 - viii. the Technical Specifications and Employer’s Requirement;
 - ix. the Tender Drawings;
 - x. the Price Schedules;
 - xi. the information to Bidders;
 - xii. Contractor’s Bid; and
 - xiii. all other documents forming part of the Contract.
3. In the event of any discrepancy or inconsistency within the Contract documents, then the documents shall prevail in the order listed above.
4. Completion of Works shall be attained within.....
5. In consideration of the payments to be made by the Employer to the Contractor as specified in this Agreement, the Contractor hereby covenants with the Employer to execute and complete the Works and, remedy the defects therein in conformity in all respects with the provisions of the Contract.
6. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of the Kingdom of Bhutan on the day, month and year specified above.

For and on behalf of the Employer For and on behalf of Contractor

Signature-----
(Name & Designation) -----
Place:

Signature-----
(Name & Designation) -----
Place:

Witnessed by:

Witnessed by:

1. Name & Address

1. Name & Address

2. Name & Address

2. Name & Address



3. FORM OF BANK GUARANTEE FOR PERFORMANCE SECURITY

(To be submitted by the Contractor)

(stamped in accordance with Stamp Act if any, of the Country of the Issuing bank)

Bank Guarantee No.....

Date.....

To, [Employer’s Name & Address]

Dear Sirs,

In consideration of the [Employer’s Name] (hereinafter referred to as the “Employer” which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators and assigns) having awarded to M/s [Contractor’s Name] with its Registered/Head Office at (hereinafter referred to as the ‘Contractor’, which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns), a Contract by issue of Employer’s Notification of Award No..... dated..... and the same having been acknowledged by the Contractor, for -----[Contract sum in figures and words] for [Name of the work] and the Contractor having agreed to provide a Contract Performance Guarantee for the faithful performance of the entire Contract equivalent to ten percent (10%) of the said value of the aforesaid work under the Contract to the Employer.

We [Name & Address of the Bank issuing the Guarantee] having its Head Office at..... (hereinafter referred to as the “Bank”, which expression shall, unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns) do hereby guarantee irrevocably and undertake to pay the Employer, on demand any and all monies payable by the Contractor to the extent of [insert amount of the Bank Guarantee and its currency] as aforesaid at any time up to (@) [days/month/year] without any demur, reservation, contest, recourse or protest and/or without any reference to the Contractor. Any such demand made by the Employer on the Bank shall be conclusive and binding notwithstanding any difference between the Employer and the Contractor or any dispute pending before any Court, Tribunal, Arbitrator or any other authority. The Bank undertakes not to revoke this guarantee during its currency without previous consent of the Employer and further agrees that the guarantees herein contained shall continue to be enforceable till the Employer discharges this guarantee or till (+) [days/month/year] whichever is earlier.

The Employer shall have the fullest liberty, without affecting in any way the liability of the Bank under this guarantee, from time to time to extend the time for performance of the Contract by the Contractor. The Employer shall have the fullest liberty, without affecting this guarantee, to postpone from time to time the exercise of any powers vested in them or of any right which they might have against the Contractor, and to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants, contained or implied, in the Contract between the Employer and the Contractor or any other course or remedy or security available to the Employer. The Bank shall not be released of its obligations under these presents by any exercise by the Employer of its liberty with reference to the matters aforesaid or any of them or by reason of any other act or forbearance or other acts of omission or commission on the part of the Employer or any other indulgence shown by the Employer or by any other matter or thing whatsoever which under the law would, but for this provision have the effect of relieving the Bank.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee the Employer may have in relation to the Contractor’s liabilities.

Notwithstanding anything contained herein above, our liability under this guarantee is restricted to and shall remain in force up to and including and shall be extended from time to time for such period, as may be desired by M/s on whose behalf this guarantee has been given.



All rights of the Employer under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities after the above-mentioned date or from the extended date.

Dated thisday of20.....at.....

WITNESS

Official of the Bank

(Signature).....

(Signature).....

(Name)

(Name).....

(Official Address)

(Designation with Bank Stamp)/with staff Authority no.

Complete Address of the Bank with Tele-Fax

Notes:

(@) This date will be thirty (30) days beyond the Defect Notification Period as specified in the Contract



4. FORM OF BANK GUARANTEE FOR ADVANCE PAYMENT SECURITY

(To be stamped in accordance with Stamp Act if any, of the Country of the Issuing Bank)

Bank Guarantee No.....

Date.....

To,

[Employer's Name & Address]

Dear Sir,

In consideration of the [Employer's Name] (hereinafter referred to as the “Employer”, which expression shall, unless repugnant to the context or meaning thereof, include its successors, administrators and assigns) having awarded to M/s[Contractor's Name] with its Registered/Head Office at (hereinafter referred to as the “Contractor”, which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns), a Contract by issue of Employer’s Notification of Award No..... dated..... and the same having been acknowledged by the Contractor, resulting into a Contract bearing No.....dated..... valued at..... for [Name of Contract] [hereinafter called the “Contract”] and the Employer having agreed to make an advance payment to the Contractor for performance of the above Contract amounting.....[in words and figures] as an Advance against bank Guarantee to be furnished by the Contractor.

We.....[Name & Address of the Bank issuing the Guarantee] having its Head Office at.....(hereinafter referred to as the “Bank”, which expression shall, unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns) do hereby guarantee irrevocably and undertake to pay the Employer, on demand any or, all monies payable by the Contractor to the extent of[advance amount]..... as aforesaid at any time up to(@) [days/month/year] without any demur, reservation, contest, recourse or protest and/or without any reference to the Contractor. Any such demand made by the Employer on the Bank shall be conclusive and binding notwithstanding any difference between the Employer and the Contractor or any dispute pending before any Court, Tribunal, Arbitrator or any other authority. We agree that the guarantee herein contained shall be irrevocable and shall continue to be enforceable till the Employer discharges this guarantee. This guarantee may be progressively reduced by amount repaid by the Contractor.

The Employer shall have the fullest liberty, without affecting in any way the liability of the Bank under this guarantee, from time to time to vary the advance or extend the time for performance of the Contract by the Contractor. The Employer shall have the fullest liberty, without affecting this guarantee, to postpone from time to time the exercise of any powers vested in them or of any right which they might have against the Contractor, and to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants, contained or implied, in the Contract between the Employer and the Contractor or any other course or remedy or security available to the Employer. The Bank shall not be released of its obligations under these presents by any exercise by the Employer of its liberty with reference to the matters aforesaid or any of them or by reason of any other act or forbearance or other acts of omission or commission on the part of the Employer or any other indulgence shown by the Employer or by any other matter or thing whatsoever which under the law would, but for this provision have the effect of relieving the Bank.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee the Employer may have in relation to the Contractor’s liabilities.

Notwithstanding anything contained herein above, our liability under this guarantee is limited to [insert currency and amount of the advance]and it shall remain in force up to and including and shall be extended from time to time for such period, as may be desired by M/s on whose behalf this guarantee has been given.

All rights of the Employer under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities after the above-mentioned date or from the extended date.

Dated thisday of20.....at.....

WITNESS

Official of the Bank

(Signature).....

(Signature).....

(Name)

(Name).....

(Official Address)

(Designation with Bank Stamp)/with staff Authority no.

Complete Address of the Bank with Tele-Fax

Notes:

((@) This date will be thirty (30) days beyond the date of Completion of the Work



5. FORM OF COMPLETION CERTIFICATE*[On the Letter head of the Employer]*

Date:

Contract No.:

[Name of Contract]

To: [*insert name and address of Contractor*]

Dear Sir,

Pursuant to **GCC Clause 8.2** (Time for Completion) of the General Conditions of the Contract entered into between yourselves and the Employer dated [..... *insert date*.....], relating to the [.....*brief description of the Facilities*.....], we hereby notify you that the following part(s) of the Facilities was (were) completed on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof: [..... *description*.....]
2. Date of Completion: [.....*date*.....]
3. Defects to be rectified, if any:

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

[.....*Signature*.....]

Project Manager

6. FORM OF OPERATIONAL ACCEPTANCE CERTIFICATE

[On the Letter head of the Employer]

Date:

Contract No.:

[Name of Contract]

To: [*insert name and address of Contractor*]

Pursuant to **GCC Clause 8.2** (Time for Completion) of the General Conditions of the Contract entered into between yourselves and the Employer dated [..... *insert date*.....], relating to the [.....*brief description of the Facilities*.....], we hereby notify you that the Functional Guarantees of the following part(s) of the Works were satisfactorily attained on the date specified below.

1. Description of the Works or part thereof: [*description*]
2. Date of Operational Acceptance: [*date*]

This letter does not relieve you of your obligation to complete the execution of the Works in accordance with the Contract nor of your obligations during the Defect Liability Period.

Yours faithfully,

[... Signature ...]

Project Manager

DRUK GREEN POWER CORPORATION LIMITED



**BIDDING DOCUMENTS
FOR
DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF JAMJEE
SOLAR PV PROJECT**

**VOLUME III
EMPLOYER'S REQUIREMENTS**

JANUARY 2025



JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
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- Section 9 - Contract Forms (COF)

VOLUME III –Employer’s Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



VOLUME III
EMPLOYER'S REQUIREMENTS



Table of Contents

1. SCOPE OF WORK.....	3
1.1. Scope of Supply.....	3
1.2. Erection, Testing and Commissioning.....	4
1.3. General Design Criteria of the Plant	4
1.4. Power Evacuation System	4
1.5. Site Security.....	4
1.6. Time Schedule.....	5
1.7. Detailed Engineering Design and Report.....	5
1.8. Progress Report and Meetings.....	5
1.9. Inspection.....	6
1.10. Installation.....	6
1.11. Acceptance & Commissioning Tests.....	7
1.11.1 Factory Acceptance Tests.....	7
1.11.2 Acceptance Tests	7
1.11.3 Mechanical Tests.....	8
1.11.4 Functional Tests.....	8
1.11.5 System Performance test	9
1.12. Training	9
1.14 Operation and Handing Over	10
2. DETAILED TOPOGRAPHICAL, GEOTECHNICAL & HYDROLOGICAL INVESTIGATION	10
2.1. Topographical survey	10
2.2. Geotechnical Investigations and Laboratory Tests	12
2.3. Hydrology and Area Drainage Study	15
3. TECHNICAL SPECIFICATION.....	16
3.1. DC System	16
3.1.1. PV Connectors and Branch Connectors	16
3.1.2. String Combiner Box.....	17
3.1.3. Inverters	22
3.1.4. Solar Cables	31
3.1.5. SCB To Inverter Cable (1.9/3.3 kV)	35
3.1.6. Module Cleaning System	39
3.1.7. ESE Lightning Protection for PV Yard.....	41
3.1.8. Weather Monitoring System	42
3.1.9. PV Module.....	48
3.2. AC System.....	56
3.2.1 Inverter Duty Transformer.....	56
3.2.2 Switchgear (33 kV)	62
3.2.3 Auxiliary Transformer	68
3.2.4 LV Switchgear.....	74
3.2.5 UPS and UPS Distribution Board	78
3.2.6 LT Power and Control Cable	80
3.2.7 33kV Power Cables	84
3.2.8 SCADA System.....	88
3.2.9 Fibre Optical	114
3.2.10 Tariff Metering System.....	114

3.3.	General System.....	115
3.3.1	Cabling System.....	115
3.3.2	Earthing and Lightning Protection.....	118
3.3.3	Fire Protection, Detection & Alarm System.....	123
3.3.4	Closed Circuit Television System (CCTV).....	131
3.3.5	Lighting System.....	137
3.3.6	Installation Works.....	141
3.3.7	HVAC System.....	143
3.3.8	Quality Health, Safety and Environment (QHSE).....	146
3.3.9	Commissioning Tests.....	152
3.4.	Civil and Structural Works.....	157
3.4.1	Scope.....	157
3.4.2	List of Facilities and Buildings.....	158
3.4.3	Land Development for Site Activities.....	159
3.4.4	Foundations.....	159
3.4.5	Excavation, Back-Filling and Disposal of Earth.....	159
3.4.6	Module Mounting Structure.....	160
3.4.7	33kV System Civil Works.....	164
3.4.8	Transformer Yard Civil Works.....	165
3.1.10.	Main Control Building (RCC/PEB Building).....	166
3.1.11.	PEB Specification (Applicable Main Control Building/Inverter Building).....	168
3.4.9	Anti-Termite Treatment.....	171
3.4.10	Reinforced Concrete and Allied Works.....	171
3.4.11	Curing.....	172
3.4.12	Masonry Work.....	173
3.4.13	Plastering.....	173
3.4.14	Windows, Doors, Ventilators and Rolling Shutters.....	174
3.4.15	Painting & Finishing.....	174
3.4.16	Structural Steel.....	175
3.4.17	Grouting.....	175
3.4.18	Plumbing and Sanitation.....	175
3.4.19	Water Supply.....	175
3.4.20	Roads.....	176
3.4.21	Chain Linked Fencing & Main Gate.....	178
3.4.22	Storm Water Drainage.....	179
3.4.23	Security Cabin.....	179
3.1.12.	Cable Trenches and Civil Works for Module Cleaning System.....	179
3.4.24	FRP Water Tank.....	180
3.4.25	Quality Control.....	180
3.4.26	Inspection and Testing.....	180
3.4.27	Drawings & Documents.....	181
3.4.28	Codes & Standards.....	181
4	KEY PERSONAL REQUIREMENT.....	185
5	KEY EQUIPMENT REQUIREMENT.....	185
6.	PERFORMANCE GUARANTEE (PG) TEST.....	186
6.1	General.....	186
6.2	Salient Points about the PG Test Procedure and Results-.....	186
6.3	Performance Guarantees.....	186
6.4	Failure in Guarantees and Liquidated Damages.....	186
6.4.1	Failure to Attain.....	186
6.4.2	Minimum Levels.....	186

1. Scope of Work

The scope of work shall include design, engineering, procurement, site development, construction/erection, testing and commissioning of 120MWp (minimum) Solar PV Plant in accordance with this specification. The solar PV power plant shall comprise, but not limited to the following:

- i. Main Electrical System including Solar PV modules, Inverters, Cables, Transformers, SCADA system and protection equipment.
- ii. Solar PV Module Mounting Structures
- iii. Site Access, Internal Roads and drainage
- iv. Main control building, 33 kV Switchgear, cable trenches, and other applicable structures or works
- v. Water supply system
- vi. Lightning protection system
- vii. External Lighting system
- viii. Earthing systems
- ix. Fire Fighting system
- x. Weather Station

The scope of work mentioned in this specification covers all necessary works/equipment for the project. The statements and explanations contained in this regard are intended to provide a proper understanding to the Bidders but should not be construed as limiting Employer's responsibilities and/or Employer's right to amend/change the scope or the terms. It shall be clearly understood that the intent of the Employer is that the Contractor shall execute this project on turnkey basis for a lumpsum fixed price subject to the terminal points explicitly identified and consequently, any omissions, conflicts or contradictions in these specifications shall be noted, interpreted and applied appropriately to give effect to this intent. No risk related to land, soil and flooding shall be passed on to the Employer after the award of contract. Claims or disputes on account of wrong interpretation or wilful misinterpretation of this intent by the Bidder after award of Contract will not be entertained by Employer nor will they be legally binding on Employer.

The physical, environmental and social characteristics of the site have been studied and a description of the key features and references to the relevant studies are provided in this document (Supplementary Information). The information only serves as an information to the Bidder and the detailed investigations and necessary studies are in the scope of the Bidder. This includes, but not limited to the following:

- i. Topographical survey and mapping, Geotechnical investigations and Flood risk assessment studies
- ii. Grid-Code regulation

Bidder is strongly encouraged to visit the site and assess the complete work before submitting the Bid.

The solar PV power plant shall meet the following minimum performance requirements

SN	Performance Guarantees	Minimum Requirements
1	DC installed capacity	120 MWp
2	AC installed capacity	85 MW
3	Annual Energy generation	197.68 GWhr
4	Performance Ratio	83%

1.1. Scope of Supply

The scope of supply shall include supply and delivery of PV modules, Inverters, DC & AC cables, remote monitoring and control systems and all other items necessary for successful completion of the project is in the Bidder's scope.

Any other supply item, erection or testing required for the plant is deemed to be considered in the scope of this contract even if not specifically mentioned in this specification.

1.2. Erection, Testing and Commissioning

The erection, testing and commissioning of all the equipment / items, including power evacuation system at 33kV voltage level at the boundary of each of the three sites, for completion of the project are deemed to be included in Bidder's scope.

Loading, unloading, storage, transportation to place of installation, including building of necessary roads and infrastructure are also included in the scope of the Bidder.

Conducting Performance Guarantee (PG) tests and submission of relevant reports as per the agreed schedule and procedure under the supervision of Employer's representative shall be included in Bidder's scope.

1.3. General Design Criteria of the Plant

The facilities shall be designed to:

- i. Deliver the required production outputs for at least 25 years subject to the recommended maintenance regime
- ii. Withstand the ambient temperature range of -10 to +35 degree centigrade and Basic wind speed of 47 m/s
- iii. Withstand seismic load for Zone V category as per IS1893
- iv. Comply with the corrosion category C2 as per EN ISO 14713, EN ISO 1461, EN ISO 12944-5 or ASTM 123.
- v. Comply with applicable international and national standards/norms and any other regulations/laws/guidelines as per the Employer country's requirement.
- vi. Permit the measurement and testing to assess and detect faults to crosscheck the equipment deterioration to ensure its conformance for output production assurance.
- vii. Prevent total or partial collapse of structures and prevent damage to existing installations that could result in major deformations of the load bearing structures.
- viii. Avoid safety hazards during construction and operation of the plant

1.4. Power Evacuation System

The power generated by the solar PV plant shall be evacuated from the Solar PV Plant at 33kV level from each site (total of 3 sites) and further integrated to 220/66/33 kV BPC Substation. Bidder has to make necessary arrangement for the termination of 33kV line including supporting structures for terminating the outgoing feeders. The transmission line from Solar PV Plant boundary at 33kV level to 220/66/33 kV BPC Substation will be executed by Employer.

The Grid Code Regulation 2024 of Bhutan shall apply for grid compliance and power quality purposes. Technical requirements to be met by the solar PV plant for interconnection with the main grid are specified in the Grid Code Regulation 2024 of Bhutan issued by the Electricity Regulatory Authority (ERA). It is the responsibility of the Contractor to design, supply, install, test and commission the plant and its accessories in compliance with the relevant provisions of the Grid Code Regulation 2024 of Bhutan.

1.5. Site Security

From the time the contractor takes possession of the site to the date of issuance of the completion certificate, the contractor shall be fully responsible for the security of the construction site. The contractor shall be required to place temporary fencing around the construction site to delineate the construction zone and construction buffer. Visible safety signs are to be securely installed alongside of roads, switchyards, large excavated areas, pits, trenches, etc.

1.6. Time Schedule

Within [28] days from the signing of Contract Agreement, the Contractor shall submit to the Employer, in both soft and hard copies, details of the system configuration, equipment, delivery, erection, testing and commissioning time schedule for the PV plant in the form of Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), using latest Primavera Professional P6, in pursuant to PCC clause 8.3. The Time Schedule is to indicate realistically all the various phases of work for every item from the commencement of the work to its final completion, e.g., civil works (site preparations, road, drainage, fencing etc.), design, ordering of materials, supply, delivery, erection, installation, testing and commissioning. If at any time during the execution of the Contract, it is found necessary to modify the approved program of work, the Contractor shall inform the Employer and submit a modified Time Schedule for approval. Such approval shall not be deemed to be consent to any amendment of the completion dates stated in the Work Plan. The Contractor shall report monthly and project-to-date progress against this program each month.

1.7. Detailed Engineering Design and Report

The Contractor shall carry out, and be responsible for, the design of the plant in pursuant to PCC Sub-Clause 5.1 with Best Industry Practices. Design shall be prepared by qualified, experienced and competent designers who are engineers or other professionals who comply with the criteria (if any) stated in the Technical Specifications.

The Contractor shall at his own expense carry out all investigations, model studies, design and preparation of specifications, construction, working, shop drawings and all other things as necessary for the performance of the Works. The design and drawings shall be accompanied by detailed calculations, including design philosophy, references (if any) and standards, and shall be submitted to the Engineer, in and the relevant clauses under the Technical Specifications, for approval, within [90] days after the signing of the contract agreement. The detailed design criteria, applicable codes and standards, required documents to be submitted are as per relevant technical specifications. The design and report shall include at least:

- i. Project Layout plan including locations of PV modules, inverters, substation, transformers, 33kV feeder lines and the location of the main control room
- ii. Design drawings for access roads, internal roads, permanent fencing and gates
- iii. General SLD including a total overview of the electrical circuit of the PV plant from the PV modules to 33kV termination point
- iv. DC SLD indicating a total overview of the electrical circuit of the DC part of the plant, i.e, PV modules to Inverter.
- v. AC SLD indicating a total overview of the electrical circuit of the AC part of the plant, i.e, Inverter to 33kV termination point.
- vi. SCADA architecture
- vii. PVsyst report from latest version of PVsyst along with editable file, .PAN, .OND, TMY files for both P50 and P90.
- viii. Water supply scheme
- ix. Relocation of existing encumbrances, if any
 - x. Location of stockpiles, offices, washrooms and other temporary structures and land uses.
 - xi. Detailed Bill of Quantities for the whole scope of work

1.8. Progress Report and Meetings

At monthly intervals after approval of the time schedule referred earlier, the Contractor shall submit to the Employer detailed progress reports in an approved form, indicating the stage reached in the design, ordering of material, site developments, civil works, supply, delivery, transport and erection of all components of plant, complaints and incidents and progress with follow up and close out in comparison with that planned. These reports shall be forwarded promptly so that on receipt by the Employer, the information contained therein is not more than seven days after its occurrence.

If during execution of the Contract the Employer considers the progress of any section of the work to be unsatisfactory, Employer shall have the right to call such meetings, as they deem to be required. If required by the Employer, Contractor with necessary officials shall attend such meetings. Access to the Contractor's and sub-Contractor/s works shall be granted to the Employer at all reasonable times for the purpose of monitoring/inspection and ascertaining progress.

1.9. Inspection

The Contractor shall provide the Employer with the technical details of the equipment/works to be inspected, however such inspection shall in no way exonerate the Contractor from any of his obligations. The Contractor, if requested by the Employer, shall arrange inspections before installation of any equipment which has been delivered to the Construction Site partly assembled.

The Contractor shall provide a copy of the packing list, packing declaration, certificate of origin and bill of lading, accompanied by an asbestos declaration and a fumigation treatment declaration (where applicable) to the Employer for each container at the time of its arrival at the relevant Port and shall provide access to the container and its contents for inspection by the Employer following the containers clearance by customs. The following inspections are to be conducted by the Employer:

- i. Construction of all civil foundations and structure: essential quality observation shall be on observing how top levels of foundations are laid accurately.
- ii. Construction of roads: essential observation shall be on road compaction level, alignment, shoulders and culverts placement/alignment
- iii. Supply and installation of module mounting structure: essential observation on structure alignments and ease of prefabricated structure erection.
- iv. Fixing of PV modules: essential observation shall be accuracy of module alignment, examining modules under stress and sagging effect along the length and width of mounting structure.
- v. Erection of the inverter: essential observation shall be accuracy of inverter alignment and support on the foundations
- vi. Control building walls: essential observation on structure, walls, floors and ceilings.

1.10. Installation

After the installation of the PV plant, the contractor shall submit all the relevant soft and hard copies consisting of but not limited to following drawings and details to the Employer all of which must be in English:

- i. The total inventory of the installed equipment, serial numbers, technical details, supplier contact details, test certificates, installation instructions and warranties/guarantees etc;
- ii. Single line diagram showing the completed PV plant including relevant equipment ratings;
- iii. As-Built Drawings including all equipment, construction activities and any other relevant issues;
- iv. Design calculations and layout drawings of PV array mounting structures;
- v. Drawings, calculations, and design details of earthing system;
- vi. Certified copies of test reports of all equipment;
- vii. Commissioning report for each of the individual items installed;
- viii. Operation manual of each equipment installed;
- ix. Maintenance manual of each equipment installed.

1.11. Acceptance & Commissioning Tests

Acceptance and commissioning tests shall be carried out in accordance with PCC clause 12 [Tests after Completion] and as specified below. The following tests are specified, but not limited to:

- a. Factory Acceptance test- at the manufacturing facility
- b. Acceptance tests- upon arrival at site
- c. Instrumentation tests- when installed
- d. SCADA tests- when installed and when plant is operating
- e. Mechanical tests- after installation
- f. Functional tests- after installation
- g. Performance tests- after installation

1.11.1 Factory Acceptance Tests

The test specification for a factory acceptance test (FAT) shall include a program for the tests and detail the following:

- a. Requirement to be tested;
- b. Step-by step method of testing;
- c. Expected results of tests.

Approval of the test specification/procedure will not prejudice the Employer's right to order additional tests, should the Employer deem necessary, following approval but before his acceptance of the material, equipment, software or system(s) for shipment, that certain conditions or combination of conditions were not foreseen in the test specification, in order to demonstrate that performance requirement of this Specification have been met.

Tests shall only be conducted with the aid and in accordance with test specification(s) and standards clearly identified as approved for use by the Employer, and, where applicable, employ test instruments of suitable quality calibrated to manufacturer's recommendations by a reputable agency within the previous six (6) months.

In addition to the specifications already provided for the Plant, the test specification shall be supplied with the test results, and it shall include at least:

- a. indicate the model;
- b. indicate the time of the tests;
- c. indicate the standards followed;
- d. cover a substantial percentage of the supported features of the equipment;
- e. indicate who carried it out.

If done by a third party, all above requirements shall apply.

The factory acceptance tests shall be carried out by the manufacturer in accordance with the requirements of IEEE 1547, including at least:

- f. Response to abnormal voltage test;
- g. Response to abnormal frequency test;
- h. Synchronization test

The Contractor shall dispatch the material, only after the successful completion of Routine Tests/Factory Acceptance Tests (FAT) and after receiving written Material Dispatch Clearance (MDC) from the Employer.

1.11.2 Acceptance Tests

The following tests will be carried out:

- a. The PV modules shall be tested prior to installation and upon arrival at the site of the project:
 - Inspected visually for defects;

- The flash tests of all the modules shall be verified.
- b. The inverters shall be inspected visually for defects prior to installation and upon arrival at the project site.
- c. The mounting structures, prior to installation and upon arrival at the site of the project, shall be:
 - Inspected visually for defects;
 - Coating must be visually verified and inspected.
- d. DC and AC Cables, junction boxes and other electrical components shall be tested prior to installation at the site of the project:
 - Inspected visually for defects.
- e. The monitoring equipment shall tested be upon delivery at the site of the project:
 - Inspected visually for defects

1.11.3 **Mechanical Tests**

The mechanical test is the first test to be performed with respect to the PV systems and shall occur on a date to be proposed by the Contractor and as approved by the Employer. The notice should not be less than 10 days before the test date;

The Mechanical test is the standard procedure to verify that the PV systems have been built according to the requirements and includes:

- Visual inspection;
- Verification of installation of all equipment.

The areas for inspection include:

- Mounting structure, bolts and fixtures;
- PV modules
- DC and AC cables
- Inverters
- DC distribution system
- Monitoring system for PV field, and weather station
- 33 kV switchgear and transformers

The Employer shall determine whether the Mechanical Test has been successfully completed.

1.11.4 **Functional Tests**

The functional tests shall be done after the successful completion of the mechanical tests. The contractor shall submit a proposed date not less than 10 days before the test date.

The Functional Tests on the PV array shall be done according to IEC 62446 and include at least:

- a. Continuity of earthing tests
- b. Polarity test
- c. String open circuit voltage test
- d. String short circuit current test
- e. Insulation resistance of the DC circuits
- f. Thermographic tests
- g. The functional tests of the inverter shall be as per the equipment manufacturers' commissioning procedures and shall include at least Thermographic tests.
- h. Low Voltage equipment test according to IEC 62446-6 and IEC 62446-7 including Thermographic tests of cables.

- i. The functional tests of the monitoring equipment shall be as per the manufacturer's guidelines:
 - Communication at the string level is required
 - Verification of the weather station operation.

The Employer shall determine whether the Functional Tests have been successfully completed or not.

1.11.5 System Performance test

The performance test for the PV plant follows the IEC 61724 to determine both the performance ratio (PR) and the AC capacity:

- a. The Performance Test shall be done after the successful completion of the functional tests. The contractor shall submit a proposed date not less than 10 days before the test date;
- b. The performance test shall have the duration of 5 days according to the following criteria:
- c. Total daily irradiation at the PV modules shall be at least 3.5 kWh/m²;
- d. If the minimum daily irradiation is not reached, the test shall be extended according to the relevant number of days until 10 days reach the minimum irradiation of 3.5 kWh / m²;
- e. The availability of the PV system and the Grid should be 100%. In case of unavailability, the test period should be extended according to the relevant number of days.
- f. The PV system performance ratio (PR) shall be calculated on the basis of the operating data recorded by the monitoring system according to the formula included in IEC 61724:

$$PR_{meas} = \frac{\sum_j E_{meas,j}}{P_{nom} \cdot \sum_j \left(\frac{G_j}{G_{ref}} \cdot \left(1 - \frac{\beta}{100} \cdot (T_{mod} - T_{meas,j}) \right) \right)}$$

- $E_{meas,j}$ = Produced energy (in kWh) over each metering interval
 - P_{nom} = Nominal power of the PV system in kWp. Sum of the individual module power of all installed modules as per the relevant datasheets;
 - G_j = Irradiation in kWh/m² measured per each metering interval j with an on-site pyranometer with an identical inclination to the modules;
 - G_{ref} = 1 kW/m², irradiance at the reference STC conditions;
 - PR_{meas} = the average PV system Performance Ratio during the testing period;
 - $T_{meas,j}$ = the average module temperature measured during each Metering Interval j by the temperature sensors placed on the reverse side of the modules (in °C). When several module temperature sensors are installed then the average measurement of the installed module temperature sensors will be considered;
 - T_{mod} = the average monthly PV module temperature expected;
 - β = Maximum power temperature coefficients of the PV modules as per the relevant datasheets. For the avoidance of doubt β shall be a negative value;
 - j = 10 minutes interval.
- g. The Employer shall compare the PR measurements with the PR as per the functional guarantees.
 - h. The Employer shall compare the determined AC capacity with the capacity in MWac as per the functional guarantees.

1.12. Training

The Contractor shall provide training to nominated Employer's engineers on grid-connected ground-mounted PV system design, installation operation and maintenance specific to the systems installed under this contract, including specific training on maintenance, and troubleshooting of equipment and materials supplied. This will include the use of remote monitoring devices for performance monitoring, fault finding, root cause analysis and preventive and corrective maintenance.

The Contractor shall provide a general operation and maintenance manual for the solar PV plant and specific operation and maintenance manuals for all major equipment such as PV modules, inverters, remote monitoring systems, phase couplers, etc. The O&M manuals should include preventive and predictive maintenance procedures and schedules, fault finding and diagnosis methods, troubleshooting, and safety precautions specific to the supplied equipment.

The training shall be provided on each phase of work for a tentative duration of 5-6 days however, the detailed training schedule shall be finalized on mutual agreement.

1.14 Operation and Handing Over

The Contractor shall prepare all documents including Test Reports, Inspection Reports, As Built Drawings, Equipment checklists, Operational check lists, list of configuration settings, operations and maintenance manuals, environmental management procedures and any other documents pertaining to the handing over and the operations and maintenance of the completed facilities and shall submit these to the Employer's for its review

2. Detailed Topographical, Geotechnical & Hydrological Investigation

The Bidder shall be responsible for detailed soil investigation and contour survey at required locations for the purposes of foundation design and other design/ planning required for the successful completion of the project. The reports and data on preliminary topographical survey and geotechnical investigations carried out by the Employer will be provided as reference. The Bidder shall submit the detailed soil investigation report and topography survey report to Employer for approval during the detailed engineering stage.

2.1. Topographical survey

The scope of work shall include mobilisation of all necessary equipment, providing necessary experienced and qualified land surveyors, supervisors and technical personnel, skilled, unskilled labour and such other services as required to carry out all field works, analysis and interpretation of all the collected data, preparation & submission of survey drawings and detailed report on the work done.

Only SI System shall be followed.

The Bidder shall conduct topography survey to:

- i. To demarcate the acquired property and fix Boundary Pillars at site in co-ordination with the Employer as well as representatives of other agencies as applicable. Lengths and bearings with respect to the Magnetic North of each Boundary line shall be determined.
- ii. To establish a baseline within the area being surveyed at location indicated by the Engineer and determination of its bearings with respect to the True North as well as the Magnetic North.
- iii. To establish and Construct permanent Benchmarks on site at locations to be indicated by Employer. These shall be tied to nearest authenticated GTS /Employer benchmark already established at site and can be used for verification.
- iv. To establish horizontal ground control points including those defining the baseline and demarcate them by permanent pillars within the area by triangulation or close traverse or both, based on the nearest GTS / Survey station. These control points shall form the basis of the site Triangulation Network.
- v. To determine Latitude and Longitude of one of the horizontal ground control points, decided in coordination with Employer.
- vi. To establish a site coordinate grids at 50m interval incorporating established baseline. Each intersection shall be demarcated by a permanent grid pillar with coordinates engraved on the plate.
- vii. To measure depths and temperature of water in wells, Monsoon stream, rivers, ponds, lakes etc. within the plot, simultaneously recording the ambient temperature and the time of the day and the date. Levels of the ground at the well locations shall be specifically taken and recorded. The survey shall also record bed levels of the Monsoon streams.
- viii. To obtain Highest High Flood Levels and Lowest Low Water Levels of normal streams and Monsoon streams; overflow levels and lowest levels of ponds and lakes; tidal levels etc. if applicable.

- ix. To identify and mark on the Survey Drawings places of worship, tombs, relics of archaeological importance, trees with girth more than 300mm at 1m above ground level, transmission lines and towers, telephone /telegraph lines and poles, power and lighting poles, trenches, identified underground services and any other structure, etc.
- x. To suitably collate all the Survey details and represent the same on drawings drawn to scales as specified.

The Bidder shall mobilize and use appropriate and adequate number of precision instruments and equipment required for the successful execution of the work. These shall include but not be limited to Differential Global Positioning System (DGPS), "Total Stations", theodolites of one second accuracy, levels, ranging rods with least count of at least 5mm, level staves, calibrated tapes, survey umbrellas, etc.

The Employer has established co-ordinates of each of the existing Boundary Pillars with respect to the Site Co-ordinate Grid. Bearings of all Boundary Lines are established with respect to the Magnetic North. The reference pillars are labelled permanently with their respective coordinates and reduced levels for future use. The top of pillars shall have Galvanized MS plate embedded in concrete for engraving necessary details as specified. Employer to cross-verify the correctness of the same.

All necessary Reduced Levels (RL) as entered in the field book have to be submitted along with pre-contour layout of the total site. The Benchmarks and reference pillars shall be shown on the survey drawings. Positions, both in plan and elevation, of all natural and artificial features of the area like waterways, railway tracks, trees, cultivation, houses, fences, any other permanent and temporary structure, permanent and temporary 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. All hills and valleys within the site are to be surveyed and plotted on maps by contours. Necessary levelling work of the entire area/areas are to be surveyed and plotted on maps by establishing horizontal location so that location and sketching of contours for the site can be done at specified intervals and in specified scales on maps. Method of survey, contour intervals etc. shall be decided by Employer on site in case of steep slopes etc. where grading is not possible. Any unusual condition or formations on the ground, locations of rock outcrops (if visible on the surface) and spring/falls, sand heap/dune, possible aggregate deposits etc. shall also be noted and plotted on the maps. The grids for the survey work shall be established in N-S & E-W direction (Corresponding to Magnetic North) or the Plant North as directed by the Employer.

The spot levels shall be taken at nodes of grid 10 m side. The grid shall essentially be perpendicular and parallel to established baseline. Finer grids may be adopted for representing local features. The Contour Maps shall show contours at 0.5m interval. Smaller contour intervals shall be adopted to indicate local mounds, field bunds, dykes, Monsoon stream, rivers, lakes, ponds, wells etc. Presence of any well or tube well in the site or adjoining areas and water level in them shall be in the documents. Details of earlier uses 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 documents.

Levels shall also be taken on all traverse stations and on salient points located at random over the area (ground points). Contours are to be interpolated at 0.5 M intervals after the above points are plotted.

The contours shall not be just interpolated but properly surveyed on the ground so that features falling between the two successive levels are also picked up. Sufficient points shall be properly distributed over the entire area and levels shall be taken so that accurate contouring can be done at places of sharp curvature or abrupt change in direction and elevation, points selected shall be close to each other.

Salient points on ridge lines and valley lines shall also be measured. Transfer of levels shall always start from Main/Subsidiary stations whose levels are based on bench mark established in the survey area.

The Bidder shall initially produce check prints of all Drawings for review and comments of the Employer prior to proceeding with the final copies at no extra cost to the Employer. All comments of the Employer shall be incorporated onto the final Drawings.

The Bidder shall submit the following drawings:

- i. Site location plan drawn to a scale of 1:20000.
- ii. One drawing, showing the complete plot and prominent features in and around it, drawn to a scale of 1:1000.
- iii. Detailed Survey Drawing drawn to a scale of 1:500.
- iv. Contour Map drawn to a scale of 1:500 with Contour Interval of 500mm. The contours shall be drawn in 3-Dimensions such that all the spot levels indicated on the drawings bear all the three co-ordinates viz. X, Y and Z - co-ordinates.
- v. Longitudinal profile of the railway lines, pipelines etc. as specified, drawn to a horizontal scale of 1:2000 and a vertical scale of 1:10. Plan shall be drawn along the profile, with scale normal to the alignment at 1:1000.

Boundary lines shall be shown on all the drawings. Bearings of each boundary line with respect to the Magnetic North and that of the baseline with respect to both the True North as well as the Magnetic North shall be indicated on the detailed survey drawing the contour map as well. Magnetic and true north shall be indicated on each of the sheets. All Pillars shall be shown on the detailed survey drawing as well as the contour maps. The unique nomenclature for each pillar shall be indicated on these drawings.

The Detailed Survey Drawing shall identify and depict all prominent features and details with their sizes, elevations / depths, bearings and co-ordinates.

It shall be noted that all Drawings, Maps, Records etc. produced by the Employer shall be the sole property of the Employer and Bidder shall not use any of the details for any other work without the written approval of the Employer.

All the maps should be prepared in digitized forms using computer software like AutoCAD or as directed by Employer. The block of name plate of all the drawings should be as per standard defined by Employer.

Bidder shall submit all data pertaining to the survey in original to the Employer including all levels & co-ordinates in X-Y-Z format for the area on Pen drive.

At least 50-meter width of the adjoining solar plots and area shall also be covered in the survey for correlation with adjoining plots. Presence of any well and/or tube well in the site or adjoining areas and water level in them shall be marked in the documents / Drawings. The survey shall be conducted through DGPS/Total station only.

2.2. Geotechnical Investigations and Laboratory Tests

The Bidder is advised to and is solely responsible to carry out detailed soil investigation to ascertain soil parameters of the proposed site for the use of planning /designing / construction / providing guarantee / warranty of all civil work including but not limited to foundations / anchoring and Moring foundation, piling works, open foundation for Floating Solar PV Plant. The Bidder shall carry out soil investigation through ISO: IEC:17025 or Laboratories accredited by Royal Bhutan Government or Employer suggested and approved by Employer. These reports shall be furnished to the Employer for approval prior to commencing work. The soil investigation shall be performed at various area including switchyard area Transmission line if applicable and project site.

The Bidder shall carry out geotechnical investigation for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Bidder shall obtain the approval for the field and laboratory testing scheme proposed by him from the Employer before undertaking the geotechnical investigation work.

The scope of soil investigation covers execution of complete soil exploration including boring, drilling, collection of undisturbed soil sample where possible, otherwise disturbed soil samples, conducting laboratory test of samples to find out the various parameters mainly related to load bearing capacity, ground water level, settlement, and soil condition and submission of detail reports along with recommendation regarding suitable type of foundations for each bore hole along with recommendation for soil improvement where necessary.

Field test shall include but not be limited to Boreholes, Standard Penetration Test (SPT), Cone Penetration Test (CPT), Plate load tests (PLT), collection of disturbed and undisturbed soil samples (UDS), Trial Pits (TP), collection of water samples, Electrical Resistivity Test (ERT), etc.

Bidder shall submit a soil investigation plan for review and approval before executing field work. The minimum requirement for field work is indicated in ensuing paragraphs.

Minimum 1 borehole of minimum 10 m depth shall be carried out in Switchyard & Structures area and other miscellaneous works excluding MMS structures. Please note that if soil data reveals significant variations, Bidder shall carry out additional investigations after intimating Employer without cost to Employer. On completion of every field work, field record shall be continuously mailed to client.

The minimum depth of borehole shall be not less than 10m /refusal strata (3 consecutive SPT $N > 100$) or 5m inside hard clay (SPT $N > 30$ consistently) or 10m inside dense sandy strata (SPT $N > 30$ consistently). Locations shall be as per approved geotechnical investigation scheme.

For MMS, the number of boreholes shall be one per 5 hectares. Where the site conditions show a challenging /mountainous terrain creating constraint for Soil exploration rig movement, adequate number of trial pits shall be excavated up to 3m depth. Number of trial pits shall be one number per 5 hectares and SPT shall be conducted. In each trial pit, SPT shall be conducted at intervals of 1m, 2m and 3m inside the pit.

DCPT may be done in lieu of SPT. DCPT shall be conducted using an appropriate DCPT test kit such as DCPT Penetrometer without using bentonite slurry up to 6m depth /DCPT Refusal which is defined as 35 blows for 100mm penetration

Standard Penetration Test (SPT) shall be carried out in all types of soils up to three consecutive refusals (SPT $N > 100$) within a borehole. In refusal strata, the number of blows and corresponding penetration of sampler shall be recorded.

SPT shall be conducted at every 1 m interval or at change of strata up to one refusal ($n > 100$). Further beyond, SPT shall be conducted at intervals of 1.5m /change of strata up to refusal.

Undisturbed samples (UDS) shall be collected at every 1.0 m interval or at change of strata in clay /semi cohesive soil layer only. In sands/silty soils, SPT shall be performed. In clays /semi cohesive soils, if SPT N exceeds 20, UDS shall be replaced with SPT.

In weathered rock /refusal strata (having nil CR), Once refusal is reached ($N > 100$), same shall be reconfirmed by conducting two more SPT at 1.5m intervals. SPT in refusal strata shall be conducted using new SPT shoes. Damaged shoes shall not be used Wash samples recovered from drilling shall be collected.

For rock having CR $< 50\%$ drilling shall be carried out for a depth of 5m. Drilling shall be done in runs of 1.5m.

For rock having CR $> 50\%$ and RQD $> 25\%$. depth of drilling shall be 3m. Drilling shall be done in runs of 1.5m.

For poor quality rock, individual drill run shall be suitably reduced to 0.5 /1m.

During drilling, Site Engineer shall record details such as time taken for drilling each drill run, individual core piece length, depth at which drilling bits changed from MS Cutter to TC /Diamond bits, water losses, borehole collapses etc.

Rock cores obtained shall be placed with sequential numbering in core boxes and photographed. In field bore log, individual core piece length shall be mentioned and CR as well as RQD computed.

Minimum 5 number of ERT, 10 Trial pit and 10 TRT shall be carried out within footprint of Proposed Project covering location of Inverter, Switchyard area, MMS structures and other areas as per approval of Employer.

All four walls of trial pits shall be photographed. Bulk samples shall be collected at every 1m interval starting from 0.5m up to termination depth. If strata are same as revealed visually, one sample is sufficient.

During field investigations, presence of localized /surface rock outcrops, laterite outcrops, localized slushy soil areas /channels or tank beds if found either within the site or in vicinity of Boreholes /Trial pits, same to be noted down by site Engineer along with GPS coordinates (UTM) and details to be enclosed in the report along with photographs.

Thermal resistivity tests, where specified by Engineer -in-charge shall be conducted on site in all the trial pits as per ASTM standards. Soil sample from the same location shall be collected and tested in laboratory for laboratory thermal resistivity.

The laboratory tests shall be conducted on soil, rock & water samples collected during field investigations in sufficient numbers as approved by Employer. Laboratory tests shall be carried out on disturbed and undisturbed soil samples for –

- i. Grain Size Analysis,
- ii. Hydrometer Analysis,
- iii. Atterberg Limits,
- iv. Triaxial Shear Tests (UU),
- v. Natural Moisture Content for UDS samples
- vi. Specific Gravity, Total and dry unit Weight for UDS samples
- vii. Specific Gravity and Bulk Unit Weight,
- viii. Consolidation Tests,
- ix. Unconfined Compression Test,
- x. Free Swell Index, Shrinkage Limit, Swell Pressure Test,
- xi. Swell Pressure Test on soils having DFS>50%,
- xii. Liquefaction analysis and its outcome
- xiii. Modulus of subgrade reaction shall be derived as per IS-2950 (Part-1)
- xiv. Thermal Resistivity Test
- xv. Compaction tests (both Standard and Modified) for bulk soil samples collected in trial pits. Sample collected at 0.5m shall be tested in Modified Proctor condition and sample collected between 0.5m to termination shall be tested in Standard Proctor condition.
- xvi. CBR tests in 97% Modified Proctor condition (Both Unsoaked and 4 days Soaked)
- xvii. Chemical Analysis test on 1 soil: 2 water extract and water samples to determine pH, chlorides, sulphates and accordingly provide recommendation of type of cement to be used for concrete.
- xviii. Chemical analysis of water samples from boreholes as per relevant IS Codes.
- xix. Water intended for use in construction shall also be tested as per relevant IS Codes.
- xx. Electrical conductivity test on soils as per IS:14767
- xxi. Electrical conductivity test on water as per IS:11624
- xxii. Silt factor shall be provided (if sought by Employer /Consultant)
- xxiii. Laboratory tests on rock samples shall be carried out for Specific Gravity, Unit Weight, Water absorption, Porosity, point load index for broken /weathered rock cores /lumps, Uniaxial Compressive Strength (in-situ & saturated), etc.

On completion of all field and laboratory work, the Bidder shall submit a soil investigation report to Employer's approval. The interpretative geotechnical investigation report shall contain field and laboratory observations/ data/ records, analysis of results and recommendations on type of foundation for different type of structures envisaged for all the areas of work. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils (including CNS layer thickness, if expansive soil is encountered), etc. shall also be covered in the report, as applicable.

The report shall provide complete recommendations on type of foundations most suitable for the MMS structure and any other building foundation, any foundation for any other equipment depending on soil strata encountered.

If weathered /hard rock is encountered at surface, recommendations shall be provided for foundations having minimum socket inside rock as per accepted Bhutan Codes of Practice /in absence of Bhutan Standards for Foundation Engineering, adopt Indian International (American /British/Eurocodes) as may be applicable. If pile foundations are recommended, capacities shall be furnished for axial, uplift and lateral capacity (free head) considering all diameters and lengths. In lateral pile capacities, the projection of pile above ground level shall be considered as per actual condition / as approved by the Employer.

SBC shall be provided for foundations of varying width and depth and rafts / isolated at below existing ground level considering all shapes (square, strip, rectangular) from both shear criteria and settlement criteria (25mm, 40mm, 50mm) considering worst condition of water table (existing ground level). For foundations in rock /refusal strata, permissible settlement shall be considered as 12mm.

Soil consultant shall understand through local enquiry and by visiting nearby project and ascertain information on foundation systems being implemented.

For short Piles, Brom's theory shall be adopted for lateral capacity evaluation. All pile capacity calculations shall be as per IS-2911 (Part-1-Sec-2) /IS:14593 (Bored piles founded in rock). The Bidder is required to initially submit draft of the complete report for comments and approval by e-mail. On receiving comments, the Bidder shall incorporate all the comments the corrected draft to the Engineer by e-mail. On written approval of the corrected Draft Report, the Bidder shall submit two (2) copies of the report. All these shall be as outlined in the Standard Specifications "Geotechnical Investigation and Report – General Purpose".

On completion of all field tests, Bidder shall interact with Employer and plan for initial test pile construction and test the same after 28 days for axial, uplift and lateral capacities up to failure condition.

2.3. Hydrology and Area Drainage Study

The hydrology study report furnished by Employer shall be considered for the information only. Bidder shall review the hydrology study report w.r.t scope of work as given below and if anything required to complete the following scope of work Employer shall arrange the same at its own cost.

- i. Sites visit for reconnaissance survey and collection of data required for successful completion of the study. Bidder need to acquaint himself regarding complete site -specific information before start of work. An interim report covering site visit report, identification of outfall locations and preliminary planning schemes of drainage network will have to be submitted to Employer
- ii. Estimation of rainfall intensity and run-off corresponding to 25-year, 50 year and 100-year return period
- iii. Report shall cover flood risk analysis and inundation map at project site for various rainfall return period of 100, 50 and 25 years.
- iv. Preparation of digital elevation model (DEM) for the study area for delineation of catchment and delineation of drainage network for comparison with drains of topo- sheet.
- v. Estimation of high flood levels at various critical locations of project site.
- vi. Catchment area of streams entering the plot and outer catchment contributing to drains within the plot to be identified
- vii. Natural streams/rivers, direction of water flow and width, depth, invert levels of streams to be captured
- viii. Estimation of run off coefficient and recommendation for plant drainage System.
- ix. In post project scenario, the plot plan will have to be considered while planning network within plant area. Runoff at critical points (at proposed culverts) of the proposed drainage network including at all outfall locations will have to be estimated.
- x. Finalization of outfall points to evacuate flood waters from plant area.
- xi. Review of safe grade elevation based on the high flood level and other considerations such as free board including optimization for land filling

- xii. Remedial measures to prevent site flooding.
- xiii. Providing technical services as and when called for by the Employer.

Bidder is advised to follow the natural contour with specific requirements. Employer reserves the right for any changes and final decision.

3. Technical Specification

3.1. DC System

3.1.1. PV Connectors and Branch Connectors

The PV connectors shall be designed, engineered, manufactured and tested to achieve high availability and reliability. The design and engineering shall make use of most recent international standards and best design practices.

The contractor shall supply all specialized equipment such as crimping, unlocking, tightening etc. and specialised services required for this purpose.

Codes & Standards

Codes	Description
UL 746C	UV Resistant
IEC 60529	Degree of protection provided by enclosures (IP Code)
IEC 62852	Connectors for Photovoltaic system
IEC 60352	Crimped connections – general requirement, test methods and practical guide
UL94-V0	Flame Class
IEC 62262	Level of Protection against Mechanical Impact (IK Rating)
BS EN 50521	Safety requirements and tests
IEC 61730	Photovoltaic module safety qualification
EN 60695	Fire Hazard testing

Design Criteria

The connectors shall be of 1500V DC grade. The connectors shall be UV resistant, ozone resistant, halogen free, dust-proof, non-conductive, ammonia resistant, non-inflammable and suitable for climatic condition of the site exposed to direct sunlight. The connectors shall be manufactured with Polyphenylene Ether (PPE) insulation having tin plated copper pin contacts.

The fuses shall be replaceable type and compatible with the Y-connector. Connector shall have slots for accepting “snap-in” type of locking tabs. The connectors shall be suitable for standard crimping tools.

Technical Parameters

Sl. No.	Item Description	Unit	Data
1.	Type	-	PV Connector and Branch Connector, snap-in locking type

Sl. No.	Item Description	Unit	Data
2.	Designation	-	Male and Female
3.	Rated Voltage	V DC	1500
4.	Highest System Voltage	V DC	1800
5.	Cable Cross- section	Sq. mm	6 sq. mm
6.	Insulating Material	-	Polycarbonate
7.	Contact Material	-	Copper tin plated
8.	Rated Current	A	30 or higher (as per design)
9.	Rated Test Voltage	kV	8 (1 min)
10.	Rated Impulse Voltage	kV	16
11.	Ambient Temperature	°C	-10 to +35
12.	Operating Temperature Range	°C	-40°C to +90°C
13.	Upper Limiting Temperature	°C	115
14.	Degree of Protection	-	IP68 (mated connection), IP2X (unmated connection)
15.	Protection / Safety Class	-	Class II
16.	Overvoltage Category	-	Cat III
17.	Contact resistance	m-Ω	<0.5
18.	Flammability Class	-	UL 94 V-0
19.	Insertion Force	N	≤ 50
20.	Withdrawal Force	N	≥ 50

Testing Requirements

All testing shall be done as per the latest IEC/IS standards.

Data to be furnished by the Contractor after the award of Contract:

Drawings / Documents for Approval:

- i. GA & Cross-sectional drawings of each Connector.
- ii. Guaranteed Technical Particulars for the Connectors.
- iii. Drawing showing the terminal connection.
- iv. Detailed quality assurance plan.
- v. Any other drawings/documents considered necessary.
- vi. Quality certifications from TUV/UL

Drawings / Documents for information:

- i. Type test certificates valid for five years for all equipment/accessories being supplied under this contract.
- ii. Routine test certificates for all equipment/accessories being supplied under this contract.
- iii. Instruction manual containing detailed instructions for all erection, testing and operation requirements.
- iv. Detailed instructions for the installation, operation and maintenance.
- v. All detailed catalogues and literature of the Connectors supplied.

3.1.2. String Combiner Box

The design, manufacture, and testing of String Combiner Box (SCB) shall be carried out as per latest applicable standards. The equipment shall be designed, engineered and manufactured to achieve high availability and reliability.

Codes & Standards

Codes	Description
IEC 61439-1 & 2	Low Voltage Switchgear
IEC 60529	Degree of protection provided by enclosures (IP Code)
IEC 61643	Low-voltage surge protective devices
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
EN 50539-11/12	SPDs for specific application including DC- Requirement and tests for SPDs in PV application.
IEC 60664	Creepage distances and clearances
EN 60715	Chromated DIN Rail
UL 94 V	Fire Resistant/ flammability
UL 746C	UV Resistant
UL-SU 6703	Fuses
IEC 62208	Enclosure for low voltage switchgear and control assemblies.
IEC 60947-1	Low voltage switchgear and control gear assemblies' part 1: General rules
IEC 60364-7-712	Requirements for special installations or locations- Solar PV power supply systems

Design Criteria

- i. The String Combiner Box (SCB) shall be of 1500V DC grade.
- ii. The enclosure material shall be of FRP material (Fire retardant), Self-extinguishing and Halogen free property. It shall be UV resistant suitable for outdoor application. The enclosure shall be dust proof, nonconductive type.
- iii. Minimum of 3mm thickness to be provided for enclosure.
- iv. All the components to be mounted inside the junction box should be mounted on FRP or Bakelite sheet with a minimum thickness of 5mm.
- v. SCB shall have IP66 Ingress protection and IK 10 Impact protection.
- vi. All live parts inside the combiner shall be insulated and shall withstand a DC test voltage of 3.8kV for 1 minute.
- vii. Enclosure shall be provided with a hinged door.
- viii. Suitable space shall be ensured for workability and natural cooling. The SCB shall be designed in such a way that the heat is dissipated in a natural way through thermal conductivity of the enclosure.
- ix. Positive side fuse shall be mounted on fuse holders and negative shall be grounded.

- x. Combiner box shall be decided during detailed engineering based on Plant SLD/Design and temperature rise calculation (without Y connector and with Y connector), the current rating of the fuses shall be calculated based on PV Module current rating considering bi-faciality factor (if applicable) and fuse factor of 1.56 in line with standard., Fuse rating shall be calculated as per IEC guidelines.
- xi. String fuses shall be of PV category and dedicated to solar applications and conform to IEC 60269-6 or UL-2579 standards and fuse base shall comply with IEC 60269-1. String fuses should be designed so that it should protect the modules from reverse current overload. Fuses or Isolation Link shall be mounted in pull out type fuse holders. Fuse holders shall be suitable for DIN rail mounting. PCB mounted fuses are not acceptable.
- xii. There should be a minimum 10 mm gap between two fuses (Fuse Holders).
- xiii. String combiner box outgoing feeder shall be provided with isolator which shall disconnect both positive and negative sides simultaneously on output side.
- xiv. The combiner box shall be provided with surge protection device (SPD) of type II, with 40kA maximum lightning discharge current.
- xv. SCB shall have provision for earthing connection with copper cable to DC Earth grid.
- xvi. The DC input cables from string or Y-connector shall be connected with PV connector and not with cable gland.
- xvii. All cable entries shall be located on bottom side of the box to prevent any possibility of water ingress into the box. The output cable glands shall be Double compression glands shall be PG Gland of suitable size.
- xviii. All metallic hardware such as hinges, nuts, bolts, screws, washers etc. shall be of SS304 and appropriate size.
- xix. Any other additional accessories as may be considered relevant and applicable for the operation and mounting of String Combiner Boxes shall be included in the scope.
- xx. Canopy / shading arrangement shall be provided on top of String Combiner Box to avoid exposure to direct sunlight. Minimum 150 mm extension and SMB enclosure can be opened without obstruction with canopy
- xxi. For SCB with less than 25 inputs 1 inputs shall be kept in spare, for SCB with more than 25 inputs 1 inputs shall be kept in spare. Total number of SCBs shall be calculated accordingly.
- xxii. System should be able to operate on error free and trouble-free mode, at -10 to 35°C ambient temperature (and internal combiner box temperature of 70°C). Heat rise calculation to be submitted.
- xxiii. The common collection bus bars should be made up of tin coated copper and shall be suitably sized to limit temperature rise within safe operating limits.
- xxiv. All internal wiring shall be carried out with stranded copper wires with voltage rating mentioned elsewhere in the specification. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring.
- xxv. Complete assembled SCB shall be subject to heat run type test to be witnessed by Employer after manufacturing. The heat run test to be carried out at the rated current i.e. (Imp of PV Modules) x (no. of string inputs) x (Bifacial factor (Excluding spare inputs)). In case it is found that the temperature rise is beyond the acceptable limits, Bidder shall redesign the assembly and perform the test free of cost to verify that temperature rise is within acceptable limit.
- xxvi. Operating temperature of the components used in the enclosure shall not exceed OEM recommended temperature limit at ambient temperature.
- xxvii. Minimum ground clearance for String combiner box shall be 600mm from bottom of SCB.

Technical Parameters

Sl. No.	Item Description	Unit	Technical Requirement
1.	General Requirements		
a)	Installation	-	Outdoor
b)	Maximum system voltage	V	1500
c)	Operating temperature range	°C	-20 to +70
d)	Design Ambient Temperature	°C	-10 to 35
e)	SCB input side	-	Fuse on positive side
f)	Mounting arrangement	-	Free standing
g)	Earthing Cable Termination	-	Bus Bar type 2mm thickness
h)	Surge Protection Device	-	Type II
2.	Input Details		
a)	Number of DC inputs (+ & - being one input)	Nos.	Decided during detailed engineering based on Plant SLD/Design
b)	Input cable size suitability	-	1C x 6 sq.mm Cu solar cable
c)	Fuse rating	A	1.56 times Isc of PV Modules for one string
d)	No of Fuse per Input	No.	1
e)	Type of cable entry/support	-	PV Connector (MC4 type)
f)	Rated System Voltage	V DC	1500
3.	Output Details		
a)	Output cable size suitability	-	Al, Armored, XLPE cable. Sizing to be decided during DE as per sizing calculations.
b)	Output Connection Type	-	Bus Bar Type Spreaders
c)	Maximum permissible DC Current	-	Bidder to specify
4.	Enclosure details		
a)	Enclosure properties	-	FRP

Sl. No.	Item Description	Unit	Technical Requirement
b)	Cover Type	-	FRP Enclosure with hinged door
c)	Degree of Protection	-	IP 65
d)	Colour	-	RAL 7035
e)	Over all Dimensions	mm	As per design requirement
f)	Weight	-	Bidder to specify
g)	Gasket Material	-	Polyurethane
h)	Flammability rating	-	Bidder to specify
i)	Mechanical impact resistance	-	IK 10
j)	Door and Locking Arrangement	-	Hinged door with latch
k)	Type of cable entry	-	Bottom/ Glands – Heavy duty Double compression glands shall be PG Gland only
l)	Bus Bar Size/material	-	Copper
m)	Back plate thickness	mm	5 mm Bakelite
n)	Min installation height from bottom of SCB	mm	750
o)	Ventilation plugs	Nos.	As per design requirement

NOTE: Technical parameters indicated above are for SCB without monitoring.

Tests

- i. String combiner box should be IEC certified system and should have proven track record and working satisfactorily since last 5 years.
- ii. Bidder shall provide all the test reports / test certificates and compliance certificates during detailed engineering and before installation at site.
- iii. The following functional tests shall be carried out for SCBs:
 - a. High Voltage Test (HV Test)
 - b. Insulation Resistance Test at 2.5 KV DC
 - c. Continuity Test (Circuit Continuity)
 - d. Torque Test
 - e. Heat Run test

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Engineering schedule indicating list of drawings, documents, data, test certificates, manuals, etc. to be submitted by the Bidder together with dates of submissions and category of approval i.e., for approval or for reference.
- ii. GA & Cross-sectional drawings of each String Combiner Box.

- iii. Guaranteed Technical Particulars for String Combiner Boxes.
- iv. Bill of materials including make, technical specification, etc. for all equipment / accessories.
- v. Detailed cross-sectional drawings showing all relevant internal details of all equipment / accessories.
- vi. Drawing showing the terminal connection.
- vii. Detailed quality assurance plan.
- viii. Final test procedures (at shop as well as at site) and Test Set-Up.
- ix. Design calculations (wherever necessary) to prove adequacy of the equipment offered.
- x. Any other drawings/documents considered necessary.

Drawings / Documents for Information:

- i. All IEC Certifications.
- ii. Type test (including temperature rise test) certificates valid for five years for all equipment / accessories being supplied under this contract.
- iii. Routine test certificates for all equipment/accessories being supplied under this contract.
- iv. Instruction manual containing detailed instructions for all erection, testing, operation and maintenance requirements.
- v. Catalogue numbers of all components which need to be replaced during the life of the equipment.
- vi. Detailed instructions for the installation, operation and maintenance of AIS and accessories.
- vii. Maintenance procedures including precautions to be taken during operation and maintenance work.
- viii. All detailed catalogues and literature of equipment supplied.

3.1.3. Inverters

The design, manufacture, delivery, factory testing and inspection, delivery to site, installation and test commissioning shall be carried out as per latest applicable standards. The equipment shall be designed, engineered, and manufactured to achieve high availability and reliability.

The supplier shall arrange all specialized equipment / services necessary for proper erection, commissioning, and performance testing of all items of the equipment covered under this contract. The cost of the same shall be included in the contract price.

All routine and acceptance tests at Factory and Site acceptance tests shall be conducted as part of the contract with prior notice to Purchaser.

Codes & Standards

Codes	Description
IEC 62446	Grid connected photovoltaic system
IEC 62548	Photovoltaic Arrays
IEC 61683 with EN50530	Efficiency measurements
IEC 62116 / IEEE 1547 / UL 1741	Anti-Islanding
IEC 61000 -6-2/ 6-4	Electromagnetic compatibility (EMC) test
IEC 62109-1 and 2 / IEC 62103	Safety of power converter use in PV system

Codes	Description
IEC 60068 2 (1, 2, 14, 30), IEC 60068 2 (6 & 2-27), IEC 62093	Environmental testing
IEC 61439-1 & 2	Short circuit
IEC 60051	Indicating instruments
IEC60529	Degree of protection
IEC 60146	Semiconductor converters
IEC 60255-5	Surge withstand capability test in accordance with
IEEE-519	Harmonic levels

The inverters must be certified by an accredited laboratory by the worldwide certification system IECCE in the photovoltaics category according to the relevant standards as given above.

Design Criteria

- i. The Inverters shall be of 1500V DC grade.
- ii. Inverters shall be either Central or String Inverter for the entire project spreading over the blocks as per Plot Plan. The Bidder must study the land profile and provide best offers for the options. Bidder shall propose the block sizes in line with latest trends of MW scale project, so that the balance of system cost minimizes as well as maintain the reliability of performance.
- iii. Busbar to be used for AC/DC termination in the inverter shall be copper busbar only
- iv. Single Core AC Cables (from IDT to inverter) on inverter side shall be terminated by multi diameter glanding system (Roxtec Comseal AISI 316 or equivalent make) including Tapping of Auxiliary transformer if any.
- v. All AC and DC cables shall be terminated by Heavy duty long barrel Copper / Bimetallic Lugs as per system requirement. Further, DC cable entry shall be with Heavy duty double compression nickel plated Brass Glands.
- vi. Inverter shall be capable of meeting all the following grid code compliance through SCADA or dedicated Power Plant Controller.
 - a. Active Power Control
 - b. Reactive power capability and control
 - c. Reactive power injection at the grid Connection Point during night time
 - d. Fault-ride-through (FRT) requirement
 - e. Start-Up Requirement
 - f. Power Quality
- vii. Inverters shall be equipped with totally un-manned auto synchronization and de-synchronization facility, so that during power generation mode the inverter shall automatically get synchronized with the network and during sleep mode will automatically isolate.
- viii. The inverter output shall always follow the grid in terms of voltage and frequency and shall always remain synchronized with the grid. This shall be achieved by sensing the grid voltage and phase and feeding this information to the feedback loop of the inverter. Thus, control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation technology.

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- xi. Thus, control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation technology.
- xii. Inverter grid synchronization time shall be as less as possible or as per requirement of country grid requirement and relevant statutory requirements.
- xiii. The inverter shall be capable of adjusting its output voltage and frequency to suit the grid condition.
- xiv. The Inverter should have the option to expand the number of DC inputs with extension cabinets.
- xv. DC input terminals must be in enough numbers so as each terminal is connected to dedicated single input. Two DC inputs shall not be connected on the single input DC terminal of the inverter.
- xvi. If adequate number of inputs are not available in the selected inverter, then a DC junction box with protection devices such as fuse DC disconnects and copper busbar with rated current carrying capacity may be incorporated into design. The Bidder has to indicate the selected parameters in the Bid.
- xvii. The Inverter shall have provision for negative grounding. Inverter shall possess ground fault detector and interrupter function (GFDI). The fuses of the negative grounding system shall be as per UL 1741 standard.
- xviii. Insulation monitoring system shall be provided according to IEC 62109-2.
- xix. The inverter shall be with minimum auxiliary power consumption on-duty & off-duty. The Bidder is required to guarantee the auxiliary power consumption.
- xx. Incoming and outgoing connections to inverter and its external components shall be through cables. Entry & exit of cables shall be from bottom of the cubicles. Suitable gland plates shall be provided.
- xxi. Incoming connections to Central/String inverter and its external components shall be through cables, whereas connections between Central/String Inverter and Inverter duty Transformers shall be with suitably rated busduct or cables.
- xxii. The inverter system shall be complete with necessary filters to limit the harmonic distortions to the load.
- xxiii. The Inverter shall have self-diagnostic software with analogue and digital I/O interface for control and monitoring.
- xxiv. The Inverter shall also have remote start and stop facility.
- xxv. The inverters should retain the maximum efficiency at high temperatures.
- xxvi. The minimum European efficiency of the inverter shall not be less than 98% measured at 100% load as per IEC 61683 standards for measuring efficiency.
- xxvii. The Bidder shall specify the conversion efficiency of different loads i.e. 25%, 50%, 75% and 100% in the Bid. The Bidder should specify the overload inverter capacity in the Bid.
- xxviii. The inverter power clipping shall be restricted to the extent possible to minimize the loss of power generation.
- xxix. Proper cooling mechanism shall be adopted for the Inverter to maintain the temperature rise at an optimum level and mitigate the loss of generation due to high temperatures.
- xxx. The DC input cable size that the inverter can accept, without any termination issues, shall be furnished by the Bidder.
- xxxi. The AC power output in case of Central or String Inverter shall be? with non-segregated phase busduct or cables of suitable size as per requirement with proper design margin.
- xxxii. Inverter shall have an inbuilt system for meeting its own auxiliary power requirement.
- xxxiii. For inverter station Auxiliary power requirements can be tapped from LV side of IDT with required protection on primary and secondary auxiliary transformer.
- xxxiv. Inverters shall be selected with respect to the local climatic and environmental conditions and equipped to withstand high amounts of dust in the air and high temperatures.
- xxxv. Inverter shall be provided with zone monitoring as a part of the base offer.

- xxxvi. Inverter shall measure the Voltage, current and calculated power for each of its DC input.
- xxxvii. Availability of individual inverter should be more than 98% and overall plant inverter availability shall not be less than 99.5%. Both the availability and up-time requirement shall be guaranteed by the manufacturer for 25 years.
- xxxviii. In case of failing to achieve this due to failure of any component of inverter the Bidder shall either replace the inverter or the component at his own cost.
- xxxix. DC input terminals must be in enough numbers so as each terminal is connected to dedicated single input. Two DC inputs shall not be connected on the single input DC terminal of the inverter.
- xl. If adequate number of inputs are not available in the selected inverter, then a DC junction box with protection devices such as fuse DC disconnects and copper busbar with rated current carrying capacity may be incorporated in to design. The Bidder has to indicate the selected parameters in the Bid.
- xli. In case of outdoor Central / String Inverter shall be installed on the platform, height of platform shall be such that cable bending radius, water logging not touch cable terminals, cooling is maintained and other relevant factors. The platform shall be covered by at least 60 cm extended canopy on all sides.

Inverter Protection

- i. Inverter DC input side shall be provided with Motorized DC Isolator with fuse / LBS for each incoming DC cable from SCB and output side with AC Air circuit breaker.
- ii. Air circuit breaker as required can be provided as a part of Inverter or separately based on standard design and configuration of Inverter manufacturer. The ACB shall be able to withstand the maximum fault current for minimum one sec duration.
- iii. ACB shall be provided with electronic protection unit as per system requirement.
- iv. Since big Inverter two nos. of Motorized DC Isolator may be provided, so that in case of fault in any DC cable at least 50% generation shall not be affected.
- v. The inverter shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of inverter component failure or from parameters beyond the inverter's safe operating range due to internal or external causes. Faults due to malfunctioning within the inverter, including commutation failure, shall be cleared by the inverter protective devices.
- vi. During low ambient temperature, output from PV Modules will be higher than at high ambient temperature. Suitable protection system shall be provided for the same.
- vii. The following minimum protections shall be provided for inverter:
 - a. Reverse polarity
 - b. Reverse power
 - c. AC-DC Over-current
 - d. Overload protection
 - e. Earth fault protection (Alarm and Trip)
 - f. GFDI and PV Array insulation monitoring
 - g. Anti-Islanding feature
 - h. AC-DC Under / Overvoltage
 - i. Under / Over frequency
 - j. Surge protection (Type I +II)
 - k. Short circuit protection
 - l. Over temperature protection
 - m. Power regulation in the event of thermal overloading
 - n. Fault Ride through (LVRT and HVRT)
 - o. Surge protection for auxiliary and communication circuits
 - p. Cooling System failure protection Synchronization Loss Protection
 - q. Emergency Stop Button on Inverter front panel for tripping Inverter with complete DC and AC electrical isolation

- ii. The inverter shall have protection against any sustained fault in the feeder line and against lightning discharge in the feeder line. The inverter shall also have the adequate protection against earth leakage faults.
- iii. Internal surge protection device (SPD) shall be provided in both the inverter on DC and AC side.
- iv. In case of grid failure, the inverter shall get desynchronized and re-synchronized with grid after revival of power supply. Bidder to furnish the time taken by inverter to re-synchronize after restoration of grid supply during detailed engineering.
- v. Inverter shall also conform to IEC 62109 or equivalent international standard for compliance to requirement for the design and manufacture of inverter for protection against electric shock, energy, fire, mechanical and other hazards.

Indications & Annunciation

The Inverter system shall be provided with necessary meters, mimic diagram, local indication / alarm conditions.

Control & Monitoring

- i. The Inverter control system shall be fully compatible for remote operation via communication link.
- ii. Inverters shall have suitable communication card (Modbus TCP/IP) for networking and SCADA integration and same shall support dual master communication. Inverters shall include all important measured and internal calculated analogue values and alarm & trips signals for remote monitoring, storing and report generation purpose in SCADA system. Detailed list of above such parameters shall be provided along with their Modbus address during detailed engineering stage.
- iii. Dedicated Prefab compartment required for Ethernet for networking
- iv. Bidder shall indicate the type of communication protocol, supported by the Inverter along with the details of links provided for controlling from local control system and Power plant controller. The control system shall operate on windows or equivalent platform. The following minimum operating conditions shall be annunciated.
 - a. Inverter Failure
 - b. Power stack over temperature
 - c. Breaker/ Disconnect failure
 - d. Over load
 - e. Over load shutdown
 - f. Emergency shutdown
 - g. DC Circuit breaker / switch open
 - h. AC Main failure
 - i. Fan failure
 - j. Asynchronous condition and synchronous condition
 - k. Control power failure
 - l. DC ground fault
- v. The inverter shall also have following features:
 - a. Maximum loss in sleep mode shall be less than 0.05% of rated power.
 - b. Set point pre-selection for Active power and VAR control.
 - c. Unit wise and integrated data logging.
 - d. Dedicated Ethernet for networking.
 - e. Protection against sync loss, over temperature, cooling system failure.
 - f. Power regulation in the event of thermal overloading.
 - g. Bus communication via interface for integration.
 - h. Integrated protection in the DC and three phase system.

- i. Ground fault detector to sense discharge current with respect to ground.
- j. Insulation monitoring System
- k. Self-diagnostic software
- l. I/O interface for control and monitoring
- m. Remote start and stop provision
- n. Anti-Islanding protection
- o. The inverter should be self-managing and stable in operation. A self-diagnostic system check should occur on start-up. Functions should include a test of key parameters on start-up.
- p. <3% of nominal power Harmonics

Harmonics

Necessary input and output filters shall be provided for the inverter. Design shall be such that the harmonics injected back to the source and to the load shall be within limits specified in IEEE-519 at the point of interconnection of the Inverter to the system.

General warranty & Service

The minimum inverter guarantees given by the manufacturer shall be include Workmanship guarantee: product guarantee against manufacturing defects for a minimum period of 5 years after Actual Facility Date. Extended warranty of 25 years shall be provided.

Power plant Controller

Power plant controller (PPC) for meeting grid connectivity shall be a dynamic system that will control the PV Inverters to fulfil the Grid utility requirements regarding the active and reactive power control.

PPC shall be designed to get a fast and accurate response at the point of connections of the PV Plant according to the set-points received from the grid authority.

The main features of the PPC shall be as follows:

- i. Reactive Power operating modes
 - a. Voltage control
 - b. Power factor control
 - c. Constant Reactive power control
 - d. Reactive power control for low power and power factor control for high power
- ii. Active Power operating modes
 - a. Active Power curtailments
 - b. Ramp rate control

Technical Parameters

Sl. No.	Item Description	Unit	Technical requirement
1.	Inverter type	-	Central or String
2.	Installation	-	(Outdoor/PV Station container)
3.	Switching devices	-	IGBT
4.	Control	-	Microprocessor / DSP

Sl. No.	Item Description	Unit	Technical requirement
5.	Maximum DC input voltage	V	1500
6.	MPPT Voltage range	V	To be selected by Bidder
7.	Number of MPPT		Single MPPT or Multi-MPPT
8.	Output Frequency	Hz	50
9.	Design ambient temperature without derating	°C	-10 to 35
10.	Operating temperature	°C	-10 to 50
11.	Number of SCB/DC inputs	No.	The number of inputs shall be decided based on layout requirement
12.	Input DC fuse box	-	Integrated
13.	Operating power factor range of Inverter	-	0.8 lead to 0.8 lag
14.	Maximum permissible DC:AC ratio at 50°C	-	1.5
15.	Maximum/peak efficiency, European Efficiency	%	98.0 (minimum) / As per IEC 61683
16.	European Efficiency		As per IEC 61683
17.	Degree of protection	-	IP 54 or better for containerised solution and IP 65 or better for direct outdoor
18.	Surge protection (AC and DC) for central inverter	-	Type I + II
19.	Grid support	-	Compliance to (Technical standards for connectivity to grid)
20.	Dynamic Active and Reactive power control	-	Required
21.	Power Plant Controller	-	Bidder to decide the requirement for meeting requirement
22.	Reactive power support during night-time at the grid connection point	-	Required
23.	Maximum total harmonic distortion	%	<3% at nominal power
24.	DC Injection		<0.5% of rated current

Sl. No.	Item Description	Unit	Technical requirement
25.	Flicker		As per Standards
26.	System availability	%	99.0~99.5
27.	Noise / acoustic level	dB	< 75 dB (A) at 1 m
28.	Zone Level Monitoring	-	To be provided
29.	Visual Display	-	Colour LCD/LED display with touchscreen
30.	SCADA Interface	-	Modbus TCP-IP
31.	Nominal AC output voltage	-	As per design requirement
32.	Humidity	-	95 % non-condensing
33.	Anti PID	-	Required

Inverter Data required for system study

- i. Make
- ii. Model Name
- iii. Type of Inverter (MW @ Temp)
- iv. Data Sheet
- v. PSSE manual shall be available in English along with OEM model
- vi. PSSE Generic model shall be compatible with version 34*.dvr file of the inverter
- vii. Site measurement report / validation report for inverter model
- viii. Power quality test report (DC Injection and Flicker)
- ix. Test report (LVRT/HVRT field test results of actual inverter at site)
- x. Harmonic test (current) report with 10% increment in active power starting from 0% up to 100% of rated power
- xi. Capability Curve for various temperature (from 35-51 deg C)
- xii. Inverter short circuit modelling of Renewable Sources in line with NCSFC (non-conventional source fault current) modelling and Voltage droop characteristics
- xiii. Protection settings of the inverter in *.dvr file.
- xiv. Block diagram of the inverter controller {controller transfer function (can be obtained from inverter manufacturer)} with suitable parameter sets and the technical documentation
- xv. Inverter benchmarking report (actual model with PSSE and PSCAD model) if inverter benchmarking report is done with PSSE UDM model, one to one comparison and mapping between PSSE UDM & generic model should be provided.

Drawing/Models/Documents/Compliances for First time charging

Bidder shall provide all technical details including Inverter bench marking report, Generic model data of Inverters, suitable for use in PSS/E and PSCAD software available at RLDC and Encrypted user-defined model (UDM)/generic model of Inverter in PSS/E software (*.dll files) as applicable. Provision of PSCAD model of inverter shall also be in Bidder's scope. In case any site testing required for grid compliance as per RLDC, it shall also be conducted.

- i. Make

- ii. Model name
- iii. Capacity of inverter (mw @ temp)
- iv. Type of inverter (Central / String)
- v. Datasheet
- vi. PSSE manual shall be available in English along with OEM model
- vii. PSSE Generic model shall be compatible with version 34
- viii. *.dyr file of inverter
- ix. Site measurement report / validation report for inverter model
- x. Power quality test report (dc injection and flicker)
- xi. Test report (lvrt/hvrt field test results of actual inverter at site)
- xii. Harmonic test (current) report with 10% increment in active power starting from 0% up to 100% of rated power
- xiii. Capability curve for various temperature
- xiv. Inverter short circuit modelling of renewable sources in line with ncsfc (non-conventional source fault current) modelling and voltage droop characteristics
- xv. Protection settings of the inverter in *.dyr.
- xvi. Block diagram of the inverter controller {controller transfer function (can be obtained from inverter manufacturer)} with suitable parameter sets and the technical documentation
- xvii. Inverter benchmarking report (actual model with PSSE and PSCAD model)
- xviii. If inverter benchmarking report is done with PSSE UDM model, one to one comparison and mapping between PSSE UDM & generic model should be provided.

Tests

Following minimum tests shall be performed as routine tests on the Inverter as per IEC 62109, IEC 61727, IEC 62116, IEC 61683, IEC 60068, IEC 61000 and other relevant standards:

- i. Main circuit HV test and IR test.
- ii. Main circuit IR test after performing HV test
- iii. Automatic Start/Stop with grid
- iv. Inverter efficiency
- v. Grid-connection current harmonics at different loads
- vi. MPP Tracker test
- vii. Power factor measurement at different load
- viii. Output power control
- ix. Anti-Islanding protection test
- x. Grid-connection recovery test
- xi. AC Over/under-voltage protection
- xii. Over/under-frequency protection
- xiii. DC over voltage protection
- xiv. Protection functions check
- xv. Synchronization test
- xvi. Fan on/off and direction of rotation check
- xvii. LCD Display panel check
- xviii. Functional test on communication circuit

- xix. Heat run test-on one unit per Lot offered for Inspection. Heat run test shall be carried out for inverter system at rated load under relevant ambient conditions.
- xx. Load test in steps of 25%, 50%, 75% and 100% loads.
- xxi. Noise level test

The following Test Reports for the supplied Inverter shall be furnished:

- i. LVRT and HVRT test report
- ii. Flicker test report
- iii. Harmonic test report
- iv. Short circuit type test report
- v. Max and Min Continuous Voltage Operation Test Report
- vi. Active Power Ramp Up Test Report

Apart from the above mentioned, tests which are necessary as per standard requirement shall be performed by the vendor. Test certificates for all components used in the inverter shall be furnished. All the instruments used shall have valid calibration certificates.

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Document specifying product technical information along with datasheet
- ii. Valid test certificates not older than 5 years
- iii. Quality assurance plan, FAT/SAT procedure
- iv. Field Quality Plan
- v. Methodology and write-up on the Grid support provided by the Inverter at the point of interconnection
- vi. Methodology and write-up on the Active and reactive power support provided by the Inverter at the point of interconnection
- vii. Methodology and write-up on the Reactive power support at night time provided by the Inverter at the point of interconnection
- viii. Product warranty document
- ix. Schedule of manufacturing and delivery

Drawings / Documents for information:

- i. Installation manual
- ii. Inverter data sheets, reactive power capability diagram (P-Q characteristic), mathematical models of inverter control system.
- iii. Harmonic spectrum of the inverters for harmonic analysis.
- iv. Recommended spare parts list
- v. Printed instructions to receive, store and handle the Inverter at site
- vi. Inverter data required for system study

3.1.4. Solar Cables

Cables for interconnection between PV modules and string combiner box shall be of suitable voltage grade to suit the maximum output voltage applicable. The DC design voltage for this project is 1500V. The design and engineering shall make use of most recent international standards and best design practices

Codes	Description
BS EN 50618	Electrical Cables for Photovoltaic system
EN 50619:2014	DC cable for Photovoltaic system
BS EN 60228	Standard for Copper Conductor
IEC 60332-1	Fire performance
IEC 60287	Electric cables – Calculation of the current rating
IEC 60216	Temperature index and service life of over 20 years
IEC 60754-1	Halogen free
IEC 60811	Resistant to chemicals and oils
IEC 62548	Photovoltaic (PV) arrays – Design requirements

Design Criteria

- i. The cables between the PV modules end to combiner box shall have the following specific requirements:
- ii. All cables shall conform to the requirements of the following standards and codes EN 50618, 50619:2014.
- iii. All cables shall be flame retardant, low smoke minimum FRLS, UV protected type designed to withstand all mechanical, electrical, and thermal stresses developed under steady state and transient operating conditions.
- iv. Conductors shall be electrolytic grade high conductivity annealed tinned copper. Conductors shall be multi-stranded, smooth, uniform in quality and free from scale and other defects.
- v. Cables shall be of solar grade and have insulation, inner sheath and outer sheath shall be of high-grade cross-linked compound as per EN 50618.
- vi. Cable employed for series connection of PV modules through MC4 connectors shall be of 6 sq mm size. 6 sq.mm cable to be used for Y-connector configuration.
- vii. The DC cabling up to Inverter shall be designed such that the average DC ohmic power loss at actual site ambient temperature does not exceed 1.5%.
- viii. The outer sheath colour of DC cable shall be black and red. The ratio of black and red cable shall be 50:50. All Positive terminals of PV module shall be connected with red cable and all negative terminals of PV module shall be connected with black coloured cable.
- ix. Cables used for inter-connecting SPV modules as well as Modules to SCB's shall conform to the requirements of EN 50619:2014 applicable for DC cable for photovoltaic system.
- x. The cables shall be laid in HDPE conduits. The HDPE conduit fill factor shall be restricted to 50%.
- xi. No joints in cable shall be allowed between terminating points i.e. cables from solar PV module to SCB.
- xii. DC Cable shall have Lifetime reliability lasts up to 25 years even under tough external conditions.
- xiii. The cables specifications / design shall be suitably selected as per laying final philosophy/ methodology decided during detail engineering by the Bidder considering the site environmental conditions etc. Bidder shall submit the final specification with methodology for Employer's Approval. All DC cable shall be fully recyclable in accordance with new environmental regulations.

- xiv. In addition to manufacturer's identification on cables as per EN50618, following marking shall also be provided over outer sheath.
- Cable size, voltage grade and code designation "PV"
 - Word FRLS /Actual specification
 - Sequential marking of length of the cable
- xv. The distance between two consecutive printing, identification or embossing shall not be more than 550 mm. The Printing shall be progressive, automatic, in line and marking shall be legible and indelible.

Technical Parameters

Sl. No.	Item Description	Unit	Data
	General		
1.	Cable Size	Sq.mm	Shall be decided during detail engineering.
2.	No. of cores	Nos.	1
3.	Specification/Construction	-	BS EN 50618
4.	Rated Voltage	Vdc	1500 V
5.	U ₀ /U	kV	1.5/1.8
6.	AC Test voltage	kV	6.5
7.	Max Permitted DC Voltage	V	1800 V DC
8.	Temperature Range		
	a) Max Temperature at Conductor	°C	120°C
	b) Short Circuit Temperature for 5 sec.	°C	250 °C as per BS EN 50618
9.	Conductor		
	a) Material	-	Annealed tinned Copper (as per EN 60228)
	a) Flexibility class	-	Class-5 (as per EN 60228)
10.	Insulation		
	a) Material	-	Polyolefin Copolymer electron-beam cross linked (XLPO)
	b) Nominal thickness	mm	0.7
	c) Outer Sheath		

Sl. No.	Item Description	Unit	Data
10.	Material	-	Polyolefin Copolymer electron-beam cross linked (XLPO) with anti-termite and anti-rodent
	a) Minimum thickness of sheath (with tolerance)	mm	0.8
	b) Nominal Overall Diameter (with tolerance)	mm	As per manufacturer
11.	Required Properties		
	a) Weathering / UV resistance	-	As per BS EN 56018 (Annex E)
	b) Flame retardant	-	As per EN 60332-1-2:2004
	c) Halogen free	-	As per EN 50525-1:2011
	d) Ozone resistant	-	As per EN 50396:2005 (Annex B)
	e) Acid and alkaline resistance	-	As per EN 60811-2-1
	f) DC cable for Photovoltaic system		EN 50619:2014
	g) Colour Coding	-	The ratio of black and black with red stripe cable shall be 50:50
12.	Drum		
13.	Type	-	Steel
	a) Packing length (along with tolerance)	M	As per manufacturer (only positive tolerance allowed)
	b) Sequential Marking on the cable	-	Required
14.	Type of end sealing	-	Required

Tests

All the tests shall be performed as per latest IEC/IS standards.

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Cross section of all cables.
- ii. QAP for all cables.
- iii. Technical specification & GTP, etc. for all cables.
- iv. Final test procedures (at shop as well as at site) and Test Set-Up.
- v. Design calculations (wherever necessary) to prove the adequacy of the equipment offered.
- vi. Any other drawings/documents considered necessary.

Drawings / Documents for information:

- i. Continuous current rating of the cable
- ii. General technical data
- iii. Construction details including type of material used and thickness of each material for each type of cable in a tabular form.
- iv. Instruction Manuals
- v. Type/Routine test certificates for all types of cables included in the order and special tests on FRLS/FS cables in line with applicable standard.
- vi. All detailed catalogues and literature of Cables supplied.

3.1.5. SCB To Inverter Cable (1.9/3.3 kV)**SCB to Inverter Cable (1.9/3.3 kV)**

1.9/3.3kV Power cables shall be provided from string combiner box up to the Inverter. The design and engineering shall be as per latest Indian standards or IEC standards.

Codes & Standards

Codes	Description
IEC 60502	Power cables with extruded insulation and their accessories
IEC 60287/IS 3961	Recommended current ratings for cables
IS 7098	Cross linked polyethylene insulated PVC sheathed cable for (Part -II) working voltage from 3.3KV up to & including 33 KV
IS 3975	Low Carbon Galvanized steel wires formed wires and tapes for armoring of cables.
IS 5831	PVC insulation and sheath of electrical cables.
IS 8130	Conductors for insulated electrical cables and flexible cords.
IS 10810	Methods of tests for cables.

General and Installation Requirements

- i. The cable shall be 1.9/3.3kV Grade, high conductivity stranded compacted circular aluminium conductor, single core, XLPE insulated, galvanized steel strip armoured with overall separate extruded minimum FRLS PVC ST2 outer sheath. Alternatively, HDPE Outer sheath (ST-7) with UV Resistant property as per IEC 60502-1 standards shall also be acceptable.
- ii. The insulation of each core and outer and inner sheath, shall comply with the IS: 5831. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.
- iii. Armouring shall be hot dip galvanized steel strip for DC application cables, whereas the same shall be of aluminium for AC application cables. The dimensions of armour shall be as per table 4 of IS:7098 (Part-II)/1985 and its latest amendment and strip shall conform to latest provisions of IS: 3975 -1988 and amendment thereof.

- iv. Extruded PVC outer sheath of type ST-2 over armouring with suitable additive to prevent attack by fungus, rodent and termite with suitable thickness. Alternatively, HDPE Outer sheath (ST-7) with UV Resistant property as per IEC 60502-1 standards shall also be acceptable.
- v. The nominal diameter of the armour shall be as the fictitious diameter under the armour according to IEC 60502-1.
- vi. All materials used in the manufacture of cable shall be new, unused and of finest quality. All materials shall comply with the applicable provisions of the tests of the specification.
- vii. The PVC material used in the manufacture of cable shall be of reputed make. No recycling of the PVC is permitted. The purchaser reserves the right to ask for documentary proof of the purchase of various materials to be used for the manufacture of cable and to check that manufacturer is complying with quality control.
- viii. Short circuit ratings of various sizes cable calculated for duration of one second at maximum temperature of 250° C.
- ix. No cable joint to join two cable ends shall be accepted except if single cable length as per OEM does not meet the requirement.
- x. Weatherproof double compression type Cable glands made of heavy-duty brass machine finished and nickel chrome plated shall be provided for cable glanding, Thickness of plating shall not be less than 10 microns.
- xi. All Cable lugs shall be Heavy duty long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve.
- xii. The cables specifications / design shall be suitably selected as per laying final philosophy/ methodology decided during detail engineering by the Bidder considering the site environmental conditions etc. Bidder shall submit the final specification with methodology for Employer's Approval
- xiii. Color of the outer sheath shall be black for negative pole and red for positive pole.
- xiv. In addition to manufacturer's identification on cables as per EN50618, following marking shall also be provided over outer sheath.
 - a. Cable size, voltage grade and code designation "PV"
 - b. Word ' FRLS/Actual specification'
 - c. Sequential marking of length of the cable
 - d. Employer's name

Design Criteria

DC power cables shall be sized based on current carrying capacity, short circuit rating and permissible power loss as specified under relevant performance guarantee clauses.

The DC cabling up to Inverter shall be designed such that the average DC ohmic power loss at actual site ambient temperature does not exceed 1.5%.

Current carrying capacity:

The cable shall be able to carry the full load current of the circuit continuously under the specified ambient temperature and other conditions of installation. For this purpose, suitable de-rating factors shall be considered due to:

- i. Thermal resistivity of soil.
- ii. Ambient ground / Air temperature.
- iii. De-rating factor for grouping of cables over the current ratings at normal conditions given in standards. The design ambient temperature for this plant shall be considered as -10 to 35°C.

Permissible power loss:

DC power loss shall be limited such that overall plant DC ohmic loss shall be within permissible limit as specified under relevant performance guarantee clauses.

Technical Parameters

Sl. No.	Description	Unit	Technical Requirements	
1.0	General requirements			
1.1	Voltage Grade	kV	1.9/3.3 kV	
1.2	Core	-	Single	
1.3	System Details			
	a) Nominal Power System Voltage	kV	1.5	
	b) Maximum System Voltage	kV	1.8	
	c) System Neutral Earthing	-	Not Applicable as used for DC system	
1.4	Design Ambient Temperature	°C	-10 to 35	
2.0	Conductor Material	-	Copper/Aluminium H2 grade	
	a) Flexibility Class	-	Class 2	
	b) Shape of conductor	-	Stranded & compacted	
3.0	Cable Size	-	As per cable sizing requirement	
4.0	Insulation	-	Extruded XLPE	
5.0	Insulation thickness	mm	2.0	
6.0	Temperature Range (as per IEC 60502-2) / IS 7098 part-2)			
	a) Maximum operating temperature at rated current	°C	90	
	b) Short Circuit Temperature for 1 sec.	°C	250	
7.0	Armouring	-	For AC application	For DC application
			Aluminium	Hot dip galvanized steel
8.0	Outer Sheath	-	Minimum FRLS PVC Compound (ST-2), HDPE Outer sheath (ST-7) with UV Resistant property as per IEC 60502-1 standards shall also be acceptable.	
9.0	Colour Code	-	Colour of the outer sheath shall be black for negative pole and red for positive pole	
10.0	Packing length with tolerance	-	No negative Tolerance	
11.0	Sequential Marking on the cable	-	Manufacturer name, voltage grade, Size of cable, Type of cable and Year of manufacture, Employer's name and PO at every one-meter interval	
12.0	Seismic Acceleration		Zone- V as per IS 1893	
13.0	End sealing	-	Required	

Tests

Sl. No.	Description	Technical Requirements
1.0	Routine tests	
	a) Electrical resistance of conductors	As per IEC 60228
	b) Partial Discharge test	As per IEC 60885-3
	c) Voltage test	As per IEC 60502-2
	d) Overall Diameter test	As per IEC 60502-2
2.0	Sample tests	As per IEC 60502-2
3.0	Type tests	
	a) Bending test	As per IEC 60502-2/ IS 3961
	b) Partial Discharge test	
	c) Tan δ measurement for cables	
	d) Heat cycle test	As per IEC 60502-2/ IS 3961
	e) Impulse test followed by a voltage test	
	f) Voltage test for 4 h	
	g) Impulse test	As per IEC 60502-2/ IS 3961
	h) Insulation resistance measurement at maximum conductor temperature	As per IEC 60502-2/ IS 3961
4.0	Type tests, non-Electrical	
	a) Measurement of thickness of insulation	As per IEC 60811-1-1
	b) Measurement of thickness of non-metallic sheaths	As per IEC 60811-1-1
	c) Tests for determining the mechanical properties of insulation before and after ageing	As per IEC 60811-1-2
	d) Tests for determining the mechanical properties of non-metallic sheaths before and after ageing	As per IEC 60811-1-1
	e) Additional ageing test on pieces of completed cables	As per IEC 60811-1-2
	f) Loss of mass test on PVC sheaths of type ST2	As per IEC 60811-3-2
	g) Pressure test at high temperature on insulations and non-metallic sheaths	As per IEC 60811-3-1
	h) Test on PVC insulation and sheaths at low temperatures	As per IEC 60811-1-4
	i) Test for resistance of PVC insulation and sheaths to cracking (heat shock test)	As per IEC 60811-3-1
	j) Water absorption test on insulation	As per IEC 60811-1-3
	k) Shrinkage test for XLPE insulation	As per IEC 60811-1-3
	l) Thermal stability test for PVC insulation	As per IEC 60811-3-2
	m) Flame spread test on single cables	IEC 60332-1-2
	n) Shrinkage test for PE over sheaths	As per IEC 60811-1-3

Sl. No.	Description	Technical Requirements
5.0	Acceptance, Routine and Type tests for HDPE outer sheath (ST-7) cables	As per IEC 60811

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Completely filled-in Data Sheets and Schedules.
- ii. Technical particulars of cable cross sectional drawing, QA Plan and technical catalogues.
- iii. Estimated weight of cables and cable drums.
- iv. Experience list where cables of similar rating and sizes have been installed and are in satisfactory operation.
- v. Type test certificates/reports for the equipment covered in the specification issued by a National or International Testing Authority.
- vi. Any other drawings/documents considered necessary

3.1.6. Module Cleaning System

Scope

The purpose of this section is to describe technical details for Design, Construction, Supply, transportation, Installation, and commissioning along with mandatory training of O&M personnel about Module cleaning system for Photovoltaic solar power plant as per details given below. The design and engineering shall make use of most recent international standards and best design practices.

Proposed Cleaning System

The Bidder Shall Install a Permanent Fresh Water based Wet cleaning system.

Design Consideration and General System Requirements for Wet Cleaning System

- i. Bidder to consider the supply of water in scope includes laying the piping system from source of water system up to the Module cleaning system.
- ii. Permanent arrangement shall be made by Bidder for Module cleaning system comprises HDPE Piping network, Pumps & Motors, PVC / FRP Tanks, & all other equipment/ materials/ arrangements and foundations required to complete the system in complete manner to fulfil the purpose. The module cleaning system shall be complete in all respect and the details shall conform to the relevant IS codes.
- iii. The Bidder shall install flow meter at pump discharge/ main header for measurement of water consumption.
- iv. Bidder shall calculate water requirement by considering at least 3 Litres per Module and anticipated water wastage and Leakage.
- v. Module cleaning system shall be designed by considering the modules shall be washed once in 15 days.
- vi. Water storage tank capacity shall be finalized by considering 2 days buffer storage.
- vii. MCS shall have Either Web page monitoring & control or SCADA monitoring & control and dedicated PLC/controller to provide at least the following data.
 - a. Pump on-off status.
 - b. Pump on-off control (Remote)
 - c. Water level status.
 - d. Water consumption.
 - e. Discharge Pressure
- viii. The Bidder shall provide the Modbus communication details and mapping list for integration of MCS with SCADA system.
- ix. The module cleaning system piping network shall be close looped pipe network configuration consists of Main pipe, submain, and branches with isolating valves on both sides.

- x. Entire MCS design, drawings and piping and the instrumentation diagram (P&ID) of Module cleaning arrangement including but not limited to Water source point, storage tank, Pumps & panels, pipelines including the sequence of Headers, branches, reducers, valves, pressure gauge, recirculation line, tapping points shall be submitted by Bidder for approval of Employer during detailed engineering.
- xi. Tapping Points shall be made of CPVC pipe with manual isolating valves & Quick release couplings and shall be provided at regular intervals for fixing the 50 Meter detachable Hose pipes to cover and spray water on entire PV Array area.
- xii. The Entire HDPE Piping network shall be laid at least 300mm below the NGL/FGL
- xiii. The HDPE pipe shall be suitably protected against any impact load. The Piping network at Road crossings and wherever higher loads are expected shall be laid 600mm below the NGL/FGL and covered with higher diameter GI pipe / NP3 Hume pipe at for protection against any heavy loads etc. The Bidder may also propose some other protection system for HDPE pipes.
- xiv. If underground laying is not possible at any location due to hard rock or any site-specific problems, then above ground laying shall be done on concrete Pedestals or anchors subjected to approval during detail engineering.
- xv. All HDPE Joints & fittings shall be Electro fusion type.
- xvi. All fasteners shall be of SS 304 or better grade to fulfill the site requirement for at least 25 years, in case of J-bolts prior approval shall be obtained.
- xvii. The entire water washing system shall be tested for minimum 0.5 N/mm² or 1.5 times of the maximum working pressure, whichever is greater.
- xviii. Minimum pressure at the outlet of Nozzle shall be 5 Bar
- xix. Necessary arrangements shall be made by the Bidder to avoid entry of foreign materials like, earth, sand leaf, gravels, etc. into the pipeline network.
- xx. Piping network of Module cleaning system shall be interconnected using isolating valves, so as module cleaning shall be continued in case of outage of any sub-system.
- xxi. Air Release Valves (ARV) shall be provided at every branch line at highest elevation point in the line to ensure that there is no surging or hammering in the pipelines.
- xxii. Prefab Chambers along with bases and removable covers shall be used to protect all valve assemblies.
- xxiii. Canopy shall be installed along with necessary foundation to protect pumps & tanks. Bidder to refer the Corrosion category as specified in technical specification and grade of concrete accordingly.
- xxiv. Suitable Earthing shall be provided as per I.E Rule/Act.

Data to Be Furnished by Bidder After Award of Contract:

Drawings / Documents for Approval and or Information:

- i. Layouts with all necessary details
- ii. GA, Data Sheets & Cross-sectional drawings
- iii. Guaranteed Technical Particulars
- iv. Design Documents with All required calculations
- v. Detailed quality assurance plans.
- vi. Any other drawings/documents considered necessary.
- vii. Test Reports
- viii. Instruction manuals
- ix. Warranty Certificates
- x. Detailed instructions for the installation and operation.

Any Design, Drawings, Test reports and any other documents which are required and related to the system shall be submitted for Employer's approval or Information as and when requested.

Guaranteed Technical Parameters (GTP)

The Bidder shall furnish the guaranteed minimum technical particulars as stated below.

Item	Description	UoM	To be filled by Bidder
General	Total no of modules in plant	Nos	
	Frequency of cleaning each module	Days	
	No of module to be cleaned per day	Nos	
	Considered cleaning time	Hrs	
	No of nozzles to be operated simultaneously	Nos	
	Water pressure at Nozzle outlet	Bar	
	No of module to be cleaned per hr	Nos	
Water	Water required to clean each module	Lit	
	Water required per day cleaning	Lit	
	Water required per cleaning cycle	Lit	
	Assumed water loss in network	%	
	Water loss in network	Lit	
	Water flow rate required for module cleaning	Lit/hr	
Pipe	Main Pipe Size considered	Mm	
	Main Pipe rating	PE & PN	
	Branch Pipe size Considered	Mm	
	Branch Pipe rating	PE & PN	
Pump	Pump flow rate	L/M	
Tank	Water tank capacity with 2 days storage	KL	

3.1.7. ESE Lightning Protection for PV Yard

Lightning Protection for PV Yard

ESE type lightning protection shall be provided to protect all building / tall structures and PV array from direct lightning strikes. The purpose is to reduce the over voltage due to atmospheric disturbances such as lightning, etc. to a safe level before it reaches the PV or other sub-system components. The design and engineering shall make use of most recent international standards and best design practices.

Codes & Standards

Codes	Description
NFC 17-102 :2011	Protection against lightning
IEC 60068	Environmental testing for electronic component
EN ISO 6988:1997	Metallic and other non-organic coatings sulfur dioxide test with general condensation of moisture
EN 62561	Lightning protection system component

Design Criteria

- The system shall include components viz., air termination equipment, Lightning Flash Counter, mechanical support, down conductor(s) and maintenance free earthing system.

- ii. The ESE lightning conductor shall operate permanently with both positive & negative lightning strikes.
- iii. Necessary foundation / anchoring for holding the lightning conductor in position to be made after providing due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.
- iv. Supply of one nos of minimum 35 sq.mm of PVC ST2 insulated flexible single core copper down conductor along with the fixing accessories along the ESE lightning arrester.
- v. Each lightning arrester should be provided with a Lightning Strike Recorder (LSR) and mounted on a down conductor to effectively count the number of lightning strikes captured by the ESE Terminal.
- vi. Minimum Two numbers of dedicated maintenance free earth pits shall be provided for each lightning arrester. Detailed specification of earth pits shall be as mentioned elsewhere in the tender document.
- vii. No shadow shall fall on PV Modules between 09:00 AM to 04:30 PM due to ESE LA structures. Appropriate care shall be taken while designing PV array layout.
- viii. Number and location of ESE air terminal shall be decided during detail engineering. For this purpose, design calculation considering protection level IV (minimum) and AutoCAD drawing of the layout of ESE terminal shall be submitted to Employer for approval.

Technical Parameters

Sl. No.	Item Description	Unit	Data
1.	Technology	-	Early Streamer Emission
2.	Reference Standard	-	NFC 17-102
3.	Level of Protection	-	Level - IV
4.	Radius of Protection	M	107 (Maximum)
5.	Height of mast	M	5, above PV Module structure
6.	Down conductor Material	-	Copper
7.	Lightning Strike Recorder Degree of Protection	-	IP 67
8.	Material of mast	-	Galvanized Iron, Hot dip galvanized
9.	Seismic Acceleration		0.36g
10.	Test Link	-	Required
11.	Guy wire	-	As per design requirement

Type test certificates as per relevant standards for the tests conducted be submitted for review and record.

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Bidder shall submit the drawings, calculations and detailed specifications of the PV array lightning protection equipment
- ii. Guaranteed Technical Particulars
- iii. Detailed quality assurance plan.
- iv. Any other drawings/documents considered necessary.
- v. Type test certificates as per relevant standards to be submitted.

Drawings / Documents for information:

- i. Test certificates for all equipment/accessories being supplied under this contract
- ii. Instruction manual containing detailed instructions for all installation, erection, testing and operation requirements.

3.1.8. Weather Monitoring System

- i. The Weather Monitoring Station shall be provided with all the equipment to monitor relevant parameters for the assessment of the performance of the PV Power Plant.

- ii. The number of sensors shall be as per IEC 61724 – 1 Class-A.
- iii. Each Weather Monitoring Station shall be capable of monitoring the following variables:
 - a. Global horizontal irradiance from ISO secondary standard class
 - b. Incident irradiance in collector plane from a calibrated reference cell from the module
 - c. Atmospheric pressure
 - d. Relative humidity
 - e. Wind direction and Wind speed
 - f. Ambient temperature
 - g. Back of module cell temperature
 - h. Rainfall (mm)
- iv. Bidders are advised to ascertain themselves the applicable regulation related to weather data which must be transmitted to control centers (Telemetry). Any signal/parameter/equipment though not specifically mentioned but which are required as per statutory regulation are also included in the scope of Bidder.
- v. Bidder's scope covers supply of complete system and its installation that includes Data logger, cabling, software setup and interface with solar SCADA as per the technical requirement mentioned herein. Bidder shall also provide Solar PV module and its support structure.
- vi. WMS shall consist of a weather-proof enclosure containing the data logger, self-power module with minimum 2 days battery backup and the meteorological sensors with an attached solar panel mounted upon a mast / Supply from the UPS. It is recommended that WMS should get an Uninterrupted Power Supply. The system shall be reported in real time via hardwired interface and soft links to SCADA. It shall also save the data for later recovery.
- vii. WMS shall continuously measure solar radiation, ambient temperature, wind speed and all other weather parameters.
- viii. The system shall be provided for making site-specific solar resource measurements / to support operational needs for system performance. The system shall provide sub-hourly measurement of the Global horizontal and inclined radiation, Relative humidity, Wind speed, Wind direction, Atmospheric pressure. Additional instruments shall be provided as required for site-specific requirements.
- ix. The configuration of a WMS shall consist of the following in minimum:
 - a. A weather-proof enclosure containing the data logger, Self-power modules with Battery, SPDs for input & output power, communication SPD's, lightning arrestor and remote interface
 - b. Metrological sensors
 - c. Power supply
 - d. Tripod Mast (SS 316 L, screws, nuts in SS)
 - e. The height of the Mast shall take into consideration the site conditions, obstructions, required measurements etc.
- x. Supplier to also install four soiling stations in the solar PV field. Cleaning frequency of soiling station shall be like the module cleaning frequency to calculate Soiling loss precisely. The Soiling Measurement System shall measure the performance loss from a PV array due to accumulation of dust, dirt, and other site-specific contaminants, collectively known as soiling. Soiling stations shall use two full -sized modules. One is allowed to soil naturally, while the other is cleaned with an automatic washing system. Power and energy are monitored for both modules.
- xi. Each instrument shall be supplied with necessary cables, transmitters, and accessories (MMS, Mounting and base stand etc.) provided by OEM of the sensors only.
- xii. Following requirements are to be taken care by Bidder: -
 - a. Data logger shall be field tested and shall be in satisfactory operation for a period not less than 6 Months.
 - b. Data logger shall be calibrated (Measurement uncertainty less than 2%) before dispatch and calibration shall be traceable to any National/International lab. Data logger shall have flash memory not less than 1GB for local storage of data.

- c. The Bidder shall submit the write up detailing the philosophy of measurement of soiling loss in his proposal. Measurement shall be based on comparison of Isc & Power.
- d. Datalogger shall have features that includes but not limited to Moving Average calibration, Time Integration etc.
- e. Bidder to facilitate the interfacing of data of Soiling Station to Solar SCADA on Modbus TCP/IP for trending, storage, retrieval, and display of data.

Codes and Standards

All equipment, systems, software, and services covered under this specification shall comply with all currently applicable statutes, regulations, and safety codes in the locality where the equipment shall be installed. All codes and standards referred shall be understood to be the latest version on the date of offer made by Employer unless otherwise specified. If such standards do not exist for any equipment or system, that equipment shall comply with the applicable recommendations of the following professional institutes

Codes	Description
IEC 61724 - 2021	Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis.
ISO 9060: 1990	Solar Energy – Specification and Classification of instruments for measuring hemispherical solar and direct solar radiation
ISO/TR 9901: 1990	Solar Energy – Field Pyranometers – recommended practice for use
NEC	The National Electrical Code
IEEE	Institute of Electrical and Electronic Engineers
NEMA	National Electrical Manufacturers Association
ICEA	Insulated Cable Engineers Association
OSHA	Occupational Safety and Health Act
ANSI	American National Standards Institute
NFPA	National Fire Protection Association
CENELEC	European Committee for Electro technical Standardization
UL	Underwriters Laboratory
ASTM	American Society of Testing and Materials
ISA	International Society of Automation
IEC	International Electro technical Commission

Standards not indicated in the specification are acceptable subject to approval by the Employer / Employer's Consultant if they are established to be equal or superior to the standards indicated in the specification. In case of conflicts between the standards and this specification, this specification shall govern.

Design Criteria

- i. Three 3) nos. weather stations shall be placed in representative locations within the plant including measuring instruments and all necessary software & hardware required to integrate with SCADA to enable availability of data in SCADA.
- ii. The weather stations shall be specified, calibrated by an OEM/Authorized Agency.
- iii. The provider shall ensure that the weather station comply (equipment and installation) with the environmental constraints of the location of the PV plant (based on its GPS coordinates) on which a weather station is to be installed. It is the responsibility of the provider to verify the environmental constraints and meet or exceed the associated requirements.
- iv. A reference pyranometer is used during commissioning tests and regularly during the PV plant lifecycle to ensure a proper orientation and functioning of the pyranometer of the weather station. To ensure that the reference pyranometer has the same orientation than the ones equipped with the weather station, two mounting brackets (one for the tilted pyranometer and one horizontal pyranometer) shall be provided.
- v. The sensor's mast shall be made available with 2 mounting options:
 - a. Option 1: Fixing brackets for installation of the mast on a concrete wall for the sensor, autonomous fixing brackets for the PV panel support.
 - b. Option 2: Autonomous mast (such as tripod) for sensors, PV panel, cabinet, etc.
- vi. The mast shall ensure that the Pyranometers are placed at a height from the ground sufficient to avoid any shading from surrounding elements (trees, hill, buildings, PV panels, etc.).
- vii. The mast, cabinet and all metallic parts shall be grounded directly at an earth point at the bottom of the mast and connected to a ground rod of 3m minimum vertical inserted into the soil.
- viii. All grounding cables shall end inside the cabinet to a terminal from which it is possible for the final installer to install the grounding from the cabinet to the ground.
- ix. For each of the installed Weather Monitoring Stations, following minimum measurements shall be made available in SCADA:
 - a. Ambient temperature, in °C
 - b. Back of module cell temperature, in °C
 - c. Global Horizontal Irradiance from pyranometer, in W/m²
 - d. Global irradiance in collector plane from a pyranometer, in W/m²
 - e. Wind speed, in m/s
 - f. Wind direction, in degrees
 - g. Rain fall, in mm
 - h. Relative Humidity, in %
 - i. Any other weather parameter required by local grid requirements.
 - j. Weather station communication status
 - k. Direct Soiling loss readout shall be available in SCADA for display and recording.
 - l. Temperature Rating The system shall be rated for operation in ambient air temperatures from - 10 °C to 35 °C
 - m. Any alternate technology proposed by Bidder shall be reviewed during detailed engineering stage.
- x. The weather stations (Pyranometer, anemometer and temperature sensor) shall be connected to switch panel located in the control box using Ethernet cable (UTP Cable CAT 6. Distance<100m) whose main characteristics shall be defined at the monitoring design.
- xi. A compact station with all the measurements integrated (except pyranometer & module temperature sensor) can be provided.
- xii. All the measurements at weather station to be integrated with data logger with one number output connection RS-485 type interface to SCADA.

- xiii. The specific configuration of the system, suitable for the subject site, with all sensors as required shall be included.
- xiv. The system shall report in real time and save the data for later recovery.
- xv. Each instrument shall be supplied with necessary cables provided by OEM of the sensors only. Pyranometer Calibration certificate with calibration traceability to World Radiation Reference (WRR) or World Radiation Centre (WRC) shall be furnished along with the equipment. All equipment supplied shall be provided with valid calibration certificate. Employer shall provide Instrument manual in hard and soft form
- xvi. Provider shall be responsible for the following activities:
- Assessment that the installation location complies with state-of-the-art requirements for a weather station installation
 - No shadows (from trees, buildings, hills, etc.) from sunrise to sunset affecting the pyranometers
 - Absence of cooling or heating systems nearby that may affect ambient temperature readings
 - Absence of ventilation or wind protection (walls, buildings, etc.) that may affect wind vane and anemometer readings
 - Assessment of any damages during transportation and providing necessary help to the Bidder for any follow-up action
 - Mechanical verification after installation and before energizing
 - Co-ordinate with Employer / Engineer during complete loop checking of the plant
 - Consolidate all loop checking reports with Employer / engineer
 - Redlining and as building of all documents and drawings
 - Provide commissioning assistance for tuning of loops, implement minor changes in interlocks, graphics etc.

The general BOM for WMS system is as below:

Sl. No.	Material Description	Units	QTY.
1	Datalogger	No's	3
2	Global horizontal irradiance Pyranometer	No's	3
3	Incident irradiance Pyranometer	No's	3
4	Anemometer	No's	3
5	Wind vane	No's	3
6	Ambient Temperature Sensor	No's	3
7	Module Temperature Sensor	No's	9
8	RH Sensor	No's	3
9	Rain Gauge	No's	3
10	Power Supply	No's	As per requirement
11	Mounting Hardware & Enclosure	No's	As per requirement
12	Ethernet Interface with extended data storage module	No's	As per requirement

Technical Parameters

Pyranometer:

Sl.No	Details	Values
1.	Principle	Thermopile
2.	Spectral Response.	310 to 2800 nm
3.	Sensitivity	Min 7 micro-volt/w/m ²
4.	Time response (95%):	Max 15 s
5.	Nonlinearity:	±0.5%

6.	Temperature Response:	$\pm 2\%$
7.	Tilt error:	$< \pm 0.5\%$.
8.	Zero offset thermal radiation:	$\pm 7 \text{ w/m}^2$
9.	Zero offset temperature change	$\pm 2 \text{ w/m}^2$
10.	Operating temperature range:	0 deg to +80 deg.
11.	Uncertainty (95% confidence Level):	Hourly- Max-3%, Daily- Max-2%
12.	Non-stability:	Max $\pm 0.8\%$
13.	Response Time (95% of final value)	$< 5 \text{ sec}$

Ambient Air Temperature Sensor

Sl.No	Details	Values
1.	Principle	RTD (Platinum) Resistance proportional to temperature
2.	Max.	35 °C
3.	Accuracy	+ 0.2 °C
4.	Operating Temperature	0 to 50 °C
5.	Radiation Shield	Non-aspirated Radiation Shield

Module Temperature Sensor

Sl.No	Details	Values
1.	Principle	RTD (Platinum) Resistance proportional to temperature
2.	Range	0-100 °C
3.	Accuracy	+ 0.2 °C
4.	Operating Temperature	0 to 100 °C

Wind Speed Sensor

Sl.No	Details	Values
1.	Principle	Frequency proportional to wind speed/Ultrasonic Sensor
2.	Velocity range	0-60 m/ sec
3.	Threshold	0.3 m/s
4.	Operating Temperature	0 to 50 deg C
5.	Accuracy	3% (up to 35 m/s), 5% (Above 35m/s) RMS

Wind Direction Sensor

Sl.No	Details	Values
1.	Principle	Potentiometric type sensor (Resistance proportional to Wind direction) /Ultrasonic Sensor
2.	Range	0-360 deg
3.	Accuracy	$\pm 5 \text{ deg}$

4.	Operating Temperature	0 to 50 deg C
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Relative Humidity (%)

Sl.No	Details	Values
1.	Range	0-100 %
2.	Accuracy	±3%
3.	Resolution	1%
4.	Operating Temperature	0 to 50 deg C

Drawings / Documents for Approval

- i. Fabrication and general arrangement drawing for cabinet/panel.
- ii. Inter panel wiring, detailed drawings for panels interconnecting drawings.
- iii. Support & mast mechanical design calculation.
- iv. Datasheet of all the items, cables supplied including bought out materials
- v. Spares list
- vi. Concrete foundation or anchorage design calculation.
- vii. All test certificates including calibration reports, degree of protection certificates and Explosion proof certificates for all services.
- viii. As Built Documents
- ix. O&M manual after design freeze

3.1.9. PV Module**Scope of Work**

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

Scope of Supply

- i. The scope of supply includes manufacturing, testing, packing and forwarding, handling (up to receipt at site) insurance, and transportation of solar PV modules up to Project site at Jamjee, Thimpu, Bhutan.
- ii. Unloading, Safe storage & Handling as per manufacturer recommendations at site, Installation on MMS, testing and commissioning of Modules.
- iii. The total capacity of PV modules to be procured under this contract, excluding mandatory spares. The contractor shall supply 0.15% of the awarded PV module capacity as mandatory spares in addition to the awarded PV module capacity. Solar PV module: (Bi-Facial module of minimum 540 Wp rating) for 1500 V system voltage.
- iv. PV module shall perform satisfactorily with operational temperatures between minimum -40°C and maximum +85°C and shall be available to work under 0-85% relative humidity.
- v. The PV module shall be made of high-quality solar cells, laminated in ultraviolet stabilized polymer material like EVA, polyester and thermally toughened low iron, tempered / heat strengthened glass and back sheet glass material shall be high quality according to relevant international standards and IEC 61730
- vi. All materials used should have a proven history of reliability and stable operation in external applications. Each PV module shall be checked for conformity with the relevant standard and shall have positive power output tolerance only. No negative tolerance shall be accepted.
- vii. PV module shall be provided with anti-corrosive/ weatherproof screw-fitted, having aluminum anodized

- finish frame (for framed module with coating thickness considering site corrosive nature) with DC cable and connector.
- viii. PV modules shall be equipped with minimum three bypass diodes to minimize power drop caused by shade. The module shall be designed for 1500 V dc system.
 - ix. Modules shall be made of light weight cells, resistant to abrasion, hail impact, rain, water and environmental pollution. The PV modules shall be provided with anti-reflection coating and back surface field structure to increase conversion efficiency.
 - x. Efficiency of PV modules at standard test conditions (STC: Irradiation 1000 W/m², cell temperature 25°C and AM = 1.5) shall not be less than 20% and fill factor of the module shall not be less than 0.70.
 - xi. Module pig tail cables shall be UV resistant solar DC copper cable of sufficient length for connection in the array grouping as per the project design requirement and of size 4 mm² with DC connectors adaptive to MC4 type connector directly. The junction box shall be split type with suitable cable connection between two PV Modules in a leapfrogging arrangement. MC4 type connector should be TUV/ any accredited certified. The positive (+) terminal has a male connector while the negative (-) terminal has a female connector. However, any different design and length of the pig tail cable offered (without any extra cost) shall be reviewed during detail engineering.

Technical Parameters of Solar PV Module

Data Sheet

Bidder shall submit the data sheet for offered PV module in line with following table.

Table 1: Technical Details of Solar PV Modules

Sl. No.	Parameter	Unit	Technical Requirements	Bidder to fill up (* with actual values)
A. General				
1.	Application	-	Utility scale ground mounted project	
2.	PV module manufacturer name	-	*	
3.	Country of origin of the PV module cell	-	*	
4.	Model no. of the PV module	-	*	
B. Technical Details				
1.	Cell type	-	Mono Crystalline	
2.	Cells per module	No.	*	
3.	Type of design	-	With frame	
	a) Frame material applicable only for modules with frame)	-	Corrosion resistant materials, coating of minimum 15 µm thickness and frame thickness of at least 30 mm ¹	
	b) Front glass and back sheet / back glass	-	*	
	i. Front glass type	-	High transmission, low iron, tempered glass with anti-reflective coating	
	ii Back sheet / transparent back sheet/glass	-	*	
4.	Mounting arrangement - screw / clamp	-	Shall be clearly stated in the installation manual	
5.	Mounting hole distance (farthest holes along longer edge)	mm	*	
6.	Module dimension	m	*	

Sl. No.	Parameter	Unit	Technical Requirements	Bidder to fill up (* with actual values)
	(L x W)			
7.	Weight	kg	*	
8.	Water quality requirement for washing the module in case of wet cleaning	-	*	
C.	Electrical data			
1.	Electrical data			
	a) Nominal minimum power (Pmin) @ STC	Wp	540	
	b) Operating voltage (Vmp) @ STC	V	*	
	c) Operating current (Imp) @ STC	A	*	
	d) Open circuit voltage (Voc) @ STC	V	*	
	e) Short circuit current (Isc) @ STC	A	*	
2.	Module efficiency at STC	%	21 (minimum)	
3.	Fill factor	%	70 (minimum)	
4.	Operating temperature	°C	-40 to +85	
5.	Maximum system voltage	V dc	1500	
6.	Power tolerance	Wp	0 to (+) 4.99	
7.	PID free solar cells	-	Yes (should comply with IEC 62804)	
8.	Module binning	-	Module wattage bin offered shall not be less than 5 Wp.	
9.	Bifaciality factor	%	70 +/- 5(minimum)	
10.	Packing (as per current binned)	-	Required	
11.	Module terminal box split type			
	a) IP	-	68	
	b) Terminal cable	-	UV protected cable(copper)	
	c) Cable length	mm		
	d) Terminal connector	-	Solar PV connector (MC4)	
12.	Temperature characteristics			
	a) Temperature coefficient of power (Pmax)	% / °C	*	
	b) Temperature coefficient of voltage (Voc)	% / °C	*	
	c) Temperature coefficient of current (Isc)	% / °C	*	
	d) Nominal operating cell temperature	°C	*	
13.	Bypass diode			
	a) Efficiency	%	> 99	
	b) Voltage drop	V	Not more than 0.7	
	c) Operating temperature	°C	(0 - 85)	
14.	Front Glass material			
	a) Glass thickness	mm	Bidder to specify	

Sl. No.	Parameter	Unit	Technical Requirements	Bidder to fill up (* with actual values)
	b) Anti-reflective coating	-	Required	
	c) Transmittance value	%	90 (minimum)	
15.	Encapsulant	-	Should be UV resistant	
16.	Sealant to seal PV module edges and fix frames	-	Sealant should be made of silicone material	
* To be indicated by the Bidder.				

Standard Testing Condition and Quality Requirements

The applicable codes and standards are as mentioned below.

Table 2: Codes and Standards

Sl. No.	Codes and Standards Requirements	Employer's Confirmation
1.	The PV module must qualify either IEC 61215 (Ed. 2) or IS 14286 :2010 - Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval.	
2.	PV modules must qualify to IEC 61730 (Part 1 and 2) or IS/IEC 61730 for safety qualification and testing.	
3.	Meet IEC 62804 requirements for Potential Induced Degradation	
4.	The PV modules manufacturer must have valid test certificates for their qualification as per IEC standards by reputed accredited test centers.	

Inspection Plan – Manufacturing Stage And / Or Pre-Dispatch Inspection

Following tests and/ or checks to be performed by manufacturer. These would be taken care during third party inspection (TPI) of module during manufacturing stage or test certificates may be reviewed during pre-dispatch inspection (PDI). Module QAP and quality checks shall be provided to Employer.

Table 3: Pre-dispatch Inspection Test

Sl. No.	Sample Test	Sampling Reference/ Standard
1.	Visual/appearance	As per special inspection level S-4 and AQL 2.5% as per IS 2500 (Part 1): 2000
2.	RFID tag	As per special inspection level S-2 and AQL 1.5% as per IS 2500 (Part 1):2000
3.	Flash test and I-V curve measurement	As per special inspection level S-4 and AQL 1.5% as per IS 2500 (Part 1): 2000
4.	Electroluminescence (EL) testing	As per special inspection level S-2 and AQL 1.5% as per IS 2500 (Part 1):2000
5.	Insulation resistance test	Sampling as per special inspection level S-2 and AQL 1.5% as per IS 2500 (Part 1): 2000
6.	Robustness of termination test	One sample per lot as per IEC 61215 or 14286 : 2010
7.	Mechanical load test	One sample per lot as per IEC 61215 or IS 14286 : 2010

This is an indicative list of tests/ checks. The manufacturer/ Bidder is to furnish a detailed quality plan indicating the practice and procedure along with relevant supporting documents. Visual and EL acceptance criterion to be submitted along with MQP.

- i. Employer has right to inspect during manufacturing of the ordered quantity starting from incoming raw material till packaging and dispatch.
- ii. Random sample shall be selected by authorized agency in consultation with Employer's representative to carry out laboratory test prior to issuance of material dispatch clearance certificate (MDCC).
- iii. All the test expenses such as transportation, obtaining certificates etc. related to PV module testing at laboratory shall be borne by the supplier/Bidder.
- iv. Standard packaging process followed by Bidder shall be shared with Employer. In case of any modification suggested by third party inspecting agency, the same shall be incorporated by the Bidder.
- v. All above tests to be carried out as per agreed schedule.
- vi. Reference cell or module shall be calibrated in compliance with IEC specification and tender specification prior to manufacturing of each batch.
- vii. The following standard to be complied by the supplier's related to sampling procedure and safety of the PV module.
 - a. IS 2500 (Part 1): 2000– Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
 - b. IS 14286: 2010 – Crystalline silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval
 - c. IS/IEC 61730: 2004 – Photovoltaic (PV) Module Safety Qualification, Part 1: Requirements for Construction
- viii. The Bidder shall propose the schedule for pre-dispatch inspection of finished goods to Employer well in advance, and in no case less than fifteen (15) days prior to commencement of inspection.

Labelling Requirement:

All PV modules shall be classified prior to their packing at the manufacturer's workplace to reduce the mismatch losses by sorting on basis of power bin and current bin positivity.

The manufacturer shall paste labels of colors red, yellow and green on the side frames of modules to differentiate between the tolerance values high, medium and low apart from usual labels "H", "M" and "L". This will help the site execution team to segregate the modules faster and connect modules with same tolerance in almost each string.

Name Plate Requirement:

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

- i. Manufacturer's name
- ii. Model number and serial number
- iii. Overall dimensions (W x L x D)
- iv. Weight
- v. Maximum power (P_{MAX}), voltage (V_{MP}) and current (I_{MP})
- vi. Short circuit current (I_{SC}) and open circuit voltage (V_{OC})
- vii. Main system voltage
- viii. Relevant standards and certification laboratory name.

- ix. Employer's Logo on the top corner of each Module
- x. Warning if any

Insurance Requirement

- i. The Bidder shall be responsible for the insurance charges for delivery of the panels from manufacturing plant till the project site and handling of modules during installation till project handover. The insurance shall cover against any breakage, damages during loading, transportation, transshipment, and handling.
- ii. Bidder shall ensure the registration of the project and the serial no. of PV modules supplied for this project in their insurance coverage scheme to ensure that the buyer can get the insurance cover at times of necessity.
- iii. Bidder shall submit the proof of such registration immediately after each lot of dispatch of materials.

Module Peak Power Warranty Insurance:

To ensure faithful Peak power warranty performance of PV modules, Bidder must submit insurance before dispatch with a coverage of minimum 6 % of 60% of the total Contract Price for 25 years, with the Employer as its beneficiary. However, the Contractor may also submit the insurance with a coverage of minimum 6% of the total order value of the Solar PV Modules envisaged under the contract, subject to submission of the required documents (invoices, receipts, Purchase Order etc.). Any financial implication encountered due to insurance shall be borne by the Contractor.

The module should be insured as per the following clauses and are to be complied:

- i. Insurance shall be taken from the reputed insurers backed by either Munich RE or Swiss RE reinsurers.
- ii. In case of insolvency of the contractor, the Employer under the terms of the insurance policy against Module Peak Power Warranty shall be entitled to raise a claim against the Module Warranty Insurance Policy and in order to benefit from the coverage provided by the aforementioned policy, the Contractor shall be responsible for maintaining the coverage provided under the Module Peak Power Warranty Insurance Policy at all times, at its cost and expense.
- iii. Further, the Contractor to note that Employer requires the following to be complied while covering the Peak Power Warranty of the supplied goods under the insurance:
- iv. Single Insurance Policy for Product Peak Power Warranty before dispatch of the first lot of PV Modules Peak Power Warranty Insurance.
- v. The Insurance Policy shall be valid for a minimum period of twenty-five (25) years from the date of receipt of first batch/lot of equipment at site.
- vi. The premium charges, recurring charges, any other expenditure under the Insurance Policy shall be covered by the Contractor.
- vii. The insurer must continue to compensate end users for warranty claims for the Peak Power Warranty even if contractor ceases to exist as an independent operating company.
- viii. The insurance shall be non-cancellable by the insurer and shall provide third party bankruptcy rights.
- ix. Coverage under the insurance policy shall be immediate, without any waiting period.

Installation Requirements

Module installation shall be carried out by qualified personal and as per manufacturer recommendations. However, PV module shall have the following requirements. This is mainly based on certain site and/ or project specific aspects.

- i. In a string, PV module may be physically connected in different configuration(s)/ arrangement(s).
- ii. PV module shall be installed with mounting holes using nut-bolt/ clamping arrangement. In case of nut-bolt arrangement, at least 4 points of connection are required between each module and the mounting surface.
- iii. Grounding holes shall be provided for all PV module.

- iv. PV modules must be compatible for manual cleaning. Bidder shall certify the PV module suitable to be cleaned by any type of manual cleaning system. Any deviation in quality and performance of PV module shall be the responsibility of Bidder and Employer shall take all necessary corrective action to replenish the performance and replace the poor-quality materials / Modules with new one.

Employer shall be provided with module installation manual and O&M Manuals.

Identification and Traceability:

Each PV module must use a radio frequency identification (RFID) tag. This can be inside or outside the laminate but must be able to withstand harsh environmental conditions and last the lifetime of the solar module. The following information must be mentioned in the RFID used on each module.

- i. Name of the manufacturer of the PV module
- ii. Name of the manufacturer of solar cell
- iii. Month and year of the manufacture (separately for solar cells and modules)
- iv. Country of origin (separately for solar cell and module)
- v. I-V curve for the module at STC (1000 W/m², AM 1.5, 25°C)
- vi. Wattage, I_m, V_m and FF for the PV module
- vii. Unique serial no. and model no. of the PV module
- viii. Date and year of obtaining IEC PV module qualification certificate
- ix. Name of the test lab issuing IEC certificate

Employer would be required to maintain accessibility to the list of module IDs along with the above parametric data for each module.

One number RFID reader must be supplied for each 50 MW_p by the Bidders which are to be compatible to read the data from the RFID tag and download the data to computer. All associated software and cables are to be provided along with the RFID reader.

Guarantee and Warranty

Bidder shall submit the guarantee and warranty as per Table 3.

Table 4: Guarantee and Warranty

Sl. No.	Item	Unit	Technical Requirements	Bidder's Data *
1.	Module efficiency			
a)	Guaranteed efficiency @ STC	%	21% (minimum)	
2.	Performance data			
a)	Performance warranty	Year	25	
b)	Peak Power warranty	%	Each solar PV module should carry a peak power performance warranty of > 90% during the first 10 years and >80% during the next 15 years.	
c)	Module power output tolerance	W	0 W to (+) 4.99 W _p , negative tolerance is strictly not allowed.	
d)	Degradation curve	-	25 years (annual degradation curve shall be provided)	
3.	Guaranteed degradation (year basis)			
a)	First year (including LID)	%	<2.5	

b)	Second year to 25 th year	%	<0.5	
4.	Material warranty			
a)	Product warranty (defects in materials and workmanship)	Year	10	

Data to be furnished along with the Bid

All required details to be filled by Bidder as per Table 1, Table 2, and Table 4.

Module data sheet

PAN file for module (certified by a third party)

IEC test certificates

Module installation manual

BoM elaborating on the properties, such as, thickness, material composition etc. of the major components of the module which shall be the same as per the type tested and approved constructional data form (CDF).

Furthermore, the contractor (winning bidder) will comply with **Due Diligence on the solar PV modules supplier(s) as outlined hereunder:**

The Contractor should clearly describe the management systems describing the internal policies and procedures regarding their commitments to human rights, and avoidance of forced labour in their supply chains. The should provide details of how each supplier identifies and manages this risk of forced labour specifically, providing details of the investigation and analysis performed to identify and analyze the supply chain of those panels that will be used for the project. This should cover, among others, the traceability that could be achieved, the companies and factories identified in the supply chain, the policies and processes of the identified companies involved throughout the supply chain, etc. The efforts should be oriented first towards the supply chain of the silica-based components.

Such specific Due Diligence should cover:

- (i) Supply chain mapping for the solar PV panels that will be used for the project. The first step is to undertake mapping of the supply chain of solar panels from upstream raw material to downstream module manufacturer, and assess if there are risks of forced labour (e.g. ILO Forced Labor Indicators). List and locations of suppliers and sub-suppliers factories involved in the supply chain of the panels used for the project - in particular for the silica-based components.

The initial minimum requirements are the following:

The Contractor will submit a supply chain mapping/declarations of origin of the PV modules and its silica-based components down to the lower tiers of the supply chain, reaching at least the level of the polysilicon or even silicon metal if possible) issued, signed, and dated by the supplier of the PV modules of the project

Name of supplier				
Tier	Raw material	Supplier	Description	Factor Location (Region, Country)
1	Silicon Metal			
2	Polysilicon			
3	Ingot			
4	Wafer			
5	Cell			
6	PV module			

In addition, the Employer shall:

- Seek further assessments, such as traceability audits, labour audits, etc. providing comfort regarding the traceability and the absence of forced labour.

- Investigate with the supplier the possibility to received bills of materials of the modules produced for the project, confirming the compliance of the components entering into the manufacturing supply chain with the supply chain mapping provided initially.
 - Investigate the possibility to have third-party auditing/verifying the information provided in the bill of materials.
- (ii) Risk assessment for all tiers of the supply chain. Review of human right policies and managements systems for the suppliers and sub-suppliers identified in the supply chain mapping, to evaluate if they are aligned with the Employer's human rights commitments, particularly in relation to forced labour, especially in the lower tiers of the supply chain of the silica-based components (e.g. mining and refining of quartz into silicon metal and polysilicon).
- (iii) Monitoring of workplaces/labour audits: results of labour audits undertaken at the level of sub-suppliers' manufacturing/processing facilities (e.g independent audits) throughout the supply chain, in particular for the silica-based components.

The results should clearly indicate the residual risk for those panels used in the project (e.g. limited mapping / lack of traceability beyond a certain point, impossibility to perform audits in certain identified factories, sub-suppliers with non-aligned policies or management systems, etc).

Based on this analysis, the Employer shall describe the actions, under implementation or planned, to further reduce this risk for the supplies. The Contractor comply to action plans.

3.2. AC System

3.2.1 Inverter Duty Transformer

The design, manufacture, delivery, factory testing and inspection, delivery to site, installation, testing and commissioning of Continuous Solar Inverter application and Inverter duty (Outdoor) Transformers as per latest applicable standards. The equipment shall be designed, engineered and manufactured to achieve high availability and reliability.

All routine and acceptance tests at Factory and Site acceptance tests shall be conducted as part of the contract with prior notice to Employer.

Codes & Standards

Codes	Description
IEC:60076	Power Transformers
IEC 61378-1	Converter duty Transformers
IEC 60137	Specification of HV Porcelain Bushing
IEC 60137	Specification of LV Porcelain Bushing
ISO 9001	Practice for selection, installation & maintenance of transformers
IEC 60836	New Insulating oils
IEC:60296	Fluids for electro technical applications – Unused mineral insulating oils for transformers and switchgear
IEC:60354	Loading guide for oil-immersed power transformers
EN 60998	Specification for terminal connector
IEC 60076	Specification for overloading of Transformers
IEC-60137	Transformer bushings
IEC 60044	Specification for Current Transformers

IEC-61869	Bushing CT
IEC 60214	Application Guide for on load tap changer & Power Transformers
EN 1998, ISO 19338	Criteria for earthquake resistant design of structures.
Latest editions of (as applicable as on date of bid submission) NFPA, HEI, ANSI, ASME, ISI, TEMA, AWS, NEMA, IEC, EJMA, codes and standards shall also apply	

Design Criteria

- i. The transformer shall be capable of continuous operation at rated MVA on any tap with voltage variation of $\pm 10\%$ corresponding to the voltage of the tap as well as in accordance with IEC 60354 or other relevant standards. The transformer shall be capable of operating at rated output at any tap position, provided the voltage corresponding to that tap does not vary by more than $\pm 10\%$ of rated voltage.
- ii. The voltage ratio and kVA rating shall be decided by the Bidder based on the system offered.
- iii. The transformers shall be of Converter Duty, multi winding, three phases, 50Hz, mineral oil filled, ONAN cooled, with off circuit taps of $\pm 5\%$ in steps of 2.5% on the HV side.
- iv. Transformers should be provided with separate galvanically isolated low voltage windings for each inverter.
- v. Transformers shall be suitable for operation with pulsed inverters.
- vi. Inverter Transformers shall be of successfully type tested design with service warrantee of 5 years after commissioning.
- vii. The thermal design of Inverter Transformer to be designed in accordance with Inverter output and under worst condition it should not limit Inverter output.
- viii. The transformer shall be capable of operating at approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal rated voltage for a period of 5 seconds.
- ix. Transformers and accessories shall be designed to withstand the expected fault levels. Dynamic ability and thermal ability to withstand the short circuit forces shall be demonstrated by tests / calculations.
- x. For 10 MVA and above, transformer differential protection shall be provided Grid requirements.
- xi. The transformer shall be provided with windings (all) and oil temperature indicators and double float type Buchholz relay with gas collecting device & pipe and potential free contacts for remote alarm and trip purpose. The transformer shall be provided with spring-operated PRD (with trip contacts) with suitable discharge arrangement for oil. The number of PRD will be as per OEM requirements.
- xii. For multi winding transformer to be designed for long term operating conditions with asymmetrical load on LV side i.e., in case three winding design, the transformer needs to operate reliably with only one Inverter supplying power to only one LV winding.
- xiii. All tank gaskets used shall be of NBR (Acrylonitrile butadiene Rubber generally known as NBR) and properties of all the above gaskets / O-Rings shall comply and manufacturer shall provide 5 years leakage free Warranty.
- xiv. 2mm Thick CRCA sheet steel, vermin and dust proof marshalling box (minimum IP55) shall be furnished with each transformer to accommodate each winding and oil temperature indicators, Buchholz relay, MOG, PRD contacts, Transducers and other contacts terminal blocks for control cables etc. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The wiring scheme (TB details) shall be engraved on a stainless-steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.
- xv. The neutral of transformer if not used should be taken out through bushing and covered by insulating cap.

- xvi. The tank shall be of conventional / bell type with bolted cover on top. In case the joint is welded it shall be provided with flanges suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise of the joint.
- xvii. The transformer shall be capable of being loaded in accordance with IEC 60354 / IEC 60076-7 up to a load of 150%. There shall be no limitation imposed by bushings or any other associated equipment.
- xviii. Bushing CTs of adequate rating for protection (differential and others if any) as required, WTI etc. should be provided. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.
- xix. Harmonic factors as per Inverter manufacturer recommendation must be considered while designing the transformer. The extra no load loss due to voltage harmonics and load and stray load loss due to current harmonics (as applicable) and must be taken into consideration in transformer design. In addition, the dc bias component of 0.5% of rated Inverter output current is to be accounted for its effect on the transformer design.
- xx. The line terminals of the windings of a three-phase power transformer shall be denoted by reference letter 1U, 1V, 1W for HV side and 2u, 2v, 2w, 3u, 3v, 3w and so on for LV sides. The neutral terminal shall be denoted as 1N for high voltage and 2n, 3n and so on for low voltage winding.
- xxi. The noise level of the transformer shall be in accordance with NEMA standard publication TR-1.
- xxii. Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.
- xxiii. All bolted connections shall be fitted with weatherproof,
- xxiv. Inverter Transformer shall have copper Shield winding between LV & HV windings. Each LV winding must be capable of handling non-sinusoidal voltage with voltage gradient. Also, each shield winding shall be taken out to tank with two separate connections from shield to bushing with proper support with 2 nos. 3.6 kV shield bushings and same shall be brought down along with support insulator from tank & copper flat up to the bottom of the tank for independent grounding.
- xxv. Main conservator shall have air cell type constant oil pressure system. Pressure gauge shall be provided for Air cell to monitor air cell pressure.
- xxvi. The MOG and prismatic oil level gauge should be clearly visible from the ground.
- xxvii. The conservator shall be fitted with lifting lugs in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept replacing air cell and cleaning of the conservator as applicable.
- xxviii. Suitable oil topping arrangement shall be provided at conservator top.
- xxix. Suitable air venting arrangement shall be provided at over Tank, conservator tank, radiators, etc.
- xxx. Transformer tank conservator shall be fitted with cobalt free Silica gel Breather.
- xxxi. Transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication with angular sweep of 270°. Range of temperature should be 0-150°C.
- xxxii. Temperature indicator dials shall have linear gradations to clearly read at least every 2°C. Accuracy class of OTI shall be 1.5% or better. OTI shall be with mercury free switches, (Ref: Precimeasure Type: 1005A or, equivalent of approved vendor).
- xxxiii. 150 mm dia with angular sweep of 270° local winding temp. indicating instrument with maximum reading pointer and two adjustable electrically independent, ungrounded contacts (one for high winding temperature alarm and one for trip) besides that required for SCADA monitoring system shall be provided for HV and each LV windings. Temperature indicator dials shall have linear gradations to clearly read at least every 2°C. Range of temperature should be 0- 150°C. Accuracy class of WTIs shall be 1.5% or better. WTIs shall be with mercury free switches preferably of Type: 1005A or, better; Make: Precimeasure or equivalent of approved make.
- xxxiv. The WTIs shall also be provided with an in-built variable resistor for connecting it to transducers for remote monitoring of the temperature. The transducers shall be provided with dual outputs of 4-20mA signal and shall be mounted in the cooler control cubicle / marshaling box. This is applicable to all windings.

- xxxv. Transducer Temperature Sensors for OTIs & WTIs: Temperature transducer with PT100 sensor RTD shall be provided with PT100 temperature sensor having nominal resistance of 100 ohms at 0°C. The PT100 temperature sensor shall have three wire ungrounded system. The PT100 sensor may be placed in the pocket containing temperature sensing element. RTD shall include image coil for OTI system and shall provide dual output 4-20mA for PLC. The transducer shall be installed in the Individual Marshalling Box. Any special cable required for shielding purposes, for connection between PT100 temperature sensor and transducer, shall be in the scope of manufacturer. 4-20mA signal shall be wired to the PLC.
- xxxvi. Suitable rating HV Bushings porcelain type and LV Bushing below 3.6 kV used within transformer cable box, epoxy type conforming IEC 60137 also allowed as alternate to porcelain type.
- xxxvii. Inverter Transformer HV & LV bushings palms shall be silver plated.
- xxxviii. For single core cable termination, cable box gland plate shall be of non-magnetic material.
- xxxix. Cable boxes shall be of sufficient size to accommodate cable & termination and allow proper heat dissipation due to high current.
- xl. For each terminal shall be brought out through bushings with suitable rated Copper Bus bars / terminal connectors of sufficient size, copper flexible jumpers, supporting insulators, and bolt holes to accommodate cable & termination and allow proper heat dissipation due to high current.
- xli. Cable boxes shall be of 3mm sheet for load bearing member and 2mm for other parts with degree of protection as IP:55 or better.
- xlii. Proper two-point earthing and two no.s. GI support shall be provided for each cable box.
- xliii. A suitable size detachable type Gland plate of non-magnetic material shall be provided. A clear spacing of 900mm shall be provided between gland plate to terminals.
- xliv. Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).
- xlv. The insulating oil shall be new, unused mineral oil, conforming to IEC-60296-2020/ IEC 61099. NO inhibitors shall be used in the transformer oil while tested at Employer's premises. The transformer shall and all associated oil filled equipment shall normally be supplied along with the first filling of oil and excess quantity of oil as per standard mentioned above. The Bidder shall furnish test certificates to Employer against their acceptance norms, prior to dispatch of oil from refinery to site.
- xlvi. The pain shade shall be RAL 7035 with painting thickness shall not be less than 150 microns.
- xlvii. Radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifting lugs, along with drain plug/valve at the bottom and air release plug at the top.
- xlviii. Name plates shall be SS 304 or better. The transformer shall be provided with a rating plate of weatherproof material, fitted in a visible position, showing the appropriate items indicated below. The entries on the plate shall be in English in indelibly marked.
- xlix. Cable glands shall be weatherproof Double compression type made of heavy-duty brass machine finished and nickel chrome plated of suitable size. The thickness of plating shall not be less than 10 microns. Cable glands shall conform to BS:6121.
1. All control terminals shall be of Stud type (screw drive operated) and control wiring shall be terminated with tinned copper ring type lugs with insulated sleeve. A disconnecting stud type terminal shall be provided for CT circuits. 20% spare terminal shall be provided of each type. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with ISO 7000 Red Ferrules and should be provided on trip circuit wiring.
- li. All wiring shall be carried out with wires of 1.1 KV grade, stranded copper conductors. Power circuits shall be wired with stranded copper conductors with minimum size shall be 2.5 sq. mm, control circuit shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 sq. mm.
- lii. All metallic hardware such as nuts, bolts, screws, washers etc. shall be of hot dip galvanized to a minimum of 110microns.
- liii. All cable entries shall be located at the bottom and all panels/Junction boxes/MKs /DBs etc. shall be min. 450mm above finished floor level for cable connections.

- liv. Outdoor panels / JB's / MK's / DB's / Buchholz relay / PRD / all cubicles etc. shall be completely weather-proof with a sloping extended SS304 canopy for protection against rain and providing a degree of protection of IP 55.

Transformer fire protection System

Transformer Fire protection system to be provided by Bidder as per OEM standard and applicable regulations/guidelines/circulars/norms etc. amended from time to time.

Technical Parameters

Sl. No.	Item Description	Unit	Technical requirement
1.	Rating	kVA	To be decided based on Inverter rating and at least match with the PQ capability of Inverter at minimum ambient temperature of -10 to 35 degree centigrade
2.	Voltage ratio	kV	33 / **
3.	Type	-	Oil filled Type
4.	Type of Cooling	-	ONAN
5.	Cooling Oil type	-	Mineral oil
6.	Frequency	Hz	50±0.5%
7.	No. of windings of each transformer	-	Multiwinding
8.	Impedance @ base MVA	-	As per Standard and fault current limitation on LV side / as per inverter manufacturer's recommendation
9.	Winding connection and vector group	-	As per Inverter manufacturer's recommendation
10.	System earthing (a) HV (b) LV	- -	As per Inverter manufacturer's recommendation
11.	Type of tap changer	-	OCTC on HV side
12.	Tapping range and number of steps	%	±5% in steps of 2.5%
13.	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 IEC60076-7. As min. requirement, Transformers shall be designed with 110% continuous thermal overloading capability.

Sl. No.	Item Description	Unit	Technical requirement
14.	Winding	-	LV – Aluminium / Copper HV – Aluminium / Copper
15.	Impulse withstand voltage of HV winding	kVpeak	170
16.	Power frequency withstand voltage of winding HV/LV	kVrms	33 kV - 70 LV – 3
17.	System Fault level for 1 sec. (a) HV Side (b) LV Side	kA kA	31.5 As per Short circuit study
18.	Permissible Temperature rise over an ambient of 35 deg C (irrespective of tap)		
	a) Top Oil	Deg. C	70 Deg. C
	b) Winding	Deg.C	75 Deg. C
19.	Short circuit withstand time	Secs.	2
20.	Clearances in air a) Between Phases b) Between Phase & Earth	mm mm	HV – 350, LV-25 HV – 320, LV-25
21.	Creepage distance	mm / kV	31
22.	Noise level	-	As per NEMA TR-1
23.	Guaranteed Losses	%	Maximum 1.0%
24.	Terminal Connection		
	a) 33 kV side	-	Phase segregated Cable box type
	b) LV side	-	Cable box
25.	Painting	-	Shade RAL 7035 as per C5-M Specifications
26.	Winding Temperature Indicator (Local and Remote – to be integrated with SCADA/PLC)	-	On HV and each LV Windings
27.	Oil Temperature Indicator (Local and Remote – to be integrated with SCADA/PLC)	Yes / No	Yes

Sl. No.	Item Description	Unit	Technical requirement
28.	Marshalling Box	-	Yes, outdoor type
	a) Degree of protection	-	IP 55

Note: “**” – Indicates the data shall be as per Inverter Model chosen

Tests:

- i. Type test shall be done as per IEC-60076/IS:2026.
- ii. Routine tests shall be performed as per IEC:60076 / IS:2026.

Data to be furnished by vendor after award of contract

Drawing / Document for Approval:

- i. Detailed technical data sheet
- ii. Efficiency at full load and 75% load at unity power factor
- iii. General outline drawings showing plan, front elevation, and side elevation, with all fittings and accessories, earthing terminals, foundation/floor fixing details, jacking pads and weights of the following:
- iv. Marshalling box
- v. Cable boxes & disconnecting links
- vi. Terminal details
- vii. Bushings: Plan, elevation, terminal details, mounting details, make and type number, current and voltage rating, creepage distance, etc.
- viii. Rating and diagram plates drawing
- ix. Valve schedule
- x. Type test certificate validity as per Standard
- xi. Fire protection system OGA, drawing and documents with O&M manuals
- xii. All accessories' drawings like, OTI, WTI, breather, Buchholz Relay, PRD, Conservator, Radiator bank, etc along with catalogue with O&M manuals
- xiii. QAP and MQAP as per standard/guideline
- xiv. Any other drawings / documents required by Employer during detailed engineering

Drawings / Documents for information:

- i. Quality assurance plan, FAT/SAT procedure
- ii. Field Quality Plan
- iii. Product warranty document
- iv. Schedule of manufacturing and delivery
- v. Detailed erection, testing & commissioning manuals
- vi. Detailed operation and maintenance manuals
- vii. Overloading Curve with time duration
- viii. Recommended spare parts list for 5 years
- ix. Printed instructions to receive, store and handle at site
- x. Any other drawings / documents required by Employer during detailed engineering

3.2.2 Switchgear (33 kV)

33 kV Switchgear

- i. The design, manufacture, delivery, factory testing and inspection, delivery to site, installation, testing and commissioning of these panels shall comply with latest applicable standards. The equipment shall be designed, engineered, and manufactured to achieve high availability and reliability.

- ii. 33 kV ICOG Panel shall consist of one Vacuum/SF6 circuit breaker as the isolation and protection device along with tariff metering.
- iii. 33 kV Sub-pooling switchboard shall consist of Vacuum/SF6 circuit breaker for the Inverter transformer and load break switch for outgoing feeders. The number of incoming feeders shall be decided based on the block configuration adopted for the project.
- iv. All routine and acceptance tests at Factory and Site acceptance tests shall be conducted as part of the contract with prior notice to Employer.

Codes & Standards

Codes	Description
IEC 60298	A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-100/200	High-voltage switchgear and control-gear
IEC 62271	A.C. disconnectors (isolators) and Earthing switches for voltages above 1000 V
IEC 60168, IEC 61466	Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 volts up to and including 300 kV
IEC 61869	Instrumentation Transformers
IEC 60529	Degree of protection provided by enclosures (IP Code)
IEC: 61850	Communication Standard for Numerical relays
IEC 60947	AC contactors for voltages above 1000 volts and up to and including 11000 Volts.

Design Criteria

- i. The switchgear shall be gas insulated, single tier, fully compartmentalized, metal enclosed construction suitable for high altitude conditions.
- ii. The switchgear shall have an internal arc test classification corresponding to system fault current and as per IEC 62271-200.
- iii. The service class continuity of switchgear shall be LSC2B-PM as per IS/IEC 62271-200.
- iv. The gas sections shall be provided with expansion joints and flexible connections, where several enclosures are connected in the longitudinal direction, such as the main bus. Expansion joints provided for installation alignment shall be locked in place when alignment is complete. Expansion joints for compensation of thermal expansion and erection tolerances shall have the means to preserve mechanical integrity of the enclosure and the plug-in contacts for the conductor.
- v. All modules of the metal clad gas insulated switchgear and components of the same rating and construction may need to be replaced and completely interchangeable.
- vi. The enclosure shall be capable of sustaining without damage all mechanical, electrical, and thermal shocks that may occur in service during normal and fault conditions, including pressure effects of internal fault arc current of specified short circuit level and time. The enclosure assembly, material and design shall be such as to minimize induced electrical losses and heating effects which could occur in service under normal and faulty conditions.
- vii. The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck in any position Service, Test / Isolated or removed and with all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets.
- viii. Cooling of switchgear Panel shall by natural air flow.
- ix. Outdoor ICOG panel with proper extended shed, plinth and working platform shall also be acceptable.
- x. The circuit breakers and VTs shall be mounted on withdrawable trucks. Suitable trollies shall be provided for each ICOG / Sub pooling stations (for each type of breaker) by the bidder for withdrawal and insertion of the truck from and into the panel. Testing of the breaker shall be possible in an isolated position by keeping the control plug connected.

- xi. Enclosure shall be constructed with rolled steel / Aluzinc / Stainless Steel sections and thickness shall be 2.5mm for Load bearing and non-load bearing 2.0 mm sheets metal of at least 2.5 mm thick. Detachable Gland plates of minimum 3 mm thick, shall be made out of hot rolled or cold rolled, for single core cables, it shall be nonmagnetic material.
- xii. Total height of the switchgear panels shall not generally exceed 2700 mm. The height of switches, push buttons and other hand operated devices shall be around 1800 mm and shall not be less than 700 mm from bottom of the panel base. All relays, meters, indicating lamps, switches etc. shall be flush mounted on the respective cubicle front door.
- xiii. Circuit breakers shall be restriking free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker. Spring charging motor winding shall be provided with Class -E or better insulation.
- xiv. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between 85% to 110% rated DC voltage. The shunt trip coils shall operate satisfactorily under all operating conditions of the circuit breaker up to its rated short circuit breaking current at all values of control supply voltage between 70% to 110% of rated DC voltage.
- xv. Breakers Operation Class shall be E2, M2 & C2 and Rated Operating Duty shall be O - 0.3Sec- CO-3MIN-CO.
- xvi. Each DC circuit and AC circuit shall have dedicated MCBs of required rating.
- xvii. VCB shall have mechanically latched separate lock out relay, trip circuit supervision of lock out relay and VCB in open and close condition, DC supervision and AC supervision. 2 NO and 2 NC spare contacts wired up to the TB shall be provided.
- xxviii. Breaker auxiliary contacts shall be used directly or contact multiplication. Contact multiplication relay shall be provided. 2NO + 2 NC spare breaker auxiliary contacts wire up to TB for future use shall be provided.
- xix. The switchgear shall be fully integrated with SCADA and with IEC 61850. All feeders shall be controlled by SCADA / respective control system and from the switchgear. All the protection and safety interlocks shall be hardwired in the Switchgear itself. The Bidder shall consider an adequate number of digital inputs and outputs for integration with SCADA. The number of DI and DO will be finalized during detailed engineering without any extra cost to the Employer. DI and DO shall be from numerical relay only (Additional RIO are not acceptable).
- xx. Mimic diagram with description of function to represent the single line diagram, shall be made available on the panel.
- xxi. The switchgear shall be provided with emergency push buttons for emergency operations.
- xxii. The panels shall be provided with internal illumination arrangement along with utility power socket.
- xxiii. All working parts of the mechanism shall be of corrosion resisting material.
- xxiv. All control terminals shall be of Stud type (screw drive operated) and control wiring shall be terminated with tinned copper ring type lugs. A disconnecting stud type terminal shall be provided for CT circuits. 20% of terminals of each type and rating in each feeder shall be provided as spare subject to a minimum of 2 terminals of each type and rating.
- xxv. Auxiliary power supply for metering, control & protection system (both AC & DC) shall be derived internally. Suitably rated AC/DC converter/power pack arrangement shall be used to meet the metering/control/protection supply requirement of switchgear panels.
- xxvi. The switchgear compartment shall be such that maintenance can be carried out safely on one (1) circuit with other adjacent circuits still in service.
- xxvii. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not, however, reduce the degree of protection of panels under normal working conditions.
- xxviii. The surge arrestors shall be provided for inverter transformer feeders and other feeders as per system requirement. The surge arrestors shall be of metal oxide, gapped or gap less type generally in accordance with IEC 60099- 4 and suitable for indoor duty. These shall be mounted within the switchgear cubicle

- between line and earth, preferably in the cable compartment. Surge arrestor specifications and ratings shall be as per insulation coordination study.
- xxix. The Currents Transformers (CT) and Voltage Transformers (VT) shall be provided for protection and metering and shall be cast-resin encapsulated type with insulation class 'B' or better.
- xxx. CTs shall be rated for switchgear fault level for 1 sec and conforming to accuracy class mentioned below: -
- a. Class PX for differential relaying
 - b. Class 5P20 for other relaying
 - c. Class 0.2s for tariff metering system with ISF, burden and ratio (obtaining approvals is in the scope of Employer) as per local regulatory requirement.
 - d. Class 0.5 or better for general metering with ISF<5
- xxxi. Separate cores shall be provided for metering and protection applications.
- xxxii. Accuracy class of the voltage transformers shall be as specified below.
- a. Class 3P for protection
 - b. Class 0.2 for tariff metering system with burden (obtaining approvals is in the scope of Employer) as per local regulatory requirements.
 - c. Class 0.5 for general metering
- xxxiii. Switchgear shall be provided with in-built earthing switches for the busbars and all breaker feeders. Earthing switches shall be standard proven switchgear design. The inbuilt earthing switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have facility for padlocking in the earthed condition.
- xxxiv. A suitable arrangement for power cable termination shall be provided as required. Cable entry shall be from the bottom.
- xxxv. All wiring shall be carried out with wires of 1.1 KV grade, stranded copper conductors. The insulation shall be halogen free and flame retardant. Power circuits shall be wired with stranded copper conductors with 2.5 sq. mm. Unless otherwise specified, control alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 sq. mm. Space heater, CT and VT circuits shall be wired with stranded copper conductor of size not smaller than 2.5 sq. mm.
- xxxvi. The meters shall be suitable for operation from the secondary of CTs and VTs and they shall be provided with a separate test block. Meters shall be equipped with a communications interface with MODBUS TCP/IP protocol.
- xxxvii. All protection relays shall be numerical type with IEC 61850 communication protocol having Self-diagnosis / watchdog / relay failure indication facility.
- xxxviii. All hardware and licensed software required for communication of relays, parameterization, download / analysis of fault data from relays and interfacing the relays with the SCADA system shall be supplied by the Bidder in complete with set of cables, accessories, etc.
- xxxix. Following minimum protections shall be provided as specified below and any other required protections, functions, features, functionality required as per applicable regulation / norms / prudent industrial practices / system requirement shall be considered by the Bidder without any extra cost to the Employer.
- a. Minimum Protections required for Inverter duty Transformers:
 - 3.1.4. Transformer differential protection (87T) for rating >10MVA
 - 3.1.5. Overcurrent protection (50/51)
 - 3.1.6. Earth fault protection (50N/51N)
 - 3.1.7. Under voltage protection (27)
 - 3.1.8. Over Voltage (59)
 - 3.1.9. Auxiliary relays for WTI (all windings), OTI, PRV1, PRV2, MOG, Buchholz etc.
 - b. Minimum protection required for ICOG panel
 1. Overcurrent protection (50/51)
 2. Earth fault protection (50N/51N)
 3. Under voltage protection (27)

4. Over Voltage (59)
5. Under frequency (81U) and over frequency (81O)
- c. Minimum protection required for Aux. Transformers
 1. Overcurrent protection (50/51)
 2. Earth fault protection (50N/51N)
- xl. Annunciator (with AC and DC supply supervision) with SCADA integration to be provided for each feeder. (4 Nos of Spare window wired up to TB is to be provided in each annunciator).
- xli. Indication lamps shall be of the panel mounting, LED type
- xlii. Hooter system is to be provided for each 33KV sub pooling switchgear board and ICOG panel.
- xliii. Earthing bus shall be provided at the bottom and shall extend throughout the length of each switchgear.
- xliv. Each switchgear cubicle shall be equipped with thermostatically controlled SS304 grade / Aluminum alloy space heaters to prevent moisture condensation within the enclosure and shall be complete with MCB for power supply. Heaters and MCB shall be suitable for continuous operation on 230V, 1 phase, 50 Hz AC supply.
- xlv. All metallic hardware such as nuts, bolts, screws, washers etc. shall be of Hot dip galvanized as per IS standard.
- xlvi. 230V, 1 phase, 50 Hz. AC plug point shall be provided in the interior of each cubicle with an on-off switch for connection of hand lamps.
- xlvii. Name plate shall be of non-rusting metal or 3-ply lamacoid tags with white engraved letterings, on black background or as per manufacturer's proven standards. Inscriptions and lettering shall be subjected to Employer's approval.
- xlviii. Each Inverter station shall consist of one 415V, 3 phase 4 wire LV Switchboard or Power Distribution Board (PDB). Each PDB shall be with dry type transformers of sufficient rating as per system requirement. Input to PDB transformers shall be from secondary terminal box of Inverter Duty Transformer or AC Incomer of Inverter through MCBs / MCCBs. PDB shall be comprise of transformers Incoming & outgoing MCBs/MCCBs, 415V outgoing MCBs/contactors, Overload relays/starter module and ventilation facility. PDB shall be of floor mounted, free standing, compartmentalized type with adequate space for cable entry at Inverter Station. Aux. supply to another inverter shall be available (Auxiliary transformer to be fed from two inverters with suitable changeover switch).

Technical Parameters

Sl. No.	Description	Unit	Technical Requirements
1.	Type of switchgear	-	Gas insulated, Metal Clad Switchgear
2.	Installation		ICOG – Outdoor RMU – Indoor
3.	Rated Voltage	kV	33 ± 10%
4.	Frequency	Hz	50 ± 5 %
5.	Max. System Voltage	kV	36
6.	Design Ambient Temperature	°C	-10 to 35
7.	Max. Temp. rise limited	°C	As per relevant IEC
8.	Auxiliary Supply (AC)	V	230
9.	Auxiliary Supply (DC)	V	As per OEM design through Power pack
10.	Humidity	%	95
11.	System earthing	-	As per system requirement
12.	Insulation level		
	Power frequency withstand Capacity for 1 min.	kVrms	70
	Impulse Withstand Voltage	kVpeak	170

13.	Short Circuit Withstand capability	kA	As per system study and design requirements with an additional 10% Margin.
14.	Bus bars		
	Material of bus bar	-	Aluminum / Copper
	Cont. Current Rating of Busbar	A	As per system design study calculation
	Support insulators	-	Required
	Short Circuit Breaking Current	kA	25
	Dynamic withstands current rating (min)	kAp	63
	Temperature rise		As per IEC
15.	Degree of Protection	-	IP42 for Indoor IP 55 for Outdoor with extended canopy
16.	Paint Shade	-	RAL-7035 C4-M specification for indoor and C5-M specification for Outdoor
17.	Earthing Bus Bar	-	Required, Size to be selected based on fault current
18.	Minimum safety clearances in air		
	a) Between phases	mm	As per IEC or type tested design
	b) Between phase & earth	mm	As per IEC or type tested design
19.	Circuit Breaker		
	a) Type	-	Vacuum / SF6
	b) Rated Operating Duty	-	0 – 0.3S – CO – 3min – CO
	c) Rated Current	A	As per design requirement with 10% margin
	d) Spring Charging Motor	-	Required
	e) Auxiliary contacts	-	As per system requirement
20.	Current Transformer	-	
	f) No. of Cores	-	system requirement
	g) ISF		<5
	h) Accuracy Class	-	As per system requirement
	i) CT Ratio	-	As per requirement
	j) Burden	VA	As per system requirement
	k) Short time rating	kA	As per system requirement
	l) Type	-	Cast Resin
21.	Voltage Transformer	-	
	a) No. of Cores	-	As per system requirement
	b) Accuracy Class	-	As per System requirement
	c) Ratio	-	$33000/\sqrt{3}:110/\sqrt{3}:110/3$
	d) Burden	VA	As per system requirement
	e) Type		Cast Resin
22.	Space heater	W	Rating to be calculated as per design
23.	Seismic Zone		V as per IS - 1893

Tests

- i. Type Test shall be performed as per IEC 622771-200. The switchgear shall have valid Type Test Reports for the tests carried out within last ten years on equipment of similar rating/design shall be submitted for review (including Internal arc test as per IEC 622771-200, service class continuity test, LSC2B-PM as per IS/IEC 622771-200).

- ii. The Routine Test shall be performed as per IEC 622771-200.

Data to be furnished by Bidder after award of contract

Drawings / Documents for Approval:

- i. Switchgear cubicle: outline dimensions and GA, including plan, front elevation, rear elevation, side elevation and relevant cross-sectional views.
- ii. Switchgear layout plan including floor opening and fixing arrangement
- iii. Schematic control circuit diagram
- iv. Single line diagram & Schematic wiring diagrams
- v. Metering and protection drawing
- vi. Short circuit withstand calculation for busbar (Thermal & dynamic)
- vii. Detail wiring diagram including terminal block numbers, ferrule numbers and cable connection.
- viii. Relay and instrument panel GA
- ix. Inter panel interconnection wiring diagram
- x. Busbar sizing calculation
- xi. Relay setting and relay co-ordination,
- xii. Design calculations,
- xiii. MQAP and QAP as per
- xiv. Relay, CT, PT, Meter, related all items details drawing, catalogue
- xv. Erection & Commissioning procedure, O& M manual
- xvi. Foundation Plan & loading details
- xvii. Catalogues / drawings / leaflets for all items
- xviii. Comprehensive memory mapping of ABT meters, Numerical relays and MFM's
- xix. Any other drawings / documents required by the Employer's during detailed engineering

Drawings / Documents for Information:

- i. Type test reports
- ii. Manufacturer's catalogues
- iii. Erection manuals
- iv. Any other drawings / documents required by the Employer's during detailed engineering

3.2.3 Auxiliary Transformer

Auxiliary Transformers

The design, material, construction, manufacture, performance, inspection and testing of Auxiliary Transformers shall comply with all latest versions of standards, statutes, regulations and safety codes in the locality where the equipment is proposed to be installed.

Codes & Standards

The design, manufacture and testing of auxiliary transformers shall be carried out as per the latest applicable standards including but not limited to the following:

Codes	Description
IS:2026	Power & Distribution Transformer
IS:11171 / IEC 60076	Dry Type Transformers
IS:12063	Degree of Protection Provided by Enclosures

Codes	Description
IEC:60905	Loading Guide for dry type transformers

Design Criteria – Oil Filled Transformer

- i. An Auxiliary station transformer of suitable KVA rating, shall be considered to cater Solar PV Plant auxiliaries and 33kV switchyard auxiliaries as well.
- ii. The transformer shall derive auxiliary power from the 33kV Main switchgear and deliver it to the 415V Main switchgear which shall be in Main control room.
- iii. 20% design margin shall be considered while sizing auxiliary transformers. Also, if required, the rating shall be increased to keep the voltage drop during starting of the largest motor within 15%.
- iv. The transformer shall conform to the latest editions of national and international standards indicated above. Also, the transformer shall comply with the requirements indicated in Technical Parameters.
- v. Transformer and accessories shall be designed to withstand the expected fault levels. Dynamic ability and thermal ability to withstand the short circuit force shall be demonstrated by tests / calculations.
- vi. The auxiliary transformer shall be suitable for cable connection on both HV and LV sides. Suitable cable terminating arrangements shall be provided for both sides. In case of single core cable termination, cable box gland plate shall be of nonmagnetic material.
- vii. All materials used shall be of best quality and of the class, most suitable for working-under the conditions specified and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short-circuits as per specified standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.
- viii. A sheet steel, vermin and dust proof marshalling box (minimum IP55) shall be furnished with each transformer to accommodate winding and oil temperature indicators, Buchholz relay contacts and other contacts terminal blocks for control cables etc. The transformer neutrals shall be brought out in a separate cable box. If the same cable box is used for neutral side, then a metallic partition between phases and neutral shall be provided.

Design Criteria – Dry Type Transformer

- i. Auxiliary transformer of 0.433kV, suitable KVA rating shall be provided for meeting the Inverter block auxiliary loads. The rating of the auxiliary transformer shall be based on the expected auxiliary loads of the Contractor's complete system.
- ii. This transformer shall derive auxiliary power from the inverter / Inverter Transformer LV cable box / LT Panel and deliver to the 415V Main switchgear.
- iii. 20% design margin shall be considered while sizing auxiliary transformers. Also, if required, the rating shall be increased to keep the voltage drop during starting of the largest motor within 15%.
- iv. The transformers shall conform to the latest editions of national and international standards indicated in above. Also, the transformer shall comply with the requirements indicated in Technical Parameters.
- v. The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23. In case it is placed outdoor, IP for enclosure shall be minimum IP-55. Enclosure shall be of a tested quality sheet steel of minimum thickness 2mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting. Suitable bidirectional skids with pre-drilled holes shall be provided integral with the enclosure or bidirectional rollers shall be provided with suitable locking arrangement.
- vi. All Auxiliary transformers neutral earthing shall be provided with dedicated earthing pit, earth flat etc.
- vii. Winding conductor shall be electrolytic grade as per standard. Windings shall be of class F insulation or better. All windings are to be uniformly insulated.

- viii. The auxiliary transformer shall be suitable for cable connection on both HV and LV sides. Suitable cable terminating arrangements shall be provided for both sides. In case of single core cable termination, cable box gland plate shall be of nonmagnetic material.
- ix. MCB / MCCB shall be provided at Primary as well as secondary sides of Auxiliary transformers. Also, MCB/ MCCB shall be provided at source (IDT or inverter)
- x. All materials used shall be of best quality and of the class, most suitable for working-under the conditions specified and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short-circuits as per specified standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform
- xi. All control terminals shall be of Stud type (screw drive operated) and control wiring shall be terminated with tinned copper ring type lugs with insulated sleeve. Disconnecting stud type terminal shall be provided for CT circuits. 20% spare terminal shall be provided of each type. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS:375. Red Ferrules should be provided on trip circuit wiring
- xii. All wiring shall be carried out with wires of 1.1 KV grade, stranded copper conductors. The insulation shall be halogen free and flame retardant. Power circuits shall be wired with stranded copper conductors of adequate sizes to suit the rated current, the minimum size shall be 2.5 sq. mm. Unless otherwise specified, control alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 sq. mm. Space heater circuits, CT and VT circuits shall be wired with stranded copper conductor of size not smaller than 2.5 sq. mm.
- xiii. Painting of all metallic enclosed electrical panels / JB's / MK's /DBs etc shall be of paint shade RAL - 7035 and Shall be as per ISO 12944-5, corresponding to minimum C5-M category specifications for outdoor equipment and C4-M category specifications for indoor equipment.

Unless noted otherwise, all steel structures exposed to environment would be painted to meet the requirements of corrosion category or would be galvanized to minimum 110microns.

Technical Parameter

Oil Filled Type Transformer

Sl. No.	Description	Unit	Technical Requirements
1.	Application	-	Auxiliary Loads
2.	Type	-	oil filled type.
3.	Power Rating	kVA	Rating through detailed engineering
4.	Quantity	Nos.	As per requirement in multiples of XXkVA rating
5.	Voltage rating		
	a) Primary	V	XXV, 3 ph, 3 wire (suitable for inverter output voltage)
	b) Secondary	V	415V, 3 ph, 4 wire
6.	Impedance	%	As per relevant Standard
7.	Rated Frequency	Hz.	50
8.	Vector Group	-	As per system requirement
9.	Full load loss @ 75°C	kW	As per relevant Standard
10.	System Earthing	-	Solid Earthing

Sl. No.	Description	Unit	Technical Requirements	
11.	System Fault level	kA	As per system requirement during detailed engineering	
12.	Tapping:			
	a) Tap range	%	--5% to +5%	
	b) Tapping step	%	2.5%	
	c) Method of Tap change	-	Off Circuit links	
	d) Tapping end	-	HV side	
13.	Type of voltage variation (CFVV/VFVV/CBVV)	-	CFVV	
	Over fluxing capability	-	110% continuous	
14.	Type of Cooling	-	ONAN	
15.	Winding insulation type	-	Uniform	
16.	Power frequency withstand voltage of winding a) HV winding b) LV winding	kV (rms)	28 3	
17.	Insulation class	-	Shall be decided during detail Engineering	
18.	Temp. rise above 50 °C (a) In winding by resistance	□C	55	
19.	Conductor material	-	Copper	
20.	Winding temperature indicator	-	Required	
21.	Oil temperature indicator	-	Required	
22.	Paint shade	-	As per relevant Standard	
23.	Ref. Standards	-	IEC:60354	
24.	Terminal arrangement with cable box	-	Primary	Secondary
			*	*
25.	Mounting type	-	Plinth mounting	
26.	Bushing particulars.		Primary	Secondary
25.1	Make	-	*	*
25.2	Type	-	Porcelain for Outdoor Type	*
25.3	Voltage class	KV	33kV	*
25.4	Min. clearance in air			
	(a) Phase-Phase (b) Phase-Earth	mm mm	350 320	25 20
25.5	Creepage distance	mm/kV	25	25

* Data to be furnished by Bidder

Dry Type Transformer

Sl. No.	Description	Unit	Technical Requirements
1.	Application	-	PV Block / sub pooling station Auxiliary Loads
2.	Type	-	Indoor 2 winding, Dry Type Epoxy cast resin/resin encapsulated
3.	Power Rating	kVA	** TBD during DE
4.	Quantity	Nos.	As per requirement in multiples of XX kVA rating
5.	Voltage rating		
	a) Primary	V	XXV, 3 phase, 3 wire (suitable for inverter output voltage)
	b) Secondary	V	415V, 3 phase, 4 wire
6.	Impedance	%	As per relevant Standard
7.	Rated Frequency	Hz.	50
8.	Vector Group	-	As per system requirement
9.	Full load loss @ 75°C	kW	As per relevant Standard
10.	System Earthing	-	Primary side as per system requirement and Solid Earthing on LV side
11.	System Fault level	kA	As per system requirement during detailed engineering
12.	Tapping:		
	a) Tap range	%	-5% to +5%
	b) Tapping step	%	2.5%
13.	Type of voltage variation (CFVV/VFVV/CBVV)	-	CFVV
14.	Over fluxing capability	-	110% continuous
15.	Type of Cooling	-	Air natural
16.	Winding insulation type	-	Uniform
17.	Power frequency withstand voltage of winding a) HV winding b) LV winding	kV (rms)	* 3
18.	Insulation class	-	Shall be decided during detail engineering
19.	Temp. rise above 50 °C in winding by resistance	°C	70
20.	Conductor material	-	Electrolytic Grade Copper
21.	Paint shade	-	RAL 7035 for indoor / outdoor and C4-M/C5-M specifications
22.	Ref. Standards	-	IS:2026, IS:1180 & IS:11171
23.	Terminal arrangement	-	PRIMARY SECONDARY

Sl. No.	Description	Unit	Technical Requirements	
			Required	Required
24.	Mounting type		to be decided during detailed engineering as per Employer's requirement	
25.	Min. clearance in air			
	(a) Phase-Phase	mm	25	25
	(b) Phase-Earth	mm	20	20
26.	Creepage distance	mm/kV	31	31

Qualification Requirements

The Auxiliary Transformers shall be supplied from original equipment manufacturer and shall be of Employer's approved make.

The Auxiliary Transformers shall have valid type test certificates not older than 5 years.

Tests

- i. The routine tests shall be carried out as per applicable standards on all the transformers. The following tests shall be performed compulsory as part of routine tests along with other tests as per manufacturer recommendation:
- ii. Ratio, polarity, phase sequence and vector group.
- iii. No Load current and losses at service voltage and normal frequency.
- iv. Resistance of windings at each tap, cold (at or near the test bed temperature).
- v. Insulation resistance.
- vi. Measurement of no-load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.
- vii. Measurement of Load loss and impedance
- viii. Pressure and vacuum test for checking the deflection.
- ix. Dimensional check.
- x. Dielectric Tests.
- xi. Magnetic Balance Test.
- xii. Following Type test reports shall be furnished along with the offer:
- xiii. Temperature rise test for determining the maximum temperature rise after continuous full load run.
- xiv. Air Pressure Test
- xv. Magnetic Balance Test.
- xvi. Noise-level measurement.
- xvii. Measurement of zero-phase sequence impedance.
- xviii. Measurement of Harmonics of no-load current

Drawing / Document for Approval and information:

- i. Detailed technical data sheet
- ii. General outline drawings showing plan, front elevation, and side elevation, with all fittings and accessories, earthing terminals, foundation/floor fixing details, and weights of the following:
 - a. Cable boxes & disconnecting links
 - b. Terminals' details
 - c. Bushings: Plan, elevation, terminal details, mounting details, make and type number, current and voltage rating, creepage distance, etc.
 - d. Rating and diagram plates drawing
 - e. Valid type test certificates not older than 5 years
 - f. Drawings / Documents for information:

- g. Quality assurance plan, FAT/SAT procedure
- h. Field Quality Plan
- i. Product warranty document
- j. Schedule of manufacturing and delivery
- k. Detailed erection, testing & commissioning manuals
- l. Detailed operation and maintenance manuals
- m. Overloading Curve with time duration
- n. Recommended spare parts list for 5 years
- o. Printed instructions to receive, store and handle at site

3.2.4 LV Switchgear

LV Switchboards

The design, material, construction, manufacture, inspection, testing and performance of 415V LV switchboards shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards mentioned in Codes & Standards.

Codes & Standards

Codes	Description
IEC 60529	Degree of protection provided by enclosures (IP Code)
IEC 61439	Standard for low voltage switchgear and control gear assembly
IEC 60352	Crimped connections – general requirement, test methods and practical guide
IEC 61326-1	Electrical equipment for measurement
IEC 62208	Empty enclosure for low Voltage switchgear and control gear assemblies
IEC 60269-6	Low Voltage Power Fuses
IEC 62262	Level of Protection against Mechanical Impact (IK Rating)
IEC 60974	Low-voltage switchgear and control

Design Criteria and general requirements

- i. Incomer feeder of 415V switchboard shall be provided with suitable MCCB along with CT & MFM of accuracy class 0.5 or better for measurement of plant auxiliary consumption. MFM shall have suitable communication port for integration with SCADA system. All outgoing Feeders shall be Provided with suitable MCB/MCCB/MPCB only.
- ii. MCCB for incomer shall be provided with auxiliary contacts to provide ON, OFF, TRIP feedbacks to SCADA & shunt trip. MCCB/MPCB/MCB, contactor and overload relay shall meet type 2 co-ordination as per applicable standard. All outgoing feeders shall be provided with suitable rated MCCB/MPCB/MCB, contactor and overload relay only.
- iii. The 415V LV switchboard shall be provided with thermostatically controlled SS304 space heater, cubicle lamp and utility power socket.
- iv. All LV switchgear, MCC, DB shall be type tested as per IEC 61439.

- v. The LVT switchboards shall be equipped with two incomers (2 X 100%) with auto change over facility (MCCB with Contactor/ MPCB/MCB plus Contactor), auto manual selection, required interlocks etc., Detail scheme shall be finalized during detailed engineering as per Employer's requirement.
- vi. All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 2.0 mm for hot / cold rolled sheet steel and 3.0 mm for non-magnetic material.
- vii. Two earthing terminals with SS304 grade nut, bolt, spring and plan washers of suitable size shall be provided on both sides of the switchboard.
- viii. All doors, removable covers and plates shall be provided with neoprene gaskets
- ix. All live parts shall be provided with phase to phase and phase to earth clearances in air of at least 25 mm and 20 mm respectively. However, for busbars the clearances specified above should be maintained even when the busbars are sleeved or insulated. All connections from the busbars up to switch / MCB /MCCB shall be fully insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits. All busbars and jumper connections shall be of high conductivity aluminium alloy / copper of adequate size and sleeved.
- x. All switchboards shall be provided with three phase and neutral busbars. Entire busbar system shall be insulated with colour coated PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.
- xi. 20% spare terminal shall be provided in each terminal block.
- xii. All wiring shall be carried out with wires of 1.1 KV grade, stranded copper conductors. The insulation shall be halogen free and flame retardant. Power circuits shall be wired with stranded copper conductors of 2.5 sq. mm. Unless otherwise specified, control alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 sq. mm. Space heater circuits, CT and VT circuits shall be wired with stranded copper conductor of size not smaller than 2.5 sq. mm.
- xiii. All metallic hardware such as nuts, bolts, screws, washers etc. shall be of Hot dip galvanized as per IS standard.
- xiv. Cable entry shall be from bottom.
- xv. Busbars shall be of insulated. Busbars shall have adequate cross-section to carry the required continuous currents such that the operating temperature of the busbars does not exceed permissible temperature as per Indian standards / specification.
- xvi. All busbars shall be adequately supported by non-hygroscopic, non-combustible, track resistant and high strength sheet molded compound or equivalent type polyester fiberglass molded insulator.
- xvii. 20% spares feeders shall be considered for each type & rating. Spare modules shall be completely wired up.
- xviii. All busbar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver-plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. Maximum operating height of the switchboard shall be limited to 1800mm
- xix. All Switchgears panels, Distribution Boards, JB's, Fuse boards, all feeders, local push-button stations etc. shall be provided with prominent, engraved identification plates All name plates shall be of non-rusting metal or 3-ply Lamicaid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Employer's approval
- xx. Cable termination arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminium conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. Unless noted otherwise, all steel structures exposed to environment would be painted to meet the requirements of corrosion category or would be galvanized to minimum 110microns
- xxi. Moulded Case Circuit Breakers (MCCB) / Motor Protection Circuit Breakers (MPCB).

- xxii. MCCBs in AC circuits shall be of 3 pole type for 3 wire system and 4 pole type for all 3-Ph and neutral system. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. Operating handle for operating MCCBs from door of board shall be provided.
- xxiii. MCCB shall be fixed type module, air break type, having trip free mechanism with quick make and quick break type contacts. MCCB of identical ratings shall be physically and electrically interchangeable. MCCB shall be provided with 1 NO and 1NC auxiliary contacts wired up to TB.
- xxiv. The DC circuits shall be provided with DC MCCB / MCBs.
- xxv. MCCBs/MPCBs shall have following accessories and features:
- Shunt trip release
 - Auxiliary contact set of 1 NO + 1 NC
 - Fault signalling contact set of 1 NO + 1 NC
 - Insulation shields to isolate the connection between each pole
 - Finger protection plate to prevent accidental contact
 - The compartment door shall be interlocked with handle of MCCB/MPCB.
 - OEM supplied Interphase Barriers, shrouds, spreader terminal etc.
- xxvi. **Miniature Circuit Breaker (MCB):** Miniature circuit breaker (MCB) shall conform to IEC 898 and IS 8828. MCB shall be provided with thermo-magnetic type release for over current and short circuit protection. The MCB shall have breaking capacity not less than 10kA. MCB's are to be mounted on DIN channel only.

Technical Parameters

Sl. No.	Description	Unit	Requirements
	Type	-	Floor mounted, Free standing, single/double front, compartmentalised.
	Fully draw out / Semi-draw out / Fixed	-	Fixed
	Installation	-	Indoor
	System Parameters	-	
	Main system	-	3ph, 4 wire
	Rated operational voltage	V	415V
	Impulse withstand voltage	V	As per IEC
	Dry frequency withstand voltage	V	As per IEC
	Earthing system	-	Solid earthing
	Sheet steel thickness	mm	2.0
	Paint shade	-	RAL 7035 as per C5-M / C4-M specifications
	Busbar continuous rating	A	As per system requirement
	Short time rating, (1-sec)	kA	As per system requirement
	Incomer & Outgoing terminals		As per system requirements
	Clearance in air		
	Between poles	mm	25
	Between pole and earth	mm	20
	Degree of protection provided by the enclosure	-	IP42 for indoor
	Earth busbar size	sq.mm	As per system requirement

Sl. No.	Description	Unit	Requirements
	LED indication lamps provided for incoming feeder	-	Required
	Space heater, illumination & 5A, 5 pin sockets in ACDB	-	Required
	Illumination with LED lamp provided	-	Required
	5A, 5 pin sockets provided	-	Required
	Surge protection provided	-	Required
	Shunt trip for incomer MCCB	-	Required
	Multifunction meter with CTs (Accuracy class 0.5s or better)	-	Required
	MCCB		
	Voltage, frequency & no. of phases	-	415 V, 50 Hz & 3 PH
	Rated operating duty	-	As per IS
	Rated ultimate breaking capacity (Icu) at 415 V, 0.25 PF	kA (rms)	As per system requirement
	Rated service breaking capacity (Ics) at 415 V, 0.25 PF	kA (rms)	As per system requirement
	Rated making current	kA (Peak)	As per system requirement
	Releases required		
	Over-load inverse time, short circuit and earth fault	Yes/No	Yes

Tests

All the LV switchgear and distribution board shall be tested in accordance with IEC 61439.

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Engineering Schedule indicating list of drawings, documents, data, test certificates, manuals, etc. to be submitted by the Bidder together with dates of submissions and category of approval i.e. for approval or for reference.
- ii. GA & Cross-sectional drawings.
- iii. Guaranteed Technical Particulars.
- iv. Single line diagram.
- v. Bill of materials indicated with make, model, type, technical specification, etc. for all equipment / accessories.
- vi. Detailed cross-sectional drawings showing all relevant internal details of all equipment / accessories.
- vii. Drawing showing terminal connection.
- viii. Detailed quality assurance plan.
- ix. Final test procedures (at shop as well as at site) and Test Set-Up.
- x. Design calculations (wherever necessary) to prove the adequacy of the equipment offered.
- xi. Any other drawings / documents considered necessary.
- xii. The manufacturer is to furnish a detailed QAP and MQAP as per standard / regulations/guidance indicating the practice and procedure along with relevant supporting documents.

Drawings / Documents for Information:

- i. Type test certificates valid for as per regulation for all equipment / accessories being supplied under this contract.

- ii. Instruction Manuals.

3.2.5 UPS and UPS Distribution Board UPS & UPS Distribution Board

The design, material, construction, manufacture, performance, inspection, and testing of UPS shall comply with all latest versions of standards, statutes, regulations and safety codes in the locality where the equipment is proposed to be installed.

Codes & Standards

Codes	Description
IEC 62040-3	Uninterruptible Power Systems (UPS)
IEC 60529	Degrees of protection provide by enclosures (IP Code)
IEC 60417	Graphical symbols for use on equipment
IEC 61439	Standard for low voltage switchgear and control gear assembly
IEC 60755	General requirements for residual current operated protective devices
IEC 61000-2-2	Electromagnetic compatibility (EMC)
IEC 61326-1	Electrical equipment for measurement
UL 508	Standard for Industrial Control equipment
IEC 60269-6	Low Voltage Power Fuses
IEEE 1184	Guide for Batteries for Uninterruptible Power Supply Systems

Design Criteria and Technical requirements

- i. The UPS systems shall be designed to meet the auxiliary power requirements in respective Inverter stations, Sub-pooling stations and PV Plant SCADA, monitoring and Spare room Buildings.
- ii. UPS shall have 2x 100% configuration with bypass supply.
- iii. For each Inverter stations and each Sub pooling stations, UPS systems shall have 1 x 100% configuration.
- iv. The UPS shall be fed from LV switchgear. UPS back up time will be 60 minutes.
- v. UPS shall be sized considering 10% margin on full load requirement. Other criteria to be considered for UPS and battery sizing are,
- vi. UPS load power factor shall be taken as 0.8 lagging.
- vii. UPS efficiency shall be taken as 80%.
- viii. UPS and charger design margin shall be taken 10% at 30 deg C.
- ix. IEEE-485 standard shall be followed for sizing calculation of Lead Acid.
- x. Battery sizing calculation shall take care of the temperature variation.

- xi. Batteries aging factor shall be taken as 1.25 and design margin factor shall be taken as 1.10.
- xii. The UPS system shall include 230V AC distribution board with necessary MCBs / MCCBs. Necessary contacts required for remote alarm in SCADA shall be provided.
- xiii. Control circuitry of the rectifier shall be designed in such a way that the failure of any part of the control circuitry shall not result in unsafe mode of operation of UPS and associated equipment.
- xiv. The conversion of DC to AC shall be carried out by IGBT based PWM DSP control.
- xv. The batteries provided for the UPS systems shall be of Lead-acid Tubular battery. For detail specification of Battery, refer the 110V Battery and Battery charger specification.
- xvi. Manual bypass switch shall be provided for isolating the UPS during maintenance.
- xvii. The static switch shall be provided to perform the function of transferring UPS loads automatically in case of failure of Inverter to standby AC source. The transfer time shall be ¼ cycle maximum in synchronous mode.
- xviii. Indications & Annunciation

The UPS system shall be provided with necessary meters, mimic diagram, local indication / alarm conditions. High resolution digital display unit shall be provided for continuous monitoring of the UPS operation. The control system shall operate on Windows or equivalent platform. The following operating conditions shall be annunciated.

Alarm Indication:

- i. System fault
- ii. Rectifier charger failure
- iii. Inverter failure/ faulty
- iv. Battery under voltage
- v. End of Battery Discharge
- vi. UPS over temperature
- vii. Overload
- viii. Static transfer to stand-by
- ix. Transfer inhibited
- x. Overload shutdown
- xi. Emergency shutdown
- xii. Battery circuit breaker / switch open
- xiii. AC Main failure
- xiv. AC stand-by source mains failure
- xv. AC stand-by frequency out of range
- xvi. Manual bypass ON
- xvii. Fan failure
- xviii. Asynchronous condition
- xix. Control power failure
- xx. Any other alarm if required during detailed engineering

Status Indication on Mimic:

- i. Mains on
- ii. Rectifier on
- iii. Battery on load
- iv. Inverter on
- v. AC Stand-by source on
- vi. Inverter on –load
- vii. Manual by-pass on
- viii. Load on static bypass.

Display of measurements:

- i. Inverter output phase-to-phase voltages

- ii. Inverter output currents
- iii. Inverter output frequency
- iv. Voltage across battery terminals
- v. Rectifier input phase-to-phase voltages
- vi. Rectifier input currents
- vii. Active and apparent power
- viii. Power factor
- ix. DC voltage & Current
- x. Any other display is required during detailed engineering.

Remote Interface: Bidder shall consider the UPS integration with remote SCADA for monitoring of all annunciations, alarm, and metering parameters. UPS shall have RS485 port with Modbus compatibility to communicate to remote system. The Modbus card shall be either an isolated port or terminal block. The terminal block shall allow conventional twisted pair cabling for daisy chaining.

Technical requirements of UPS DB:

- i. The UPS Distribution board is to be provided to feed the loads. The UPS DB shall be provided with single input - Multi output feeders and the same shall be decided as per system requirement.
- ii. The AC Distribution board shall be made of CRCA material with full dust, water & vermin proof arrangement.
- iii. UPS Distribution board shall be provided with High Quality MCCB, RCCB, MCB, Aluminium busbar and cables of suitable ratings.

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Detailed schematic diagram of the UPS system showing all components
- ii. Bill of Material indicating rating & type designation of components.
- iii. General Arrangement drawing showing overall dimensions, foundation fixing details, location of various devices, mimic diagram, list of protections, annunciation and meters, cable openings, etc.
- iv. UPS and Battery Sizing Calculation
- v. Battery Drawings/documents as specified in battery Specification
- vi. Single Line Diagram
- vii. Data sheet
- viii. Factory acceptance test
- ix. Manufacturing quality plan
- x. Any other drawing required during detailed engineering

Drawings / Documents for information:

- i. Type test reports on components chosen.
- ii. Quality assurance plan.
- iii. Instruction manuals.

3.2.6 LT Power and Control Cable

LT Power and Control Cable

LT Power & control cables shall be of minimum 1100 volts grade XLPE & PVC insulated conforming to IEC 60502-1 and IS 7098

Codes & Standards

Codes	Description
IEC 60502	XLPE insulation and sheath of electric cables.
IEC - 332	Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).
IEC 754 Part I	Test on gases evolved during combustion of electric cables.
IEC 60332 Part I & III	Smoke Compound
SANS 1520 - Part 1	Cables with Operating voltages 640/1100 volts & 1900/3300 volts
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEEE-383	Standard for type test of Class IE Electric Cables

General Requirements of LT Power Cables

- i. All LT cables shall be of minimum 1100 V grade, single/multi-core, stranded aluminium conductor, extruded XLPE insulated (hot water cured), with extruded PVC inner sheath (Type ST-2), armoured and overall sheath with extruded Flame-Retardant Low Smoke Halogen free (FR-LSH), PVC compound (Type ST-2), however cable for Inverter-to-Inverter transformer shall be of minimum 1.9/3.3KV grade. These cables shall conform to IEC 60502-Part-I.
- ii. All cables shall be flame retardant, low smoke, halogen free (FR-LSH).
- iii. For 3 Phase, 4 Wire power system, Neutral conductor size shall be half size of the phase conductors' size.
- iv. LT cable maximum voltage drop shall be limited to 3% of rated voltage. 1.9/3.3kV grade LT cable shall be used for interconnection between inverter-to-inverter transformer.
- v. For single core & multicore armoured cables, armouring shall be of galvanized steel.
- vi. The aluminium used for armouring shall be of H4 grade as per IS: 8130. Copper / aluminium conductor shall be of electrolytic grade.
- vii. All the MV, LV cables (Power and control) shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to saline water, UV radiation, fungus, etc.
- viii. For Power cable joint shall only be permitted if single cable length as per OEM does not meet the requirement.
- ix. Cable selection & sizing:

Cables shall be sized based on the following considerations:

Rated current of the equipment. Full load current carrying capacity under installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation. Permissible voltage drops limits under steady state/transient state as applicable. Voltage drop shall be limited to 3% of rated voltage.

General Requirements of Control Cables

- i. 1.1 KV Grade Control Cables shall have stranded copper conductor and shall be multicore PVC insulated, PVC inner sheathed, armoured, FRLS/as per Standard PVC outer sheathed conforming to IEC.
- ii. The cores of the cables shall be identified by the colouring of insulation. Following colour scheme shall be adopted:

a	1 core	Red, Black, Yellow, or Blue
b	2 cores	Red & Black
c	3 cores	Red, Yellow & Blue
d	4 cores	a) Red, Yellow, Blue, and Black

- iii. For control cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g., say for 10 core cable, core numbering shall be from 1 to 10).
- iv. No Joints shall be permitted in any of the control cables.
- v. While preparing cable schedules for control / protection purpose following shall be ensured:
 - a. Separate cables shall be used for AC and DC circuits.
 - b. For different cores of CT and VT, separate cables shall be used.
 - c. Two separate cables shall be used from DC Source-I & Source-II to each control /relay panel, each 33 KV board, SCADA, server, etc. for main & redundant control supply and Auxiliary supply
- vi. Cable selection & sizing: Control cables shall be sized based on the following considerations:
 - a. The minimum conductor cross-section shall be 1.5 sq.mm.
 - b. The minimum number of spare cores in control cables shall be as follows:

No. of cores in cable	Min. No. of spare cores
2C, 3C	NIL
4C,5C, 7C	2
10C & above	4

Technical Parameters

The 1.1KV grade XLPE Power Cables shall comply with the particulars indicated below:

SN	Description	Unit	Requirements
1.0	General Requirements		
1.1	Voltage Grade	kV	Minimum 1.1
1.2	Core	-	Single, Multi
1.3	Conductor Material	-	Copper – Cable size upto 6sq.mm Aluminium - Cable size above 6sq.mm
1.4	Insulation	-	XLPE
1.5	Inner Sheath	-	Extruded PVC Compound (ST-2 for PVC Insulation)
1.6	Armouring	-	Galvanized steel round wire/ galvanized steel strip
1.7	Outer Sheath	-	Extruded FR LSH, PVC Compound (ST-2 for PVC Insulation)

SN	Description	Unit	Requirements
1.8	Maximum Conductor temperature	-	
	a) Rated	°C	90
	b) During Short Circuit	°C	250
2.0	System details	-	
2.1	Nominal power system voltage	V	415
2.2	Maximum system voltage for continuous operation	kV	1.1
2.3	System neutral earthing	-	As per system requirements
2.4	Design Ambient Temperature	°C	-10 to 35

The 1.1KV grade PVC Control Cables shall comply with the particulars indicated below:

SN	Description	Unit	Requirements
1.0	General Requirements		
1.1	Voltage Grade	kV	Minimum 1.1
1.2	Core	-	Multi
1.3	Conductor Material	-	Copper
1.4	Insulation	-	Extruded PVC
1.5	Inner Sheath	-	Extruded PVC Compound (ST-1 for PVC Insulation)
1.6	Armouring	-	Galvanized steel round wire/ galvanized steel strip
1.7	Outer Sheath	-	Extruded FRLS, PVC Compound (ST-1 for PVC Insulation)
2.0	System details	-	
2.1	Nominal power system voltage	V	415
2.2	Maximum system voltage for continuous operation	kV	1.1
2.3	System neutral earthing	-	As per system requirements
2.4	Design Ambient Temperature	°C	-10 to 35 or working committee report whichever is higher

The 1.9 /3.3 KV grade XLPE Power Cables shall comply with the particulars indicated below:

SN	Description	Unit	Requirements
1.0	General Requirements		
1.1	Voltage Grade	kV	1.9 / 3.3
1.2	Core	-	As per system requirements
1.3	Conductor Material	-	Copper / Aluminium - Cable size as per system requirement
1.4	Insulation	-	XLPE
1.5	Inner Sheath	-	Extruded PVC Compound (ST-2 for PVC Insulation)
1.6	Armouring	-	Galvanized steel round wire/ galvanized steel strip
1.7	Outer Sheath	-	Extruded FRLS PVC Compound (ST-2 for PVC Insulation)
1.8	Maximum Conductor temperature	-	

SN	Description	Unit	Requirements
	c) Rated	°C	90
	d) During Short Circuit	°C	250
2.0	System details	-	
2.1	Nominal power system voltage	V	As per system requirements
2.2	Maximum system voltage for continuous operation	kV	1.9/3.3
2.3	System neutral earthing	-	As per system requirements
2.4	Design Ambient Temperature	°C	-10 to 35

Tests

Cables shall be subjected to routine and acceptance tests as per IEC 60502 (Part-1).

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Design basis report
- ii. Cable sizing calculation
- iii. Completely filled-in Data Sheets and Schedules.
- iv. Technical particulars of cable cross sectional drawing, MQAP, FQAP, QA Plan and technical catalogues.
- v. Estimated weight of cables and cable drums.
- vi. Experience list where cables of similar rating and sizes have been installed and are in satisfactory operation.
- vii. Type test certificates/reports for the equipment covered in the specification.
- viii. Any other drawings/documents considered necessary

Drawings / Documents for information:

- i. Continuous current rating of the cable
- ii. General technical data
- iii. Construction details including type of material used and thickness of each material for each type of cable in a tabular form.
- iv. Instruction Manuals
- v. Type/Routine test certificates for all types of cables included in the order and special tests on FRLS/ cables in line with applicable standard.
- vi. All detailed catalogues and literature of Cables supplied

3.2.7 33kV Power Cables**33kV Power Cables**

33kV Power cables shall be provided from HT side of Inverter Duty Transformers to 33kV Sub Pooling substation, from sub pooling station to 33kV Transmission line, from 33Kv transmission line to PS -2 Switchgear. The design and engineering shall as per IEC standards.

Codes & Standards

Codes	Description
IEC 60502	XLPE insulation and sheath of electric cables.
IEC 60287	Recommended current ratings for cables

IEC 60502- Part 2	Recommended current ratings for cables
IEC 60502- Part 2	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.
IEEE-383	Standard for type test of Class IE Electric Cables
IEC-332 Part-3	Tests on electric cables under fire conditions. Tests on bunched wires or cables (Category-B).

General and Installation Requirements

- i. The cable shall be 19/33kV Grade, high conductivity stranded compacted circular aluminum conductor, three cores, XLPE insulated, Inner PVC ST2 sheathed, metallic screened suitable for carrying the system earth fault current, conductor and insulation screened galvanized steel strip armored with overall separate extruded PVC ST2 outer sheath, FRLSH conforming generally to IEC 60502 (part-II) and lasted amendment thereof suitable for 33kV 3 phase 50 Hz earthed system. Alternatively, HDPE Outer sheath (ST-7) with UV Resistant property as per IEC 60502-1 standards shall also be acceptable.
- ii. The sheath shall be suitable to withstand the operating conditions and the desired temperature rating of the cable. It shall be of adequate thickness, consistent quality and free from all defects.
- iii. All the armoring shall be hot dip galvanized steel strip.
- iv. Extruded PVC outer sheath of type ST-2 and Its thickness shall be in accordance standard. All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the outer sheath compound of the outer sheath. The sheath shall be resistant to saline water, UV radiation, fungus, etc. Alternatively, HDPE Outer sheath (ST-7) with UV Resistant property as per IEC 60502-2 standards shall also be acceptable.
- v. In addition to manufacturer's identification on cables as per IEC, following marking shall also be provided over outer sheath. Cable size and voltage grade - To be embossed Word 'FRLS/ actual specification ' at every three meter - To be embossed Screen Fault current __KA for ___ Sec. (Value of current & time shall l be indicated (If applicable). Sequential marking of length of the cable in metres at every one metre -To be embossed / printed the embossing shall be progressive, automatic, in line and marking shall be legible and indelible.
- vi. All cables shall meet the fire resistance requirement as per IEEE - 383 with cable installations made in accordance with 'Flammability Test' and as per Category-B of IEC 332 Part -3
- vii. Allowable tolerances on the overall diameter of the cables shall be +\2 mm maximum, over the declared value in the technical data sheets. Repaired cables shall not be accepted.
- viii. The cores of the cables of up to 3 cores shall be identified by coloring of insulation or by providing colored tapes helically over the cores with Red, Yellow & Blue colors.
- ix. Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted, except if single cable length as per OEM does not meet the requirement.
- x. Cable installations shall be as per Standard.
- xi. Cable identification system

- a. In addition to manufacturer's identification on cables as per standard, following marking shall also be embossed/printed on the outer sheath at an interval of three (3) meter throughout the length of cables.
 1. Employer's name:
 2. Manufacturer's name and or trademark.
 3. Year of manufacture
 4. Cable code
 5. Type of cable and voltage class.
 6. Nominal cross section area of conductor and no. of cores.
 7. Progressive sequential length marking at every meter.
- b. Cables shall be marked as having FRLS/actual specification outer sheath at every three (3) meters.

Design Criteria

The HT 33kV power cables shall be sized based on current carrying capacity, short circuit rating and permissible power loss as specified under relevant performance guarantee clauses. Cable shall be capable of laying in underground soil with saline water.

Current carrying capacity:

The cable shall be able to carry the full load current of the circuit continuously under the specified ambient temperature and other conditions of installation.

Short circuit rating:

HT power cables, if protected by circuit breaker, shall be able to withstand the fault current of the circuit for the desired fault clearing time as per protection time grading requirement and as per statutory requirement.

Permissible power loss:

The power loss in HT cables shall be limited such that overall plant AC ohmic loss shall be within permissible limit as specified under relevant performance guarantee clauses.

Technical Parameters

SN	Description	Unit	Requirements
1.0	General requirements		
1.1	Voltage Grade	kV	33 kV
1.2	Core	-	Multi
1.3	Conductor Material	-	Aluminium as per applicable standards and codes
1.4	Conductor screen	-	Extruded semi conducting compound
1.5	Insulation	-	Extruded XLPE
1.6	Insulation screen	-	Extruded semi conducting compound with metallic tape screen over it
1.7	Inner Sheath	-	PVC Compound (ST-2)
1.8	Armouring	-	Galvanized steel strip / galvanized steel round wires
1.9	Outer Sheath	-	FRLSH PVC compound (ST-2) as per Standard. Alternatively, HDPE Outer sheath (ST-7) with UV Resistant property as per IEC 60502-2 standards shall also be acceptable.
1.10	Cross Sectional area of conductor		Shall be as per design calculation and no negative tolerances is permitted

SN	Description	Unit	Requirements
2.0	System Details		
2.1	Nominal Power System Voltage	kV	33
2.2	Maximum System Voltage	kV	36
2.3	System Neutral Earthing	-	As per system requirement
2.4	Design Ambient Temperature	°C	-10 to 35
2.5	FRLSH as per Standard PVC outer sheath required	Yes / No	Yes
2.6	Short circuit fault current capability	kA	As per System Design
2.7	Metallic screen ground fault current capability for 1 sec.	kA	Bidder to select as per the ground fault current of the system
3.0	Specific Requirements and Quantity		
3.1	No of cores	-	As per system requirements
3.2	Quantity required.	km	As per project requirement
3.3	Cable Size	-	As per project requirement
3.4	Drum length requirement	-	As per project requirement

Tests

Cables offered shall be type tested and proven type. Routine tests shall be as per IEC 60228 / IEC 60502-2 / IEC 60885-3 shall be carried out on 100% drums. Type test shall be as per IEC 60502-2 and IEC 60811 Acceptance tests & Special Test shall be carried out on no. of drums selected on random basis in the lot as per IS 7098 Part-I (Appendix-A) & Part-II (Annexure-D), of each type and size of cable of each lot. Bidder / Cable manufacturer shall provide the Type Test & Special Test reports as per Cl. No. 12.2 of IEC-62067.

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval:

- i. Completely filled-in Data Sheets and Schedules.
- ii. Technical particulars of cable cross sectional drawing, QA Plan and technical catalogues.
- iii. Estimated weight of cables and cable drums.
- iv. Experience list where cables of similar rating and sizes have been installed and are in satisfactory operation.
- v. Type test certificates/reports for the equipment covered in the specification.
- vi. Any other drawings/documents considered necessary.
- vii. MQAP & Field quality plan
- viii. Cable sizing calculation

Drawings / Documents for information:

- i. Continuous current rating of the cable
- ii. General technical data
- iii. Construction details including type of material used and thickness of each material for each type of cable in a tabular form.
- iv. Instruction Manuals
- v. Type/Routine test certificates for all types of cables included in the order and special tests on cables in line with applicable standard.
- vi. All detailed catalogues and literature of Cables supplied.
- vii. Any other drawings/documents considered necessary.

3.2.8 SCADA System

- i. This Section specifies the minimum requirements for design, engineering, installation, and testing of the PV Plant SCADA System.
- ii. The SCADA includes all the software, hardware, wiring, servers, infrastructures, Gateway, Networking Equipment, HMI, Laser Printer etc., required to provide the monitoring, control and management capabilities described in this section. The provided system shall include a Graphical User Interface (GUI) for display and representation of data. The SCADA must be permanently connected to the internet and the software platform shall have the ability to be accessed remotely and locally with an HMI machine. The SCADA hardware infrastructures shall be in the Control Room along with all required supporting equipment. Communication equipment installed shall be interoperable, to allow seamless integration between different vendors.
- iii. The SCADA system shall be designed with Redundant and HOT stand by.
- iv. All 33KV switchgears, IEDs, Meters, tariff meters, all other electrical equipment's shall be fully integrated to SCADA system in comprehensive manner for monitoring and control with time synchronization.
- v. Reliability of SCADA shall be as per Technical Standards for Communication System.
- vi. The system must be designed, engineered, and installed by an experienced integrator/provider with proven track record of successful installations. All component manufacturers must be ISO 9001 certified. All software must be modular and be programmed using open-source programming languages.
- vii. All software License shall be perpetual/ SCADA life.
- viii. In case of anti-virus software, the license shall include regular updates until the end of warranty.
- ix. Any defect in the software, which may arise during defect liability period of the system shall be fixed at no cost to the Employer. During warranty period for any fault in entire SCADA package, the fault shall be rectified within 24 hours from time of intimation given to Employer/O.E.M and system should function with all functionalities as at time of commissioning.
- x. All software with license and key shall be handed over to Employer.
- xi. Control and monitoring of photovoltaic systems and Inverters are essential for reliable functioning and maximum yield of PV solar electric system
- xii. A common, centralized, Supervisory Control and Data Acquisition System (SCADA) is envisaged for providing control and monitoring functions related to PV solar plant, Electrical system shall be envisaged
- xiii. The PLC based SCADA System shall monitor, control and process alarms of all required components and be able to integrate and display information of such components in a single software platform. The Scada must accumulate functions of control, monitoring, data processing and analytics and supervision and alarm management.
- xiv. The SCADA should be designed and engineered with the following guidelines:
 - a. The system should have high availability, stability, and reliability as per Technical Standards for Communication System.
 - b. The solution should allow scalability to include the possibility of expansion of the system without rearrangement of the existing system architecture, allowing an increment just by adding equipment.
 - c. Architecture should be simple and should be modular to account for system maintenance, addition and correction of features or components to the system
- ix. The I&C system shall permit centralized operation of the plant from the Main Control Room in the control building. The Human Machine Interface (HMI) of the SCADA shall be housed in the Main control room in the control building
- x. The Plant SCADA (Supervisory Control and Data Acquisition) software applications consist of acquisition and gathering of all information generated by the solar plant equipment such as fiscal meters, inverters, recombiner box, network analyzer, weather stations, and data loggers.
- xi. The SCADA is composed for software and hardware, and it is designed for local and remote monitoring, historical trending, and operation of the plant. Receive in real-time plant information for all plant monitoring.

- xii. All services including specialized services necessary for proper erection, testing and commissioning of all items of the package covered under this proposal shall be arranged by the Bidder. The SCADA shall be of latest OPC version 2.05a or higher compliant and implement an OPC- DA 2.05a server as per the specification of OPC Foundation
- xiii. SCADA system shall support Modbus (TCP/IP, RS-485), RTU, ASCII, IEC 61850, IEC 60870-5-101 & 104, FTPs, Redundant Gateway (at site end) to communicate to Remote Client Centralized Server on OPC UA or DA Server protocol and communication to SLDC via FOTE on IEC 60870-5-101, IEC 60870-5- 104 protocols. The arrangement to transmit data required by the Load Dispatch Centre (LDC) from solar plant to LDC as per regulations shall be in Bidder's scope. The necessary details of connecting substations, availability of systems at substations has to be ascertained by Bidder for ensuring the Telemetry/data communication till final control centres. Necessary software and hardware, including laying of Communication cable/ Fiber Optic cable up to LDC for communication of plant data from Solar plant SCADA to LDC is included in the contractor scope. Communication link and communication controller/Gateway used for data communication to LDC shall be redundant (one for normal operation and other as hot standby).
- xiv. SCADA shall provide for the following control / monitoring as per technical standards
- PV plant Monitoring– Zone monitoring at Inverter Level in case of Central inverter
 - Control and monitoring of Plant electrical equipment, Feeders and their energy meters (Tariff based / Performance based) etc.
 - Redundant PPC shall be provided at Solar end MCR.
 - Module Cleaning System dry and wet (if applicable)
 - UPS and battery chargers
 - NIFPS
 - Fire Protection System
 - Weather Station
- xv. SCADA shall have the following hardwired / Soft links to facilitate the below:
- Weather station data (Soft link)
 - Soiling Station
 - Inverter parameters, alarms, and ON/OFF Command (Soft link)
 - Transformer monitoring (hardwired)
 - HT Switchgear all equipment including annunciator
 - NIFPS Integration with SCADA
 - UPS and Battery Charger data (Soft Link)
 - Display and storage of derived/ calculated/ integrated values
 - Tele protection, Data and Speech communication with LDC as per technical standards and local grid regulations
- xvi. 5% spare IO shall be considered for engineering contingencies and 10% overall spare shall be considered for each type of module for future expansion.
- xvii. Critical plant and Outgoing Feeder related parameters shall be made available online and shall also be historized, for offline analysis to track plant performance and ensure asset availability.
- xviii. SCADA shall provide 1, 15, 30 minutes interval daily, monthly, and annual average of all the measurements. PPC reports shall have minimum 1 sec time resolution or as per requirements. All reports shall be made available in CSV, MS Excel file type. It also generates, store and retrieve user configurable periodic report.
- xix. All systems shall be "State of the Art", (Latest Technology) with a proven track record, suitable for the entire range of site ambient conditions as specified in Specification.
- xx. Entire equipment pertains to the I&C system including SCADA system shall not get obsolete within 15 years of taking over of the complete plant. The Bidder shall provide spares and service support letter on O.E.M letter head for the offered systems for at least 15 years from COD.
- xxi. Bidder shall ensure appealing aesthetics and ergonomic designs while selecting control room consoles, HMI equipment and furniture and obtain Employer's prior approval for the same.

- xxii. The SCADA system from Solar Power Plant to PSS Common communication Panel shall be connected through 2 nos. of Optical Fiber Cable (armoured).
- xxiii. Power plant controller (PPC) shall be provided with two processors (main processing unit and memories), one for normal operation and one as hot standby.
- xxiv. In case of failure of working PPC processor, there shall be an appropriate alarm and simultaneously the hot standby PPC processor shall take over the plant control function automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever.
- xxv. It shall be possible to keep any of the PPC processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. The solar plant SCADA and PPC networks shall be suitably designed, so that PPC shall directly and independently able to control the individual solar inverter. Detailed control logic in the PPC shall be finalized during detailed engineering stage.
- xxvi. PLC/SCADA system shall comply as per the latest Cybersecurity requirement & necessary Hardware's shall be considered.

Codes and Standard

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to:

Codes	Description
IEEE	The Institute of Electrical and Electronic Engineers
ANSI	American National Standards Institute
IEC	International Electrochemical Commission
EN	European standards
ITU	International Telecommunication Union
ISO	International Standards Organization.
ISA	Instrumentation, Systems and Automation society

Design Criteria

- i. Data Acquisition, Storage and Analysis
- ii. The SCADA shall acquire process and analyses data. All required components shall have communication protocols compatible with the SCADA and all communication lines and infrastructures shall be included in the monitoring system. After acquisition of data the software platform shall be capable of providing the following analytics and reporting:
 - a. Yield and Performance Ratio (PR) calculation.
 - b. Display of reports, events, and alarms.
 - c. Creation and scheduling of reports of PV plant KPIs trends for different time scales, such as hourly, daily, monthly, and yearly.
 - d. Display of overall plant layout, individual equipment status and areas with colour codes for each area of the PV Power Plant in the GUI.
 - e. Max irradiation, annual irradiation, and generation today, month and year with date.
 - f. Block number and 15 min generation in that block / as per the regulation requirements.

- g. Any other requirement as required by Employer.
- h. All data acquired during the lifespan of the plant must be logged, archived and available in the platform.
- iii. The acquired data shall be stored in local servers and periodically send to Historian. Acquisition system parameters:
 - a. Monitoring stations, SCADA Hardware, Accessories and Communication Link
 - b. Weather station
 - c. Inverter
 - d. Alarms and warnings of PV equipment
 - e. Main PV Plant Switch
 - f. Monitoring of electrical parameters of Energy Meter, MFM, PQ Meter, Numerical relay, Fire alarm panel, GPS, Transformers.
 - g. Data logger equipment
 - h. Reading of network analyzers
 - i. Supervisor of systems and protections (team that monitors the status of the protection low voltage and medium voltage).
 - j. HT Switchgear equipment
 - k. UPS and Battery Charger (if required) parameters
 - l. Any other equipment parameters required
- iv. The connection between different field communication devices (Inverters, network analysers, weather station, etc.) and the server will be made through the local network installation, using switches to group equipment. The field communication devices will be located on the control box at each power station. Through the fiber optic (Single mode) the data collected from the power stations, meter and weather stations will be carried to Main switch panel into the Main Control box located at control room.
- v. The SCADA shall have control functions to issue commands and settings to the control enabled equipment. Control functions of the PV power plant shall include at least:
 - a) Remote and local curtailment of power, through issuance of commands to the PV inverters as per requirements of local grid codes and regulations
 - b) Control functions shall allow a reaction time for ramp up and ramp down of PV output power at a rate in compliance with local grid codes and regulations
 - c) Reaction time for controls and curtailment of PV inverters shall the shortest possible and must comply with local grid codes
 - d) All limits and thresholds shall be easily adjustable remotely and via local operator login at the HMI
 - e) Remote control (on/off) of PV inverters, main switchgear including setting of all parameters
 - f) Other required control functions not listed in this document required by local grid codes and regulations.
- vi. Following Meteorological Station data shall be included in SCADA
 - For each of the installed meteorological stations:
 - a. Ambient temperature, in °C
 - b. Back of module cell temperature, in °C
 - c. Global Horizontal Irradiance from pyranometer, in W/m²
 - d. Global irradiance in collector plane from a pyranometer, in W/m²
 - e. Wind speed, in m/s.
 - f. Wind direction, in degrees
 - g. Rain falls in mm
 - h. Humidity
 - i. Weather station communication status
- vii. Following Inverter minimum data shall be included in SCADA
 - a. Inverter alarms including diagnostic alarm
 - b. DC voltage, in V DC
 - c. DC current from each input, in A

- d. Power supply voltage, in V
- e. Power supply load, in kW
- f. AC output apparent power, in kVA
- g. AC output active power, kW
- h. AC reactive power, kVAr
- i. Power Factor
- j. Phase angle, in degrees
- k. For each output AC phase
 - l. Voltage, in V
 - m. Current, in A
 - n. Active power, in kW
 - o. Reactive power, in kVAr
 - p. Apparent power, in kVA
 - q. Temperature inside the inverter
 - r. AC switch position (open or closed)
 - s. AC trip status
 - t. All other standard PV inverter parameters
 - u. Communication status
 - v. ON/OFF command to Inverter
 - w. Any other parameters as required by Employer
- viii. Following Energy Meters minimum data shall be included in SCADA
 - a. Active (kWh) and reactive (kVArh) exported energy at the output of the inverter.
 - b. Active (kWh) and reactive (kVArh) imported energy at the output of the inverter.
 - c. Frequency (in Hertz) at the output of the inverter.
 - d. Harmonics
 - e. True RMS of current (in Amperes), voltage (in Volts) and power (in kW): average, actual, maximum, and minimum, for each of the phases of the output of the PV inverter.
 - f. Voltage shall be measured at the middle of each pair of cables in the inverter output bus.
 - g. Current shall be measured by high accuracy current transformers and the point of measuring should be in the output cables of the inverter.
 - h. Communication status
 - i. Any other parameters as required by Employer
- ix. Following MV Switchgear minimum data shall be included in SCADA
 - a. MV AC switching cell status (open or closed) for all the cells: transformer, line 1 and line 2.
 - b. Transformer MV fuse trip status (blown or ok).
 - c. Trip status of transformer MV switch for pressure and/or temperature.
 - d. Communication status
 - e. Any other parameters as required by Employer
- x. Following Plant Delivery Station minimum data shall be included in SCADA
 - a. Switching station temperature.
 - b. Status of each switch for each loop line, transformer and exit line (open or closed).
 - c. Transformer trip status from pressure and/or pressure.
 - d. Status of protection from the current transformer cell and its protection fuses (blown or ok).
 - e. Status of each protection relay.
 - f. Differential pressure and its status.
 - g. Status of cooling fans.
 - h. Communication status of all devices in the room.
 - i. Any other parameters as required by Employer
- xi. Following Fire Protection Devices minimum data shall be included in SCADA
 - a. Alarm status of MV switching cell room.
 - b. Alarm status of Plant Delivery Station.

- c. Alarm status of buildings.
- d. Any other parameters as required by Employer

Hardware & Software Requirements

PV Plant SCADA Monitoring shall have the following feature:

- i. Facility for implementation of all logic functions for control, protection and annunciation of the equipment and systems.
- ii. SCADA shall be provided with two processors (main processing unit and memories), one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete plant operation automatically.
- iii. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever.
- iv. In the event of both processors failing, the system shall revert to fail safe mode.
- v. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor.
- vi. The memory shall be field expandable.
- vii. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future.
- viii. Programmed operating sequences and criteria shall be stored in non-volatile semiconductor memories like EPROM.
- ix. All dynamic memories shall be provided with buffer battery backup for at least 360 hours. The batteries shall be lithium or Ni-Cd type.
- x. A forcing facility shall be provided for changing the states of inputs and outputs, timers, and flags to facilitate fault finding and other testing requirements. It shall be possible to display the signal flow during operation of the program.
- xi. Bidder must provide suitable firewall to restrict unauthorized access to HMI/ SCADA system.

State of the art microprocessor-based SCADA system for Plant control and monitoring including PV solar plant, BOP systems, Electrical system. In addition, SCADA shall facilitate optimized inverter control. The performance, memory and hard disk of the workstation shall be sufficient to fulfil the requirements specified in this document and supports its activities throughout the lifetime of the plant. one number mini-PLC controller shall be mounted in each Inverter Room and Redundant PLC for main control room at sub pooling station

Human Machine Interface (HMI).

- i. Two numbers Operator workstations, one number Engineering workstation, one historian server, two gateway systems, CCTV server with 24 inches" LED monitor minimum for Engineer work station and 50 inches for CCTV workstation. Both the systems to be connected to redundant servers (24x7). The Systems to be functionally interchangeable. I.e., The function of both Engineering station and operator station shall be possible from both the systems. Operator shall be able to access all control/information related data under all operating conditions including a single processor and computer failure/hardware failure.
- ii. All the required software to be provided including supply of Graphic interface card for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible.
- iii. The SCADA shall include two (2) redundant Control Unit Servers working in hot-standby mode. The performance, memory and hard disk of Control Unit servers shall be sufficient to fulfil the requirements specified in this document Hard disk for archiving shall be a RAID05 system providing resilience against a single hard disk failure. The servers shall be form type. As a minimum, the servers shall meet at least the following:
 - a. Redundant monitored power supply, hot pluggable

- b. Monitored cooling fans
- c. Redundant hot pluggable, hot swappable hard disk array
- d. Power supply: redundant from UPS
- iv. One number A4 cum A3 colour Laser printer equipped for colour laser printing, scanning, copying and faxing facility.
- v. Redundant Server based Network Panels including Network switches, Remote wireless connection related interface devices etc.
- vi. The Bidder shall provide standard hardware and software configurations to the extent possible if it meets or exceeds the requirements of this Specification. International standards shall be applied for hardware and software interfaces to allow system expansion in terms of equipment and software functions (if required).
- vii. Licensed software copy required for the proposed system shall be provided. The latest proven antivirus software shall be installed in the SCADA
- viii. All logins to the system shall be password protected. Data transmission via public internet shall be encrypted.
- ix. Application software, MIS software & HMI software to meet the specified functional requirements of SCADA.
 - x. Sequence of Events recording and annunciation system – integral to SCADA system.
 - xi. Historization and archiving relevant data for analysis.
 - xii. Interposing relays, isolators as required.
 - xiii. Control desk, Control panel, system / marshalling cabinets, as required.
- xiv. All Instrumentation & Control cables, serial link cables, single mode / Multi mode armoured fiber optic cables, SCADA system cables etc., between any two-system supplied by Bidder.
- xv. 2x100% Redundant 230VAC UPS for SCADA. UPS shall be provided as per requirement.
- xvi. Required Power Distribution Boards as required for distributing the UPS / other power supplies to all consumers of the total system.
- xvii. MIS Server for Enterprise network interface.
- xviii. Dedicated Earthing system (separate electronic and frame earth).
- xix. Emergency local push buttons.
- xx. Control panel to be in Control room, with operating, monitoring hardware and Annunciation system as per system requirement.
- xxi. GPS Master Clock-They shall be connected, and time synchronized via the Global Positioning System (GPS). All measured data, events, alarms, logs etc. shall be time stamped with a 1msec resolution. A master clock (e.g., via GPS) shall be provided and shall be used for time synchronization of all auxiliary systems and equipment of the PV power plant such as Meteorological Measurement Station, etc.
- xxii. The SCADA shall be based on standard proven firmware and software, which shall already be implemented in other systems. The software engineering tool shall be provided to configure, set up and modify the data acquisition, data processing and database system components. The software application shall include facilities to perform programmable logic functions.
- xxiii. The system shall have monitoring and self-diagnostics features for both, hardware, and software. Licensed software copy required for the proposed system shall be provided. The latest proven antivirus software shall be installed in the SCADA. All logins to the system shall be password protected. Data transmission via public internet shall be encrypted. Application software, MIS software & HMI software to meet the specified functional requirements of SCADA. Sequence of Events recording and annunciation system – integral to SCADA system. Historization and archiving relevant data for analysis.
- xxiv. The Bidder shall provide software license for all software being used SCADA system. The software license shall be provided for the project (e.g., Organization or Site License) and shall not be hardware/machine specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good, and it shall not be necessary for Employer to seek a new license/renew license due to up gradation/change of hardware/machine in SCADA system at Site. All licenses shall be valid for the continuous service life of the plant. All SCADA software with license shall be handed over to Employer.

Parametric Requirements

The control system shall be designed such that under worst case loading conditions the response time shall not be worse than the following: -

- i. On/Off Command: - The response time for screen update after the execution of the control command from the time the command is issued shall be one second (excluding the drive actuation time).
- ii. Adjustment Command: - 0.5 to 1 second.
- iii. On screen Updating and All Control related displays: - 1 second.
- iv. Bar Chart displays, Plant Mimic displays, Group review displays, X-T Plot Displays and Plant Summary Displays: - 1 to 2 seconds.

All the Analog data shall be scanned at the resolution of 1(one) second and refreshed on screen however, recording of data shall be as finalized during detailed engineering.

Plant Performance Calculation & Tracking in SCADA System

SCADA shall have provision to calculate and display the following:

- i. Performance Ratio.
- ii. Energy yield
- iii. Day, month, annual generation curves etc.
- iv. Displays shall also include current and histories trends for generation curve, yield curve, module temperature variations, wind velocity, radiation variation etc.,
- v. Individual Inverter performance shall be tracked and displayed.

Archiving Server System

- i. Multiple, dedicated RAID disk systems shall be provided in all servers, to maximize system throughput and minimize data exchange delays.
- ii. Disk drives that make up the RAID array shall be hot pluggable and be capable of being replaced online. The system shall be capable of automatic recovery from a single disk drive failure.
- iii. Each disk array's total capacity shall be expandable in configuration and adding more drives, with no requirement to physically shutdown of the disk array and restart the system.
- iv. Minimum capacity of the data disk array that is useable data storage shall be 1TB and shall be of sufficient qty to store data for duration of three (3) years.
- v. For regular backup of the RAID data storage array a Network Attached Storage unit (NAS) shall be provided. The unit shall have a sufficient capacity to allow:
 - a. Complete backup of the whole server and workstation operating system files and application programs – this backup to be done by the system administrator on monthly basis. Only one historical backup and one actual backup shall be maintained on the storage unit.
 - b. The unit shall be capable to ensure backup capacity of those files for a continuous period of 6 months. An alarm shall be raised when the NAS capacity decreases to less than 20%.
- vi. Equipment for automatic backup of operator workstation and Central Unit Servers shall be provided. Removable media (e.g., hard disk, DVD or similar) shall be provided to enable storage of backups

Inverter Trip Analysis

Inverter trip mechanism and settings shall be tuned site specific to match with the evacuation system requirements. Inverter trips and causes of trips shall be logged with a sequence of events recording feature of SCADA as per the local grid requirements.

Historization And Archiving

- i. Data temporarily stored in inverters memory shall be periodically acquired in PLC hard disk. Data logging shall be envisaged for various environmental and PV plant system related parameters and shall facilitate detailed overview about the whole system. User configurable trend and Report formats shall be available.

- ii. Alarm, Event, Periodic plant data, selected logs/reports History shall be available for archiving.
- iii. The Historian shall collect, store and process system data from SCADA data base. The data shall be saved online on hard disk and automatically transferred to nonerasable long term storage media once in every 30 Days periodically for long term storage. Provision shall be made to notify the operator when hard disk is certain percentage full.
- iv. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on operator cum engineering workstation in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same.
- v. In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration on portable external long-term storage media. Bidder shall provide two numbers of portable external hard drive of 2TB each.
- vi. For long term plant performance analysis, the following plant data as a minimum with time stamping and interval as indicated in below table but not limited to shall be stored daily on historian.
- vii. Important plant data for a very long duration (plant life) Storage on Historian

Sl.	Parameter	Time Interval *
1	Weather Monitoring Stations data: Global Horizontal Irradiance, Global Inclined Irradiance Ambient Temp, PV Module Temperature, Wind Speed, Wind Direction, Rain Fall and Relative Humidity.	1 (One) Minute
2	Calculated Daily Global Horizontal Insolation, Global Inclined Insolation and Diffuse Horizontal Insolation.	24 (Twenty-Four) Hours
3	Inverters: DC Voltage, DC Power, DC Current, SMB/SMU Current (Inverter end), AC Active & Reactive Power, Power factor, AC Current & Voltage, Energy, Inverter room temp, Inverter Cabinet temp and Modules Temp	1 (One) Minute
4	MFM, Energy meter and Numerical Relay data: - Active & Reactive Power, Energy (day), Current and Voltage	1 (One) Minute
5	Export feeder/s Energy Meter Data: - Active & Reactive Power, Energy import and export, Current and Voltage and Grid Frequency	1 (One) Minute
6	Daily energy export from each Inverter	24 (Twenty-Four) Hours
7	Total sum of daily energy export from all Inverter	24 (Twenty-Four) Hours

* The time interval shall be in compliance with relevant Standard / LDC requirement etc.

Overall Scada Performance Requirements

- i. All equipment shall be of high quality and reliability. The overall system availability of the shall be 99% or better.
- ii. Loss of monitoring data shall be avoided by means of redundant hard disk drives or RAIDs and an appropriate automatically operating backup technology for removable media.
- iii. The SCADA Manufacturer shall provide service support for minimum 15 years.
- iv. Diagnose performance issues (soiling, incorrect alignment) detection and alarms Optimize solar farm operations and maintenance (panel cleaning schedule)
- v. Track Module performance, weather monitoring system data, irradiance
- vi. Evaluate long-term system reliability and performance, inverter failure rate etc.
- vii. Track System Losses to provide basis for upgrades
- viii. Online "Overall Photovoltaic System Performance Monitoring" as per IEC 61724
- ix. Alarm detection and management and alerts to minimize the equipment downtime.
- x. Integrated Reporting system to meet compliance requirements

- xi. Online Weather-corrected PR calculations for mapping consistent results throughout the year, as a metric for performance guarantees & for use in predicting actual annual system yield
- xii. Remote connection to Module, Inverter OEM Centre's for remote diagnostics and immediate corrective actions (Optional)
- xiii. Online calculation and reporting of carbon credits under CDM.

SCADA Graphical User Interface (GUI) Requirements

- i. HMI configured around latest state-of-the art servers/Workstations with open architecture supporting OPC /TCP/IP protocols, etc.
- ii. Display of status of major equipment in Single Line/Mimic Diagram. Mimic Diagram colour shall comply to IS 11954: Guide for colour coding of electrical mimic diagrams.
- iii. Screen shots shall cover topography of the layout with dynamic colour change based on generation Daily plant PR, plant down time and the cumulative inverter down time shall be displayed on the main screen.
- iv. Clear indication of screen for Summary, IR, Block, SLD DC, SLD AC, SLD Communication Architecture, Customized and defined Report, Data Flow to SLDC, String / SMB, Alarm, Trend to choose and drop any parameter for comparison graphically.
- v. Operation of plant along with central restriction for load to be injected.
- vi. From the main screen plant layout, one should be able to enter any specific block by pressing on that block in the plant layout Overview Screen
- vii. In the inverter summary page, the fault description shall be indicated.
- viii. All weather station data, meter data, relay data (numerical relay, protection relay etc.,) shall be displayed block wise.
- ix. Fault locations (E.g., Earth, LV/HT panels) shall be displayed.
- x. On the Outgoing Feeder screen, the AC SLD should be displayed. All circuit breakers, positions should be displayed and controllable remotely (with layered security access) from this page. Another pop-up should allow navigation to detail of the 33kv switchgear panels which should display (red/green) the mimic diagram, and all alarms and positions of switches. Transformers winding temperature & oil temperature should be displayed and logged. Grid failure indication and battery charger failure indication should have displayed here and the main screen as well. The mimic shall be configured on the HMI, and it shall be possible to control, monitor and operate the plant from the same.
- xi. All 33kv transformers winding temperatures & oil temperatures in each block should be displayed and logged.
- xii. SCADA access should be layered as per criticality and each layer should be password protected.
- xiii. Remote access of the system should be layered, and password protected.
- xiv. On the main screen, actual power of each inverter shall be monitored with the other inverters and if the difference is more than a set value (e.g., 10 kW), an indication / alarm should appear on the front screen for that inverter tag
- xv. The graphical display should allow plotting plant AC power, plant DC power, GHI, GTI, average irradiation of all pyranometers, and individual irradiation of all pyranometers, Module surface temperature & ambient temperature values.
- xvi. There should be separate generation of all Event logs, Fault logs, inverter logs (including individual inverter down time), alarm logs, transformer winding and oil temperature logs.
- xvii. All the above specified data shall be available in SCADA for the last 30 days.
- xviii. Alarm signals shall be accompanied by hooter /Buzzer.
- xix. The SCADA shall have a view displaying a connection single line diagram with different voltage levels. The current state of all equipment/plant sectors shall be displayed using a colour code.
- xx. The equipment access structure should be organized in a logic hierarchy. When selecting equipment in the platform, a new view shall be shown with detailed information and the appropriate graphs or tables (power, currents, availability, etc.) about the device.
- xxi. The main view shall be a plant map with different areas corresponding to each inverter.

- xxii. Each different section of the plant named, and its status shall be distinguished by colour gradient from green to red, with full red being an error/alarm. When selecting a section, it shall trigger a detailed view of all information relating to that section.
- xxiii. The main view shall include a section of the screen dedicated to display information of total production and of also of each plant sector.
- xxiv. In other data directly from the plant we will have a record of historical data, alarms and events. These historical are represented by tables or diagrams.
- xxv. The above data shall be available via the Web portal.
- xxvi. The operator workstation shall have minimum but not limited to the following interlinked display graphics:
 - a. PV Power Plant Overview with user adjusted real time data display.
 - b. PV Plant Single Line Diagrams representation with overview and details for different voltage levels for all main electrical equipment including presentation of real time data and status (open/closed switches).
- xxvii. System parameter setting and command issuance management with command log and settings change log; The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions. Assignment of allowable functions and entry fields shall be based on user profile. The system security shall contain various user levels with specific rights as finalized by the Employer during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).
- xxviii. Alarm and event management system including alarm and event list.
- xxix. SCADA architecture along with communication network status.
- xxx. User configurable and adjustable views.
- xxxi. Programming of the SCADA and Historian shall be user friendly with graphical user interface and shall not require knowledge of any specialized language. For example, Flow-chart or block logic representing the instruction graphically or Ladder Logic, etc.
- xxxii. The programming of SCADA (like development and modification of data base, mimics, logs / reports, Historian functionalities etc.) shall also be possible through user-friendly menus etc.
- xxxiii. All programming functionalities shall be password protected to avoid unauthorized modification.

SCADA Accuracy and Commands / Feedbacks

- i. The overall system accuracy from signal input terminals to output presentation on display and printers for the least accurate input range and maximum scan rate shall not be worse than $+ / - 0.1\%$ of full scale of the engineering process range $+ / - 1/2$ LSB for 4 - 20 m A input.
- ii. Monitoring of UPS, DC system, Weather station shall be included
- iii. Control and monitoring of all plant electrical equipment from Plant control room mounted consoles shall include – all HT/LT breakers, etc.,
- iv. Monitoring shall include surge protection device monitoring, Inverter, Transformers, Relays (numerical and microprocessor-based protection relays), ABT Meters, MFM Etc..
- v. Virus scanners, Malware scanners, firewalls etc., shall be envisaged to protect SCADA system
- vi. Control of Electrical Equipment (Hardwired)
- vii. **Commands:**
 - a. Two Remote Commands from SCADA system to HT SWGR- Start /Stop.
 - b. Individual interposing relays for the above two commands shall be provided and mounted in respective SWGR. SCADA digital output (24 V DC) shall drive these relays.
- viii. **Feedbacks:**
 - a. SCADA shall include minimum 6 numbers of feedbacks (potential free contacts) for the following:
 - b. Breaker - ON
 - c. Breaker - OFF
 - d. Lockout relay activated

- e. Trip circuit healthy
- f. Breaker available
- g. Breaker in Local/Remote
- ix. Tariff meters and multifunction meter interface to comprehensive data to SCADA
- x. Protection relay interface to provide individual protection activated, deactivated signals with time stamping
- xi. Operator Interface Graphics shall include
 - a. Control displays
 - b. Online Performance calculations (Management information system)
 - c. Configurable trends, X-Y plots
 - d. SER (sequence of events recording) with time tags
 - e. Configurable logs /Reports etc.,
 - f. AC/DC SLD
 - g. Electrical Mimics
 - h. SMJB status
 - i. Inverter displays
 - j. Description of system architecture offered for this project (plant network, control network etc.)
 - k. Alarm (alarm segregation, history collection) & Event management (including sequence event recording) and alerts to minimize equipment downtime
 - l. Graphic implementation philosophies (Colour code, display builder settings, symbol philosophy pop up behavior, Font behavior, logs, phase plate display of controller & other electrical systems etc.)
 - m. Logic implementation philosophies
 - n. Hardware & Software diagnostics
 - o. System redundancies in Power supply, communication, controller etc.
 - p. Trend display & configuration
 - q. Mimic display for plant and different systems
 - r. Disturbance recording
 - s. Remote access facility
 - t. Grid synchronization details

Earthing

For SCADA, electronic earth pit shall be provided as recommended by the system supplier.

Cabinets

- i. Central Unit Servers and associated accessories shall be accommodated in dedicated equipment cabinets.
- ii. For indoor application, the cabinets shall be constructed as follows
 - a. Standard sized steel cabinets with external painting colour as per Client's approval.
 - b. Certified for minimum IP31 protection class.
 - c. Power distribution box with main filter and main switch (separate 2-pole breakers for each device).
 - d. Front-patches for LAN cabling.
 - e. Cable organizers, cable trays, suspensions, and termination components with strain relief for all internal and external cabling.
 - f. Overvoltage protection for all devices (if applicable).
 - g. Housing space for future equipment.
 - h. Ventilation fan to ensure proper equipment working temperature.
 - i. Bottom cable access.
 - j. Document pocket.
 - k. Grounding bus bar for grounding connections.

- l. Doors with glass front and locking system.
- m. Inner light and power socket for maintenance.
- n. Provision of easy access for maintenance and repair, all devices with rear plugs shall be under a drawer type rack.

Alarm and Event Management

All alarms including system alarms and important events shall be listed up on the display. The lists shall be in chronological sequence showing:

- a. Time stamped, the precise date and time with the specified resolution in actual sequential of events shall be shown.
- b. Clear identification of device alarm with clear text/denomination of alarms and/or events and status message (open, close, off, high, low). For the case of analogue values, the values shall be shown along with the thresholds.
- c. Sorting of alarms per subgroup shall be possible.

Flashing functions of alarm messages shall be according to standards related to conventional alarm. The flashing frequency for coming and going alarms shall be adjustable. Alarms shall be checked to be cleared.

Automatic and configurable generation of typical reports with user selected variables shall be supported. It shall be possible to print the generated reports and export to common file formats. The format of the logs and reports shall be subject to the approval of the Client.

Communication Network Infrastructures

Data Communication System

The Data Communication System shall include a redundant Main System Bus with hot back-up. Other applicable bus systems like cubicle bus, local bus, I/O bus etc shall be redundant except for backplane buses which can be non-redundant.

The following are minimum features:

- i. Redundant communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) and PLCs and between PLCs and operator workstation.
- ii. The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.
- iii. If the system bus requires a master bus controller philosophy, it shall employ redundant master bus controller with automatic switchover facility.
- iv. Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/logged.
- v. The design and installation of the system bus shall take care of the environmental conditions as applicable.
- vi. Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 25% spare capacity shall be available for future expansion
- vii. Cat 6 UTP or fiber optic cables shall be employed.
- viii. The Bidder shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.
- ix. Bidder shall setup Gigabit Ethernet based Plant Local Area Network (LAN) to connect to different communication nodes at Inverter /Switchgear location etc. with redundant backbone using ring or better topology.

The network infrastructures of the SCADA, includes all hardware, wiring, connections, and equipment required to comply with the specifications defined herein. These components and hardware include, but not limited to cables, accessories, converters, repeaters, amplifiers, switches and routers, servers, UPS, equipment including accessories, their housing as required, as well as the management systems necessary to operate the data communication network.

The network design must include redundancy and account for reliability and availability as a design factor. All Ethernet infrastructures shall have a minimum data rate of 100 Mbit/s.

Uninterrupted power supply for the SCADA shall be provided by a UPS. All servers and data archiving servers shall have redundant power supply modules.

The Bidder shall perform all cabling and installation works for outdoor and indoor equipment as well as the interface interconnection and termination at existing devices.

Industrial Ethernet Switches (Managed Type)

Industrial Ethernet Switches foreseen for installation shall provide the following:

- i. Compliance: IEEE 802.3 ISO/IEC 8802/3
- ii. Technology: Store and forward
- iii. Filtering Services/prioritization: IEEE 802.1 D/p
- iv. Port type: Min 100 Mbps Media as necessary
- v. Diagnostics: Indication of power status, link status, data, full duplex, link failure (fiber disconnected)
- vi. Management: SNMP, HTTP, RSTP
- vii. Design: Fan less
- viii. Mechanical design: Stability against shock and vibration
- ix. Min. operating temp. range: 0°C - 55°C
- x. Rel. humidity: 0% - 100%
- xi. Diagnostics: LEDs for indication of power status, link status, data, full duplex, link failure (fiber disconnected)
- xii. EMC: EN 55022, EN 50082-2
- xiii. VLAN support: IEEE 802.1Q, MAC Address / Port Based
- xiv. MTBF: >20 years

Layout of PV Plant SCADA monitoring

- i. PV plant SCADA & all related systems shall be located in an air-conditioned room.
- ii. All furniture for control room mounted equipment shall be supplied and shall be subject to Employer's approval.
- iii. Plant control desks, system and marshalling cabinets shall be complete with all instruments and control equipment duly mounted and pre-wired.
- iv. The Bidder to submit the proposed drawing of control room building for Employer's review.

Technical Data Sheet

Sl. No.	Description	Requirement
1.0	SCADA	SCADA system shall support Modbus (TCP/IP RS-485, RTU, ASCII, IEC61850, IEC60870-5101 & 104) standard protocols (Included but not limited to) to communicate with different sub system/Devices
1.1	SCADA Interface	Latest OPC version 2.05a or higher compliant and implement an OPC- UA or DA 2.05a server as per the specification of OPC Foundation

Sl. No.	Description	Requirement
1.2	System offered	Make / Architecture / Configuration Drawing to be enclosed
1.3	Year of launching of the system in the market	Bidder to specify
1.4	Technical Features of SCADA system	
1.4.1	Operating System	Latest /As per monitoring design
1.4.2	UPS (2X100% Redundant or HOT STAND BY) 230 V AC, 1Ø, 50 Hz	UPS (Power supply 12-24V is required to be derived by Bidder)
1.4.3	Power Consumption	As per monitoring design, Bidder to indicate
1.4.4	Modules – type and Manufacturers	<ul style="list-style-type: none"> a) Time / clock interface dev. b) EIU (Electrical Interface Unit) for data acquisition c) DS (Data server) d) CU (Control units) e) I/O Modules f) Graphic Interface modules g) Communication Modules h) Workstation i) I. Archive Server
1.4.5	Environmental conditions description	To be Compliant with project requirement
1.4.6	Minimum operation temperature	+5°C
1.4.7	Maximum operation temperature	+50°C
1.4.8	Maximum Humidity	100% relative indoor
1.4.9	Cycle time Data In to command out	10ms
1.4.10	PV power curtailment rate	Minimum: 10%/sec
1.4.11	Programming Capacity	As per monitoring design
1.4.12	Data handling Capacity	As per monitoring design
1.4.13	SCADA Precautions	RAID 5 Access per password
1.4.14	Response time	<ul style="list-style-type: none"> a) Scanning rate of maximum 1 second for measurement analog signals system parameters b) Loop execution time- 200 ms (max) for all loops including for CLCS input scan. c) Loop execution time: 100 ms (max) for all loops including for OLCS input scan.

Sl. No.	Description	Requirement
		d) Scanning rate of: Programmable 50 -100 ms (max.) digital signals e) Update time of 1 second or better. display OLCS / CLCS f) Time for display in 1 -2 seconds. screen on operator's request g) Keyboard command to field equipment to be executed in less than 1 second. h) The communication network in any case shall not be loaded more than 50% under worst case data loading i) Under worst system loading conditions, the controller loading to be limited to 50% within the specified scan/loop response time and screen update times after considering all specified spare I/O channels, modules, and slots.
1.4.15	Auto switchover time to backup/redundant component at a) Processor level b) Communication level c) Power supply level d) I/O module level	a) Transfer from main to hot standby shall be Instantaneous and bump-less. (Bidder to indicate the switchover time) b) During switchover, by default, outputs shall be held stay put
1.4.16	Display Call up time in HMI	1-2 sec
1.4.17	Dynamic update time of parameters in the HMI monitor	1sec
1.4.18	Spare Memory capacity required in the control processor (after considering spare I/O channels, modules, slots)	Minimum 40 %
1.4.19	Output status on controller failure	Configurable in Engineering station
1.4.20	Output status on power supply failure	Configurable for switching to fail safe mode
1.4.21	Status indication for each channel in card	LED indication required
1.4.22	Power supply healthiness status in all modules	LED indication required
1.4.23	Optical Isolation for DI / DO	Required
1.4.24	Galvanic isolation for AI / AO	Required
1.4.25	Spare capacity in RAM	Minimum 40 % including spare I/O
	Processor Redundancy	Dual redundant hot stand-by

Sl. No.	Description	Requirement
	Software	Required software including application software, MIS software, HMI software
1.4.26	Battery backup for RAM	Rechargeable Ni. Cd /Flash RAM
1.4.27	Duration of battery backup for dynamic memory	72 Hrs.
1.4.28	Server	a) Industrial grade server b) Based on latest state of art Servers c) Technology suitable for Power Plant Requirement d) Redundant Power supply e) Redundant Communication controllers f) Power Fail Auto Restart (PFAR) g) Rack / blade / Tower type Redundant and HOT STAND BY server with dual power supply port h) Operating system- /latest i) Antivirus & MS office software- Latest j) No of HDMI & VGA ports: 1 (Minimum) k) RAM- 8 GB RAM or better l) Hard disc-Min. 1 TB hard, RAID 5 configuration m) Processor: 64-bit server grade Xenon or equivalent, Octa core minimum n) Processor speed- 3.1 GHZ, 64 bits o) Monitor-24" inch and 50" inch LED MONITOR p) No: of USB port: 2(minimum) q) No: of Ethernet port: 4(minimum) r) DVD R/W feature s) Storage Capacity=1 year
1.4.29	Communication Port	a) Modbus RTU b) TCP/IP c) Ethernet 60780-5-104 d) RS 232 e) RS 485 f) OPC RDI g) Others: to be named
1.4.30	I/O modules	Online insertion/replacement of modules to be supported
1.4.31	Signal type analog (Type and quantity to be named)	4 – 20 mA 0 – 10 V Others to be named Galvanically separated Resolution: 12 bits Number of inputs /outputs per card
1.4.32	Signal type digital / binary	Voltage rate: Contacting loads: Number of inputs /outputs per card
1.4.33	Cable connection	Terminated screwed Wire wrap

Sl. No.	Description	Requirement
		Plug In Others:
1.4.34	Maximum number of channels in I/O modules -	Analog I/O modules - 16 Channels RTD, Thermocouple - 16 Channels Digital I/O modules - 32 Channels
1.4.35	Power supply to the field transmitters /	Analog input module shall drive the connected field transmitter on 2 wire loops
1.4.36	Interrogation voltage for Digital signals	24 V DC
1.4.37	USB ports on Operator station	4 nos. (minimum)
1.4.38	Displays on HMI monitor	Process mimic displays, trend displays, system status, alarm displays, logs / reports etc.
1.4.39	Minimum no of plant mimics	75
1.4.40	Time activated logs	Periodic logs, shift report, daily report, status change log, Control system fault log etc.,
1.4.41	SER / Annunciation System	Integral SER with one m sec resolution for 256 points, Integral Annunciation with HMI display.
1.4.42	Password protection	Included
1.4.43	Programming language	English
1.4.44	Printers	One (1) number A4 printer colour laser jet printer,
1.4.45	Interface with Other systems	Through redundant, proven Industrial communication links
1.4.46	Spare Channels in I/O Modules	10 % (wired up) spare channels over the entire population of each type of module.
1.4.47	Spare slots in the I/O rack	20% additional slots in each rack
1.4.48	Fuse for I/O channels	Individual for analog signals Group of max 8 for digital channels
1.4.49	Diagnostics	As per monitoring design/Extensive self-diagnostic features to monitor completely the software and hardware faults in the system. Hardware diagnostic up to card/component level shall be provided.
1.4.50	Test facilities	included

Sl. No.	Description	Requirement
1.4.51	Interposing Relays.	24 V DC with freewheeling diode across the coil – Relay contact rating shall be 5A at 240 V AC
1.4.52	Cabinets to be in control room	Self-Standing type with maximum height of 2200mm
1.4.53	Height /Width/Depth	Bidder to specify
1.4.54	Weight	Bidder to specify
1.4.55	No. Of cabinets	Bidder to specify
1.4.56	Construction	Form type
1.4.57	Mechanical features of PLC cabinet	a) Minimum 2mm thick CRCA b) 3mm removable gland plate c) 2.5 mm thickness for double doors d) door switch operated light e) Fans f) IP31 in A/C rooms and IP65 enclosure outdoor g) Smoke detector in PLC cabinet h) All accessories as required
1.4.58	Panel Earthing	Separate Safety earth for enclosure and electronic earth for electronic modules with dedicated earth pits.
1.4.59	Quality Assurance	As per OEM quality plan to be approved by the Purchaser / Consultant
1.4.60	Remote interface to OEM facility etc.,	Wireless communication if required
1.4.61	Factory Inspection Requirements	Integrated test at factory for SCADA, PLC, HMI, Printer
1.4.62	Approved makes of PLC	SCADA system, including PLC shall be of the same make based on Employer's approved make.
1.4.63	Software	a) All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other specified functional requirement shall be provided. b) All system related software including Real Time Operating System, File management software, screen editor, database management software, online diagnostics/debug software, peripheral drivers, software, serial link software, remote interface software and latest versions of standard PC-based software and latest WINDOWS based packages etc. c) Soft I link software, Remote interface software, etc., which shall comply with the requirements on the other side. d) ABT software, MIS software, as applicable

Sl. No.	Description	Requirement
1.4.64	Industrial standard Serial Links	As specified
1.4.65	Number of Controllers	Bidder to specify
1.4.66	SCADA Electrical function requirements: <ul style="list-style-type: none"> • Control • Interlocking function • Emergency operation • Graphic mimic display • Synchronism & Energizing check • Analog measurements • Event Recording function • Disturbance Recording • All 33kv Switchgear Feeder protection functions 	
1.4.67	Network Management system: <ul style="list-style-type: none"> • Configuration Management • Fault Management • Performance Monitoring 	
1.4.68	Redundant Armoured 12 core minimum Fibre optic cables shall be supplied for the Redundant FO ring. CAT-6 Ethernet cable to be provided wherever applicable for local wiring within the building only.	
1.4.69	Ethernet switch/Network switches: <ul style="list-style-type: none"> • Redundant, Manageable type • Redundant power supply • Min 2 nos of spare port • Min refresh rate of 1 sec • Shall accept both IEC 61850 as well as Modbus TCP/IP, RTU network 	
2.0	GPS Master Clock system	
2.1	Make & Model no. Latest make and model supports SNTP	
2.2	The system shall be linked to Global Positioning satellite and shall include GPS antenna, GPS receiver, comparator units, signal processing & multiplexing unit etc. Accuracy +/- 1µSec or better.	
2.3	System shall be with redundant configuration: <ol style="list-style-type: none"> GPS Receiver: Microprocessor based Tracking method: Code / Carrier tracking Output data format: NEMA 0183 Communication speed: > 9600 BPS Output rate: every second Signal Processing Unit: Microprocessor based Digital type Overvoltage Protection 	
3.0	Operator / Engineering Stations	

Sl. No.	Description	Requirement
3.1	Monitors	Full HD LED Min. 24inch for engineering and 50 inch for operator station No: of USB port: 2 No of HDMI and VGA ports: minimum 1 port each Refresh rate- min 75 Hz Graphic Memory: 16 MB
3.2	Keyboard	Qwerty type (ASCII)
3.3	Mouse	Optical type
3.4	Slots and devices	DVD 16X or higher USB SDHC Others to be named
3.5	Interfaces	Ethernet: 4nos built in ethernet network port Graphic interfaces Printer Modems Serial Bus: 2 nos. Expansion Slot: 2 nos. Others to be named
3.6	CPU	Processor: 64-bit server grade Xenon or equivalent, Octa core minimum Type: 62 Bit, RISC based, consisting of measurement system, interlock and protection system, sequence control, closed loop control, etc. Clock freq: Bidder to specify Make and type: Bidder to specify
3.7	Workspace (RAM)	Minimum 16 GB RAM (upgradable up to 24 GB minimum) capacity shall meet all the process functional requirements, response requirements, I/O requirement including the spare philosophy specified. (Spare capacity in RAM Minimum 40 % including spare I/O). Make and type: Bidder to specify
3.8	HDD	HDD capacity: 1 TB minimum RAID 5 HDD make and type: Bidder to specify
	Software	M.S Windows (latest), MS Office Editor (Excel, Word, Power Point), Adobe Acrobat, Anti-virus, Network Security, etc.
4.0	FOCSs and ODFs:	
4.1	Cable:	
4.2	Type of cable	Armoured type Single mode

Sl. No.	Description	Requirement
		Multimode
4.3	No of fibers	According to monitoring design
4.4	Cable abbreviated designations	According to monitoring design
4.5	Switches/Patch panels	According to monitoring design
4.6	Manufacturer	Bidder to specify
4.7	Type	19"
4.8	Bandwidth	100MHz
4.9	No. of ports	According to monitoring design
4.10	ODF ports connector type	ST, SC, FC/PC

Time Synchronisation Equipment

- i. Bidder may supply his own Time Synchronization equipment and shall be in the Control Room.
- ii. It shall receive Coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite (GPS) for time synchronization of all components of the SCADA.
- iii. It shall be complete in all respects including antenna, all cables, processing equipment, etc.
- iv. All auxiliary systems and special cables required for synchronization of the equipment shall be supplied and commissioned by the Bidder.
- v. It shall work from DC supplies only and the Bidder to clarify if any built-in battery backup is provided, in which case, same shall be of long-life lithium batteries.
- vi. It shall be immune to hostile electrical environment. Suitable protections are to be provided against lightning surges and over-voltages in power supply systems and antenna feeders.
- vii. The system shall be fully tested to the relevant international standards such as IEC: 801 and IEC: 255.
- viii. All components of the SCADA, Workstations, and all numeric protection relays, ABT meters, MFMs etc. as per requirement under this scope of technical specification or offered by Bidder shall be synchronized with an accuracy of 1ms.
- ix. The GPS shall be synchronized with the SCADA system to be supplied under this contract. Necessary software and Hardware (including laying of communication cable) required for time synchronization with SCADA and all other devices shall be in scope of Bidder.

The system should be able to track more than 1 satellite at a time to ensure no interruptions of synchronization signals.

The system shall have provisions for combination of any of the following output signals:

- i. NTP (network time protocol) 100Mbps Ethernet port IRIG-B00x (TTL, pulse width modulated signal) x Pulse per half-hour/ Pulse per minute/ Pulse per second outputs via potential free contacts. Any other output port as may be required for the offered system. Alarm status contact indicating healthy status of system.
- ii. These output ports shall be compatible with the requirement of the equipment to be synchronized as per scope of the specification. The master clock in control room shall also be synchronized with the time synchronization system. The actual port requirements (no./type) in line with the system offered shall be finalized during detailed engineering.

- iii. The equipment should have a periodic time correction facility of one-sec. periodicity. The equipment shall also have real time display in hour, minute, second (24-hour mode) and have a separate time display, having display size of approx. 144mm height

Technical Specification for Network Firewall

These are minimum features additional feature shall be finalized during detailed engineering

Technical Requirements for Network Firewall		
Sr .NO	Feature	Required Parameter
A	General	
1	Common criteria certification	The offered product series or its operating system series must have achieved EAL (Evaluation Assurance Level) certification of EAL4 or higher in the common criteria for Information Technology Security Evaluation (ISO/IEC 15408) for computer security certification.
2	Architecture	The firewall shall be a purpose build hardware application based next generation firewall (NGFW) solution having application awareness & intrusion prevention function.
3	End of sale	OEM end of sale declaration shall not have been released for the offered model at the time of bid submission
B	Hardware Specification & Performance Parameter	
1	Firewall Interfaces	Minimum four or as required nos of gigabit 10/100 base T Ethernet ports to be provided
		Provision of addition of at least Two Nos of gigabit fibre SFP ports shall be available
		Each port must be configurable flexibly in any security zone as per the requirement without any fixed zone assignments
		All the above specified interfaces shall be firewall interfaces. Internal Switch interfaces shall not be considered.
		The firewall shall not have any wireless interfaces
2	Security Zones	At least four security zones must be supported
C	Firewall Inspection	
1	Application Support for Inspection	Should support Standard Protocols
		Internet based applications like Telnet, FTP, SMTP, http, DNS, ICMP etc. Should be supported for filtering
		Internet web 2.0 application and widgets
2	NAT & PAT	Dynamic NAT as well as one-to-one NAT
		Port/IP Address Forwarding
		PAT
3	Resistance to Evasion	The firewall shall be able to detect and block evasion techniques including SYN flood, address spoofing and TCP split handshake etc.
D	Application awareness	
1	Application intelligence and control	Firewall should support detection of application regardless of port, protocol etc
		Firewall must identify and control applications sharing the same session
		The firewall should allow creation of securities policies to identify, allow, block, or limit an application regardless of port, protocol etc
E	Intrusion Prevention System (Integrated with firewall)	
1	General	The IPS must provide intrusion prevention functionality out of the box

		The IPS should be capable of accurately detecting intrusion attempts and discern between the various types and risk levels, including unauthorized access attempts, pre-attack probes, suspicious activity, vulnerability exploitation etc
		The IPS should provide protection from Advanced Botnets, inbound and outbound
		The IPS should use stateful detection and prevention techniques and provide zero-day protection against worms, Trojans, Spyware, Keyloggers and other malware from penetrating the network
2	Detection Methods	The offered solution should use the following methods for detection of malicious traffic. Signature based detection Statistical Anomaly based detection
3	Threat Intelligence and signature updates	The IPS OEM should have a 24X7 security service update and should support real time signature update of the system as soon as updates are released
4	Exception List	The IPS should support the creation of Access Control List to bypass the inspection of any specific flow
5	DoS/DdoS protections	The offered solution should be capable of preventing Denial of service and distributed denial of service attacks
6	Threat Control Features	The offered solution should provide the following security features Detection and blocking malicious web traffic on any port Capability of detecting attacks within protocols independent of port used IPS sensor should allow the admin to create IPS policies on the basis of IP address and range
7	Signature Tuning	The offered solution should allow enabling/disabling of each individual signature. Each signature should allow granular tuning to suit user requirement

System Spare Capacity:

Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, Control System shall have spare capacity and necessary hardware/equipment/accessories to meet the following requirement for future expansion at site:

- i. 10% spare channels in input/output modules fully wired up to cabinets TB.
- ii. Wired in "usable" space for 10% module in each of the system cabinets for mounting electronic module wired up to the corresponding spare terminals in the system cabinets.
- iii. Empty slot between individual modules/group of modules, kept for ease in maintenance or for heat dissipation requirement as per standard practice shall not be considered as wiring "usable" space for I/O modules.
- iv. Terminal assemblies (if any offered) corresponding to the IO module shall be provided for above mentioned 20% blank space.
- v. Each processor/controller shall have 20% spare functional capacity to implement additional functional blocks, over and above implemented logic/loops.
- vi. Further, each processor/ controller shall have spare capacity to handle minimum 20% additional input/output for each type including above specified spare requirements, over and above implemented capacity.
- vii. Each of the corresponding communication controllers shall also have same spare capacity as that of processor/controller.
- viii. The data communication system shall have the capacity to handle the addition mentioned above.
- ix. 10% spare relay of each type and rating mounted and wired in the cabinets TB.

- x. All contact of relay shall be terminated in the terminal block of the cabinet.
- xi. The spare capacity as specified above shall be uniformly distributed throughout the cubicles.
- xii. The system design shall ensure that above mention addition shall not require any additional controller/processor/peripheral drives in the system delivered at site.

Further, these additions shall not deteriorate the system response time/duty cycle, etc. From those stipulated under this specification.

SCADA Panel/Cabinet/Control Desk/Furniture

- i. The SCADA cabinets shall be IP-22 or better protection class.
- ii. The Bidder shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design.
- iii. The Bidder shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition and specification requirements for remote I/O cabinets.
- iv. Ventilation blowers shall be furnished as required by the equipment design and shall be soundproof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper. Suitable louvers with wire mesh shall be provided on the cabinet.
- v. The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables for control room.
- vi. 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, preferred height of the cabinet shall not higher than 2200 mm. The cabinets shall be equipped with full height front and rear doors.
- vii. The floor mounting arrangement for other cabinets shall be as required by the Employer and shall be furnished by the Bidder during detailed engineering. Wall mounted cabinet is acceptable for Inverter room/sub-pooling switchgear.
- viii. Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type.
- ix. Door latches shall be of three-point type to assure tight closing.
 - x. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage.
- xi. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.
- xii. Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces.
- xiii. A minimum of 2 spray coats of final finish colour shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm.
- xiv. The Preferable finish colours for exterior and interior surfaces shall conform to following shades:
 - a. Exterior: - As per RAL 7035 (End panel sides RAL 7035)
 - b. Interior: - Same as above
- xv. Paint films which show sags, checks or other imperfections shall not be acceptable. As an alternative, single coat of anodic dipcoat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable
- xvi. Control desk shall be free standing tabletop type with doors at the back and shall be constructed of 2 mm thick CRCA steel plates. A 19 mm thick wooden top shall be provided on the desk to keep the monitors at top and computers inside. Control desk shall consist of vertical, horizontal, and base supports with their coverings for work surface, keyboard trays, mouse pads, monitor shelf and

- concealed cable and wire way management, perforated trays with covers in both horizontal and vertical directions. ASCII Keyboard shall be capable of being pulled out through a tray.
- xvii. Bidder shall provide the two power supply feeders (DC supply or UPS AC) and one raw supply feeder of suitable rating to cater all the load requirements of SCADA panel/cabinet/control desk. System remains in service in case of single power supply failure/power supply module failure. Suitable alarm shall be generated in case of any power supply failure.
 - xviii. The cabling/wiring between monitor and CPU power supply cable etc. shall be aesthetically routed and concealed from view.
 - xix. Chairs Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators and other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back. Armrests in one piece shall be of polyurethane and twin wheel castor of glass filled nylon.
 - xx. One Printer Table made of Laminated Wood or Heavy Duty MDF shall be provided for printer.
 - xxi. All the furniture shall be of reputed make (Godrej or Equivalent).

Factory Acceptance Test (FAT)

- i. FAT procedure shall be submitted by Bidder for Employer's approval and after approval of FAT procedure.
- ii. SCADA shall communicate with all third-party devices which are part of Solar Plant and the same shall be demonstrated during the FAT. ROUTINE TESTS: All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price
- iii. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

Drawings/Documents for Approval

- i. Concept Note for SCADA design
- ii. Technical specification / Datasheet for SCADA
- iii. SCADA configuration drawing / system architecture drawing including HMI and third-party interface details
- iv. Control room layout
- v. Input / Output list (SCADA I/O list) with Alarm/SER points
- vi. Hardware and software design manual of SCADA engineering
- vii. Factory Acceptance Test (FAT) procedure / SAT / Availability test procedure /PG test procedure for SCADA equipment.
- viii. Process and Electrical mimics
- ix. List of logs with point assignment
- x. Power supply and earthing schemes (Typical)
- xi. Interconnection cable schedule (ICS) and cable schedule
- xii. QAP for all major equipment including SCADA.
- xiii. GA / IGA drawings of control desk / panel
- xiv. Spares list
- xv. Functional Design specification (including Graphic philosophy, design basis)
- xvi. Bill of material for SCADA panel, HMI, Network components
- xvii. Datasheet for all bought out items
- xviii. Drawing/Models/Documents required for First Time Charging
- xix. Make of PPC
- xx. Datasheet of PPC
- xxi. Block diagram of PPC with controller transfer function with suitable parameter sets and the technical documentation for PSSE

- xxii. PSS/E MODEL OF GENERIC CONTROLLER FOR PSSE 34 VERSION
- xxiii. PSSE manual shall be available in English along with OEM model
- xxiv. *Dyr File of The PPC For PSSE Modelling for PSSE 34
- xxv. Bidder shall address all the queries of LDC with respect to reports and models are answered to their satisfaction.

3.2.9 Fibre Optical

Fibre Optic Cable

- i. Depending on the requirements, armored single mode with minimum 12 fibers shall be used. If required, indoor fiber optic cable shall also be used as required.
- ii. These cables have been foreseen for the interconnection between inverters and "PV Plant, monitoring and spare buildings" (Servers) and redundant armored Single Mode minimum 12F optical fiber cables between "PV Plant, monitoring and spare buildings" (Servers) to Employer's PS-2 Common Communication Panel.
- iii. The manufacturing, construction, labeling and testing of the fiber optic cable system shall meet the requirements established in the relevant applicable ITU and IEC codes, standards and recommendations.
- iv. The fiber optic cables shall be moisture, chemical, and rodent protected and no splicing is permitted. The recommended fiber types are:
 - v. Over 800m distance mono mode (SM) 8 fibers.
- vi. The fiber cables shall be able to withstand temperature cycling in the range -10°C to +60°C without changing the optical values during laying, installation, stocking, and transportation.
- vii. Fiber optic cables shall have no metal screening material but shall be suitably protected against damage by vermin and shall have a waterproof self-healing membrane.
- viii. Fiber optic installation methods, performance, and testing shall be to ISO/IEC 1476-3, ISO/IEC 11801, and ISO/IEC 24764 specifications.

3.2.10 Tariff Metering System

Tariff Metering System

This section covers the requirements of tariff metering system at solar generation plant as per applicable regulations, codes and standards issued by the Electricity Regulatory Authority of Bhutan.

Codes and Standards

Codes	Description
IEC 62052-11	Electricity metering equipment (AC) –General requirements, tests and test conditions -Part 11: Metering equipment.

Scope of Work

Scope of work shall be included following equipment but not limited to.

- i. To supply and installation of Tariff metering system at solar project including tariff meters, CTs, PTs with required all accessories for 33kV system.
- ii. 33kV outgoing feeders from each block of solar plant shall be provided with independent tariff metering system as indicated in the single line diagram.
- iii. The responsibility of arranging for the meters, CTs, PTs etc. its approval / inspection/calibration/testing charges etc. rests with the Bidder. All charges incurred on Meter testing, CTs, PTs etc. shall be borne by the Bidder.
- iv. Bidder shall finalize the scheme with concerned competent authorities/local regulations including the approvals.
- v. The tariff meters shall be part of the ICOG panel with necessary sealing & segregation arrangement.

3.3. General System**3.3.1 Cabling System**

This section covers various types cabling system to be followed for the proposed PV Solar plant. Cable laying, installation, testing and commissioning of cables shall comply with all currently applicable statutes, regulations, and safety codes in the locality where the system will be adopted. The system shall also conform to the latest applicable standards mentioned in Codes & Standards.

Codes & Standards

Codes	Description
IEC 60502	Code of practice for installation and maintenance of power cables up to and including 33 kV rating
IEC 60502	Cabling and wiring methodology

Cable Installation Notes – General

- i. These notes in general apply to installation of cables up to and including 33 kV grade.
- ii. Installation of cables shall include unloading, storing, shifting from place of storage to place of installation, laying, fixing, jointing, termination, and all other work necessary for completing the job. Supply of glands and lugs whenever the same are not supplied by the respective switchgear manufacturers, together with other necessary materials for jointing and termination shall also be included in Bidder's scope.
- iii. All cables shall be provided with extra cable length at joints & termination end irrespective of route cable length. Adequate loop length shall be provided at every straight joint and at each end of the cable. Cables to each circuit shall be laid in one continuous length. Cable jointing and splicing shall be avoided as far as possible.
- iv. UV rated self- locking nylon cable-ties shall be used to hold and guide the solar cables / wires from modules to junction boxes or inverters etc.
- v. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker. The Bidder shall submit route marker drawing for Employer's Approval.
- vi. Cable tag shall be of 2 mm thick SS-304 with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IEC 60364.
- vii. Cable tag shall be provided on both sides of control room at entry & exit.

Solar Cable, DC, Control and Power cable laying philosophy

- i. All solar cables should be aesthetically tied to module mounting structure and no loose loops shall be kept. All solar cables shall be laid in UV rated double wall corrugated HDPE conduits with 50% fill factor for inter row connection and to SCB. HDPE conduits shall be laid on cable trestle or above ground cable racks up to the string combiner box. Positive and Negative cables shall be laid in separate conduits. Solar cables shall be terminated at input terminals of SCBs through cable glands of appropriate sizes. Inner sheath / insulation of the cable shall not be exposed to the sun.
- ii. All cable to be laid above ground / underground keeping in view of the site-specific issues related to water submergence, soil condition etc., which shall be reviewed during the detail design engineering.

- iii. In case of Duct banks, pull-pits shall be filled with sand and provided with PCC covering.
- iv. All cable route sections shall have identification, designations as per cable routing layout drawings and painted / stenciled at each end of cable route and where there is a branch connection to another cable route. For long lengths of trays, the identification shall be painted at every 10 meters.
- v. For good sealing arrangement at entry points, suitable pipe sleeves, adequate in number and of adequate sizes shall be provided in building walls / slabs for passage of cables into a building from cable trays / racks / cable trenches located outside the buildings.
- vi. Power and control cables shall be laid on separate tiers in line with approved guidelines/ drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables.
- vii. The cable tray shall be fabricated out of mild steel sheets with min thickness of 2 mm and for coupler plates it shall be 3 mm thick. Material of Cable tray and all its fittings and accessories shall be Hot dip Galvanized as per IS standard.
- viii. Suitable size clamps with all fixing GI accessories shall be provided for clamping of multicore cables at every 5 meters interval. Die cast Aluminum or Fiber glass or Nylon Trefoil clamps with all fixing GI accessories shall be provided for single core cables. Trefoil clamps shall be provided at every 3 meters for horizontal laying / every 1 meter for vertical laying, and on either side of bends. Control cables shall be bunched, clamped, and tied with self-locking type nylon cable ties with the interlocking facility to keep them in position.
- ix. The cable passing through openings in the cable trenches/ road /wall /floor/cable tunnel/ cable culvert shall be laid in the GI pipe /HDPE// Hume Pipe of approved make. All opening/ entry of cables shall be provided with fire stop sealing.

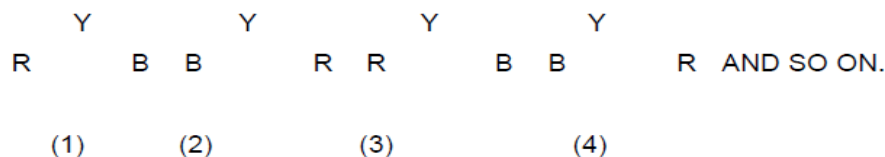
Fireproof Sealing for Cable Carrier Systems

- i. The fire proofing system for cable carrier system shall broadly consist of the following:
 - a. Cable penetration fire stops / seals
 - b. Cable fire breaks.
- ii. Fire stops shall be provided for cable penetration openings listed below:
 - a. The passage of cables / cable trays from one walled-in fire-zone / area to another, from cable galleries to adjacent rooms / areas, between cable galleries of two units, switchgear rooms to adjacent rooms and from indoor to outdoor locations shall be sealed suitably by fire stops after the installation of all the cables.
 - b. Vertical raceways which carry cables between successive floors, through openings provided in RCC floor slab, shall be sealed by fire stops at each floor level.
- iii. The modular cable transit / sealing system should have been tested for water tightness – 4 bar pressure catastrophic & 0.3 bar pressure constant, gas tightness-2.5 bar pressure, blast load-3 Psi minimum as per OISD 163, 3hrs fire insulation tests as per UL 1479, fire Insulation and Integrity as per EI120 as stated in BS476 & ASTM E814, IP69 as per IEC60529, shock & vibration test as per IEC 60068 and anti-rats/rodents test certificate. The above-mentioned tests are mandatory.

Cables in Trays / on Racks / on Trestle

- i. Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. HV power cables shall be laid in top trays and cables of subsequent voltage grade in lower tier of trays. Power and control cables shall never be laid in the same tray.
- ii. Power and control / instrumentation cables in trenches, tunnels and racks shall be run in ladder and perforated type cable trays respectively (600 mm ladder type & 450mm perforated type), supported on trench / tunnel / rack carrier arms. The cables shall be tied/clamped to trays by means of ties / strips/clamp at every 3M interval in horizontal run. Interval of clamping shall be 1M for cable trays in vertical disposition.

- iii. Power cables of 3.3 kV and above shall be laid in trays / on racks as follows:
- In a single layer only, without exception.
 - 3 core cables shall be laid in touching formation, provided proper derating factors are considered while sizing of cables.
 - Single core cables used for AC cabling purpose shall be laid in trefoil groups with spacing equal to diameter of the cable between edges of the trefoils. Cables in trefoil groups of the same circuit shall be laid as indicated below so as to ensure balanced current distribution:



- iv. Control and instrumentation cables can be laid up to a maximum of three layers in each tray/rack.

Cables in Buried Underground

- Buried cables shall be protected by suitable brick cover. Prior to cable laying, bottom of trench shall be well compacted and bedded with 150mm thick layer of sand over and below the cable.
- Continuous PVC warning tape shall be laid along trench route at depth not less than 300 mm from FGL. Cable route markers shall be provided at suitable intervals.
- Communication and control cables shall be laid at least 300 mm away from power cables. Communication and control cables shall be laid through double wall corrugated HDPE pipe.

Bending Radius for Cables

The bending radius for various types of cables shall be as per cable manufacturer recommendations.

Terminations, Clamping & Miscellaneous details.

- Cable entry to electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.
- Identification tags made from SS-304/Aluminum/Nylon sheet shall be attached to each end of each cable by means of nylon / PVC binding wire. Tags shall be additionally put at an interval of 10 meters on long runs of cables and at each bend.
- Thickness of plating shall not be less than 10 microns. Cable glands shall conform to BS:6121.
- All Cable lugs for power cables shall be double compression type Heavy duty long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve to be terminated to stud type TB only.

Joints & Termination

- Termination and jointing kits shall be of proven design and approved make only and fully type tested.
- Termination and jointing kits shall be suitable for the following types of cables as per IS.
 - 19/33 kV earthed grade cable
 - 1.9/3.3 kV cable
 - 1.1 kV grade power cables
- Termination kits shall be 'heat shrinkable type' for LV & HT Cables.
- Straight through joint and termination shall be capable of withstanding the fault level of 31.5 kA for 33 kV cables.
- Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.

Cable Lugs

- i. All Cable lugs for power cables shall be double compression type Heavy duty long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve. Thickness of tinning shall be not less than 10 microns. Type of end connection shall be solder less crimping type.
- ii. Cable lugs for conductors of power cables shall be "heavy duty" long barrel type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.
- iii. Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be ring type. However, other types such as pin type/flat type /U Type are only permitted if it is technically not feasible.
- iv. Type of cable lugs shall be as follows:
 - a. Power cables with aluminium conductor: Tinned copper or Bi metallic/Aluminium
 - b. Power cables with copper conductor: Copper crimping type.
 - c. Control Cables: Copper ring type
 - d. Special cables: pin type / maxi-termi type

Tags

- i. Cables shall be provided with cable number tags for identification.
- ii. Cable tags shall be 2.00mm thick of SS-304/Aluminium/Nylon
- iii. Cable numbers shall be engraved type.
- iv. Tags shall be of durable quality of size 60 mm x 12 mm with a tie hole at each end.
- v. Samples of tags shall be approved by the Employer before delivery.
- vi. Tags shall be provided with non-corrosive wire (Nylon tie) of sufficient strength for tagging.

Testing and Commissioning of Cables

Cables shall be tested for insulation resistance before and after jointing. The voltage rating of the megger for cables of different voltage grades shall be as per the app:

High voltage testing shall be as per relevant standard.

Earthing

- i. Metallic sheaths, screens and armor of all multicore cables shall be earthed at both equipment and switchgear end.
- ii. Sheath and armor of single core power cables shall be earthed at switchgear end only.
- iii. Earthing of CT and PT neutral lead shall be done at one end only, as per respective control wiring drawings.
- iv. GI Earthing flat of suitable design shall be laid along the cable trays. GI Earthing flat shall be connected to earth grid at regular intervals and at both ends as per IS/IEC standard.

3.3.2 Earthing and Lightning Protection

Earthing and Lightning Protection System

Earthing and lightning protection system installation shall be in strict accordance with the latest editions of the applicable international Standards and Codes of Practice safety codes and those issued by the Electricity Regulatory Authority of Bhutan.

Codes & Standards

Codes	Description
IEC 62305	Protection against lightning
IEEE: 80	Guide for safety in AC substation grounding

Codes	Description
BS: 7430	Code of practice for the protective earthing of Electrical installations
IEC 65561 -7	Earth Enhancing Compound

The Bidder shall ensure that measuring instruments and gauges to be used for testing and inspection shall have valid calibration and the accuracy can be traced to National / International Standards.

Earthing System

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

Design Criteria

- i. Earthing System Design calculation
- ii. The earthing conductor shall be designed considering the maximum DC system fault current for the solar PV yard and AC system fault current for the remaining AC systems. The net earth resistivity shall also be calculated, and the value of net resistivity shall be as per IEC/IEEE/IS. The soil resistivity data will be furnished to the Employer during detailed engineering. The Bidder shall carry out separate ERT measurement without cost implication to the Employer. Earthing pit shall be 1 Nos. per 1.50 MWp. Nos. of earth pit indicated is valid if all the earth pits are interconnected in single mesh of earth pits

Conductor Material

i)	Conductors above ground level and in trenches	:	Galvanized Steel
ii)	Conductors buried in ground or embedded in concrete	:	Galvanized Steel
iii)	Electrodes	:	Maintenance free earth pit
iv)	Lightning protection air termination and down conductors for buildings	:	GI Flat

The earthing conductor shall be sized for a life of 25.

Size of Conductors

Main Earthing Conductors

The earthing conductor sizes shall be calculated based on BS 7430 and the earthing system shall comply with IEEE-80.

Resistivity of Soil In Ohm-m	Reduction in thickness / diameter in mm
<10	8.0
>10 to <25	7.0
>25 to <50	5.5
>50 to <75	4.5

Resistivity of Soil In Ohm–m	Reduction in thickness / diameter in mm
>75 to <100	3.0
>100	1.5

Rod Electrodes

Maintenance free earth pits shall be considered for the complete plant with copper rod electrodes of suitable diameter and length shall be provided as per the recommendation of BS: 7430. Electrodes installed in the test pits shall have disconnecting facilities.

Equipment Earthing Leads

The size and numbers of the earthing leads shall be decided based on the type of equipment and structure to be earthed and the earth fault current carried by each equipment shall be provided generally as per BS 7430 and with a view to minimize the number of sizes. Calculations shall be submitted for Employer's approval.

General Requirements

- i. Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used in line with BSIEC standard. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.
- ii. Inside dimension of the earth pit shall not be less than 600x600 mm. it shall be brick work / precast of M35 Grade RCC with base of 75mm thick PCC below wall.
- iii. Top cover of Earth Pit shall be precast RCC earth pit chamber.
- iv. All bolt joints must be protected from corrosion by applying suitable paste / grease / petroleum jelly etc. at the time of installation. Same shall be included in the notes of all relevant drawings. All metallic hardware such as nuts, bolts, screws, washers etc. shall be of SS304 grade only.
- v. SS 304 bolts, nuts with plain and spring washer (on both sides) shall be provided for petty clamp of earth electrode.
- vi. Date of testing, value of earth resistance measured, and next date of testing shall be provided on each earth pit either by painting or by weatherproof vinyl sticker. Letter size shall be not less than 25 mm.
- vii. Pre-galvanised GI Strip with GI coating not less than 85micron shall be used
- viii. Dedicated electronic earth pit shall be provided as recommended by the system supplier.
- ix. All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.
- x. Required Nos. of risers (2 Nos. for each equipment) shall be provided in, Inverter stations, Transformer yards, outdoor switchgear areas, etc. for connection to various electrical equipment.
- xi. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building
- xii. For entry of earth wire / earth strip / earth cable to earth chamber, 75 mm PVC/HDPE pipe shall be provided at least on two sides or as required. Patty clamp shall be designed for connection of minimum 4 nos of earth wire/flat/ rod. Patty clamp and earth conductor shall be designed so as to facilitate easy disconnection for testing of earth resistance of earth electrode. Top of earth rod / patty clamp shall be 75 mm below the top cover Earth pits shall be treated with earth enhancement compound if resistivity is more than 20ohm meter
- xiii. Bidder shall obtain all necessary statutory approvals for the earthing system before charging of the plant and electrical equipment

Earthing Conductors Inside Building

- i. Buried grids shall be provided around the periphery of the building. These grids shall be interconnected by providing main grid conductors.
- ii. Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.
- iii. Measurement of Ground Resistance
- iv. After completion of grounding system installation, the measurement of ground resistance shall be performed by the Vendor. Before measurement, the overhead ground wires shall be disconnected from the Substation. The method of measurement shall be as per relevant standards / codes.

Earthing System Installation

- i. The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.
- ii. Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 750 mm.
- iii. The earthing conductor crossing the road / track shall be laid in Hume pipe or laid at a greater depth to avoid damage.
- iv. Street lightning poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.
- v. Flexible earth conductors shall be provided at expansion joints for earthing gates, operating handles, etc.
- vi. Connection between the equipment earth lead and the grid conductor (riser) shall be welded at earthing grid end. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

Solar Array Earthing

- i. Each Module mounting structure (MMS), PV Module frames, mounting arrangement for String Combiner Boxes, Metallic Junction Boxes, Metal frames / Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. The earthing system for solar array shall consist of earth mat / earth grid to be laid at a depth of 600 MM below ground. Earth mat shall be a mesh of interconnected Galvanizing Steel (GS) flat laid in the solar farm for the purpose of earthing / grounding. Equipment and structure in the solar farm shall be earthed in compliance with relevant codes and standards indicated above.
- ii. Size of earth mat conductor shall not be less than 25X6 GS flat. The minimum size of riser to connect the structures and JB etc. to the earth-mat in the solar farm shall be 25X3 GS Flat. Location of earth pits and laying of earth conductor shall be decided during detail engineering.

System Requirement:

a) Life Expectancy	:	25 Years (Minimum)
b) System fault level	:	As per system requirement
c) Soil resistivity	:	Actual as per site conditions
d) Min. Steel corrosion	:	0.12 mm / year as per IS/IEC Earth Conductor joints, by electric arc welding, with resistance of joint not more than that of the conductor

- i. Connection of riser to the structures shall be bolted or welded type.
- ii. Connections between equipment earthing leads and between main earthing conductors shall be of welded type.
- iii. A continuous earth path is to be maintained throughout the PV array.
- iv. Each PV Module frame shall be earthed in accordance with module manufacturer guidelines. In case module frame earthing is to be separately provided, it shall be earthed with minimum 2.5 sq.mm flexible copper cable with lug at suitable location of module frame. Both ends of the loop of copper cable for earthing shall be connected with nearest earthed structure or earth conductor.
- v. Bidder shall seek Employer's approval for connecting solar array earth mat with any other earth mat / earth grid of the solar PV plant.
- vi. Maintenance free earth pits shall be provided with copper rod electrodes of suitable diameter and length as per the recommendation of BS: 7430. Electrodes installed in the test pits shall have disconnecting facilities.
- vii. Irrespective of Earthing calculations, minimum four (4) Nos. of maintenance free electrodes shall be considered for each DC block of four (4) inverters.
- viii. On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by Bidder.

Testing of Earthing System

Earth continuity tests, earth resistance measurements and other tests shall be carried out to prove that the system is in accordance with the design, specifications, code of practice and regulations.

Lightning Protection System

Lightning protection system shall be provided for control buildings, switchgear room etc., depending on the need for protection as per IEC 62305.

Lighting protection system installation

- i. All roof conductors and down conductors shall be cleated to steel structures at 1000 mm interval or cleated to wall at 750 mm interval. Whenever welded, the weld locations shall be treated to provide rust protection.
- ii. All connectors, cleats, clamps, anchors, etc. shall be made of galvanized steel.
- iii. Joints shall be avoided in down conductors. If necessary, joints shall be welded type.
- iv. Each down conductor shall be terminated on an earth electrode which in turn will be connected to the main earthing grid.
- v. All down conductor shall be provided with a testing link at a height of 1500 mm above grade level. Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

Tests

Materials offered shall be of type tested and proven type. Type test reports shall be submitted for approval. All routine and acceptance tests in accordance with the latest versions of applicable standards shall be conducted.

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval and or information:

- i. Earthing and Lightning protection calculations
- ii. Technical Data sheet earthing & lightning protection materials
- iii. Earthing and Lightning protection layouts
- iv. Earthing and Lightning protection installation details
- v. Calculations showing need for Lightning protection

3.3.3 Fire Protection, Detection & Alarm System**Fire Protection, Detection & Alarm System**

- i. The scope of Bidder shall cover design, engineering, manufacture, inspection and testing at manufacturer's works, third party inspection if any, packing and forwarding, supply at site, storage and handling at site, erection with associated civil, I&C and electrical works, inspection, testing and commissioning, performance testing and preparation, the remedy of all defects during the Defect Notification Period of the Complete Fire Protection, Detection & Alarm system.
- ii. The Fire protection, detection & alarm system shall be designed, engineered and manufactured to achieve high availability and reliability. The design and engineering shall make use of most recent international standards and best design practices.

Codes & Standards

Codes	Description
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 11	Standard for Low, Medium and High - Expansion Foam
NFPA 70	National Electrical Codes
NFPA 72	National Fire Alarm and Signalling Code
NFPA 850	Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
-	Under writer's laboratory (UL) – USA
-	Fire Officers Committee (FOC) – UK

Design Criteria

- i. A comprehensive fire detection, alarm as well as fire protection system shall be installed in conformity with relevant standards.
- ii. All building and switchyard shall be provided with fire detection and alarm system based on smoke detector and/or heat detectors. The fire alarm system shall conform to relevant IS or IEC standards.
 - a. Fire Detection and alarm System
 - b. Portable Fire Extinguishers
 - c. Wheel/ Trolley mounted Fire Extinguishers
 - d. Sand buckets (min. 9Ltrs capacity) with stand
 - e. Any other requirement (If required as per Regulations and other regulatory regulations)
- iii. All the systems shall be designed in such a way so as to make the system complete and acceptable to the Employer.
- iv. Class A wiring of fire detector with fire alarm panel shall be provided

Fire Detection and Alarm System

Fire Detection and Alarm System shall consist of:

- i. Fire Alarm Panel (FAP):
- ii. FAP shall be installed at the Solar PV plant SCADA and monitoring room.

- iii. FAP shall also be installed in the Sub-pooling switchboard room, Individual Inverter Station area and adjoining areas. Local fire panel shall be provided in Inverter station room. No of panel shall depend on the distance between Inverter station and number of devices connected to it as per technical standards. These local panel shall be able to send data to Main fire panel, repeaters if required may also be provided. FAP shall receive signals from the detectors, call points installed all over the plant in case of occurrence of fire to provide alarm to the operator in the control room, to identify the location from where the alarm has originated and initiate hooters to draw attention of the personnel and evacuate if necessary.
- iv. Analogue addressable type of fire detectors: Fire detectors shall be installed in control room, switchgear rooms, Inverter stations (if applicable), battery rooms, etc. to detect the fire at the incipient stage and send signal to FAP.
- v. Push type manual call points: Manual call points shall be installed at strategic locations to draw attention of firefighting personnel.
- vi. Hooter: Hooter of appropriate rating shall be installed in the Inverter stations (if applicable), to draw attention of the personnel in case of fire accident in the plant.

Scheme and layout for Fire Detection & Alarm system shall be prepared covering all areas and the complete plant for effective operation of FDA system.

Proposed detection system for the areas under consideration:

SL. No.	Area	Type of Detectors
a)	Solar PV plant SCADA and monitoring room	Addressable Multi sensor fire detectors (if located in container), Manual call points
b)	Sub-pooling Switchboard room	Addressable Multi sensor fire detectors (if located in container), Manual call points
c)	Inverter stations	Addressable Multi sensor fire detectors (if located in container), Manual call points

Fire Alarm Panel (FAP):

- i. Microprocessor based fire alarm panel shall comprise of the redundant processor, various functional modules, loop modules for detector loops, display devices, output modules for alarm control & interlocks, communication modules for interfacing etc. The control system shall be analogue type.
- ii. Fire alarm panel shall be provided with integral HMI.
- iii. The microprocessor-based fire alarm panel shall be incorporated with the following features:
 - a. Continuous supervision of the detector connecting lines, individual detector performance / operation and disconnection / removal of detectors. The system shall automatically reset on clearance of a fault.
 - b. Discrimination between a real fire and false fire conditions by incorporating signal verification and other features.
 - c. Individual detector addressing capability.
 - d. Detection of over / under sensitive detectors and automatic calibration by increasing or decreasing their sensitivity levels based on environmental conditions like air movement, fumes, humidity, etc.
 - e. Pre-alarm in case of any detector / detectors requiring maintenance.
 - f. Facility shall be provided such that the relevant codes are to be entered for alteration or access to the stored program. The system should be protected against interference by unauthorized personnel.
 - g. Compatibility with all detector / devices connected to the fire alarm panel.
 - h. Logging of alarm, time and action text on printers.

- i. Programmed activation of various interlocks with fire protection system and other associated system such as ventilation and air conditioning, etc.
 - j. Fire alarm panel shall have adequate potential free contacts for hooking up with HVAC feeders for interlocks in case of fire is detected.
 - k. Activation of fire alarm sounders or evacuation alert signal.
 - l. RS485 port shall be provided in Fire alarm panel to interface with SCADA system.
 - m. Any fire alarm generated at Inverter station, main fire panel hooter and local panel hooter shall ring the audible alarm and also alarm shall be annunciating in SCADA and log of alarm shall be recorded in alarm/event log.
 - n. Bidder shall consider 10% spare provisions in each loop.
 - o. Bidder shall consider 30 % design and aging margin for selection of nos. of sensors in each loop and length of each loop. Bidder shall submit the certificate from OEM indicating maximum nos. of sensors in single loop and maximum length of single loop allowed with offered panel and type of cable to be used. Each Fire Alarm Control panel shall have provision for minimum 10 (Ten) % rounded to next higher integer but not less than 2 (two) nos. spare loops for future use of Employer.
- iv. Fire alarm panel shall derive power supply from 240V, 1ph, 50Hz UPS. Panels shall be provided with SMF Lead acid battery to provide backup time of minimum 48 hours for full load from the instant of charger / AC supply failure after which sufficient capacity would still be available for 30 minutes during alarm condition.

Fire Detectors:**Multi sensor detectors:**

It detects smouldering smoke generated due to short circuit conditions in electric cables and burning of furniture, clothes, PVC flooring. The optical smoke detecting component uses a photoelectric sensor using light scattering method while the heat detecting component uses thermistor-based sensor. The advantage of Multisensory detector is that it can detect both smoke and heat simultaneously.

Manual Call Points:

The manual call points (MCP) of push type shall be provided at switchgear rooms, battery rooms, at two ends of corridor of the control building and at strategic locations in ICR areas. MCPs shall be addressable and wall mounted type. Sequence of alarm and actuation scheme for MCPs shall be same as that for fire detectors.

Hooters:

Indoor type hooters having a distinct sound from other alarms and annunciations with flashing strobe shall be installed at two ends of the corridor in the MCR building. This shall be automatically actuated in case of actuation of any of the detectors / manual call points in Solar PV plant SCADA and monitoring room and inverter station. The minimum sound level shall be 85 dB (A) which shall be adjustable. Provisions shall be made to activate the hooter from the control room.

Hooters shall be either addressable type or conventional type with control module for interfacing with fire alarm panel.

Hooters shall be designed for two tones viz., Fire and All clear.

Cabling:

All detectors and manual call points shall be wired for class A wiring.

Cables required for complete fire alarm system for interconnecting fire alarm panel, detectors and manual call points shall be 1100V grade, multicore, annealed, high conductivity stranded copper conductor, extruded PVC / XLPE insulated, laid up inner sheathed, galvanized steel strip / wire armored, outer FRLS extruded PVC sheathed cable.

Cables shall be cleated on ceiling for detector looping and laid in trenches up to the panel, buried in ground with other control / communication cables in the indoor area.

Fire Protection System

Portable & Mobile Fire Extinguishers

The fire extinguishers shall be selected to suit the hazardous area and normally be located near the exit. Each type and capacity of extinguishers as follows:

- i. Portable (DCP) dry chemical type fire extinguishers (9 Kg)
- ii. Mobile (DCP) dry chemical type fire extinguishers (min. 20 Kg), if applicable
- iii. Portable CO₂ type fire extinguishers (9 Kg)
- iv. Mobile CO₂ type fire extinguishers (20 Kg), if applicable
- v. Mobile Foam type extinguishers (min.20 Kg), if applicable
- vi. Sand buckets with stand & canopy

Portable fire extinguishers shall be installed as per the requirements of NFPA 10. Location of extinguishers shall be decided based on following considerations:

- i. Maximum travel distance
- ii. Uniform distribution
- iii. Easy accessibility
- iv. Nearness to doors, windows and emergency doors / exits.
- v. Access and escape route
- vi. Safe distance from application area

Technical Parameters

Sl. No.	Description	Unit	Technical Requirements
A.	Fire alarm control panel		
1.	Type	-	Microprocessor Based,
2.	Type of Display	-	LCD, Alphanumeric, display of addresses of at-least 320 characters
3.	Response Time	Sec.	3 Sec. (Max.) for full loaded panel
4.	Addressable / Intelligence Capability	-	Yes
5.	Fault Isolation Capability	-	Yes
6.	Alarm Verification Capability	-	Yes
7.	Sensor self test capability	-	Yes
8.	Memory	-	Non volatile
9.	Fault Tolerant wiring capability	-	Required
10.	No. of loops per panel	-	To be decided by the Bidder
11.	Min. acceptable loop length	Km	2.5 km for fully loaded panel
12.	Power Supply	-	230V 10%, 50Hz, mains supply
13.	Type of batteries	-	Lead acid batteries
14.	Weather Protection Class	-	IP 65
15.	Loop Isolator	-	Built-in
16.	Networkable to other panel	-	Yes
17.	Temperature Range	°C	0 to 50 °C
18.	Humidity range	°C	0 to 100%
19.	Auto detection of periphery	°C	Yes
20.	No. of wires SLC loop cabling type	°C	2 wires for detectors Style 6, Class A
21.	Other Standard Approvals.	°C	UL Listed, ULC listed, FM approved,

Sl. No.	Description	Unit	Technical Requirements
22.	Seismic Acceleration		To be decided during detailed engineering
B.	Multi – sensor detector		
1.	Type	-	Analogue addressable type Photo thermal Multi criteria detector comprising of photoelectric type & Fixed temperature type detection
2.	Memory	-	Non-volatile
3.	Temperature setting of the rate of rise sensor	°C/min	8 °C/min
4.	Sensor Coverage / Nominal Sensitivity for Optical smoke sensor	-	Wide, 0.5% obs / ft to 4% obs / ft
5.	Facility to adjust the sensitivity and Facility to reset the detector sensitivity to factory setting level	-	Required
6.	Base	-	Suitable to mount the Multicriteria detector in a simply click/turn arrangement. Shall have inbuilt fault isolator in the base. Suitable for two wire loop-in loop-out termination
7.	Fault isolator module	-	To be present in the detector base
8.	Operating voltage & power requirements	-	24V DC, loop powered
9.	LED indication	-	Multi status – Multi colour LED with 360° angle view, to be visible from 6 m distance
10.	Type of addressability	-	Electronic addressability with device mapping
11.	Moisture	-	0-100 % RH
12.	Operating temperature	°C	0-60°C
13.	Type of signaling circuit suitable for	-	Class A, Style 6
14.	Wire to which the base shall be suitable for	-	2C x 1.5 Sq mm
15.	Remote and Local Test Capability		Required
16.	Marking of the detector	-	Type, Power supply requirement, Upper limit & Lower limit, date of manufacture
17.	Facility for cleaning the detector during maintenance	-	Required
18.	Pre-alert alarm capability	-	Required
19.	Audible base	-	Not required
C.	Manual call point		
1.	Type	-	Analogue addressable type microprocessor based pull down type manual call point
2.	Power supply requirement	-	Loop powered, 24 V DC
3.	Colour	-	Fire red shade as per IS-5
4.	Operating temperature	°C	0-60°C
5.	Moisture	-	100% RH, Non-condensing
6.	Operating instructions	-	Clear And Visible Operating Instructions on the Body
7.	Marking and data	-	To be marked the type, manufacturer name, maximum operating voltage, current and frequency The word FIRE indication on the front of the MCP in raised letters, 1.75 inches (44 mm) or larger

Sl. No.	Description	Unit	Technical Requirements
8.	Dimensions for knockouts for conduit	-	25 mm diameter, Top entry
9.	Type of addressability	-	Electronic addressability with device mapping
10.	LED indication	-	Not required
11.	Cable to be used	-	2C x 1.5 Sq. mm.
12.	Ingress protection	-	IP-54 for indoor use and IP-67 for Outdoor use
13.	Memory	-	Non-Volatile
14.	Remote and Local Test Capability	-	Required
15.	Fault isolator module	-	Required to be Integrated
D.	Siren / Hooter		
1.	Type	-	Electronic hooters, Addressable, 4 wire, suitable in industrial environment
2.	Sound level	dB	Range of 75 dB - 120dB (A) with field settable feature.
3.	Mounting	-	Type – A Hooter: Suitable for Recessed mounting. Type – B Hooter: Suitable for Surface / wall mounting
4.	Fault isolator module	-	To be inbuilt in control module
5.	Operating voltage & power requirements	-	24V DC, separately powered
6.	LED indication	-	Multi status – Multi colour LED with 360°angle view, to be visible from 6 m distance.
7.	Moisture	-	0-100 % RH
8.	Operating temperature	°C	0-60°C
9.	Type of signaling circuit suitable for	-	Class A, Style 6
10.	Remote and Local Test Capability	-	Required
11.	Marking of the detector	-	Type, Power supply requirement, date of manufacture, sound level
12.	Enclosure	-	Weatherproof protection, IP 55
13.	Facility for cleaning the detector during maintenance	-	Required
E.	Dry Chemical Powder (DCP) type fire extinguisher		
1.	Extinguishing agent Type	-	Dry Chemical Powder type as per NFPA 10
2.	Extinguisher handling mode	-	Portable - handheld
3.	Class of fire	-	A, B, C
4.	Capacity	kg	9 kg
5.	Mounting type	-	Wall/column mounted
6.	Mounting arrangement along with all necessary hardware/ plates for fixing extinguishers	-	To be provided
7.	Material of construction	-	
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved
F.	Trolley mounted fire extinguisher (DCP type)		
1.	Extinguishing agent Type	-	Dry Chemical Powder type as per NFPA 10
2.	Extinguisher handling mode	-	Mobile – Trolley/ Wheeled mounted

Sl. No.	Description	Unit	Technical Requirements
3.	Class of fire	-	A, B, C
4.	Capacity	kg	20 kg (minimum)
5.	Mounting type	-	Wheel type trolley
6.	Trolley	-	Carbon steel with corrosion resistant coating
7.	Wheel type	-	Toughened Rubber
8.	Material of construction		
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved
G.	CO2 type fire extinguisher		
1.	Extinguishing agent Type	-	CO2 type as per NFPA 10
2.	Extinguisher handling mode	-	Portable - handheld
3.	Class of fire	-	A, B, C
4.	Capacity	kg	9 kg
5.	Mounting type	-	Wall / Column mounted
6.	Mounting arrangement along with all necessary hardware/ plates for fixing extinguishers	-	To be provided.
7.	Material of construction	-	
	a) Body		Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved
H.	Trolley mounted CO2 type fire extinguisher (if applicable)		
1.	Extinguishing agent Type	-	CO2 type as per NFPA 10
2.	Extinguisher handling mode	-	Mobile – Trolley/ Wheeled mounted
3.	Class Of fire	-	B, C
4.	Capacity	kg	20 kg (minimum)
5.	Mounting type	-	Wheel type trolley
6.	Trolley	-	Carbon steel with corrosion resistant coating
7.	Wheel type	-	Toughened Rubber
8.	Material of construction		
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved
I.	Trolley mounted Foam type fire extinguisher (if applicable)		
1.	Extinguishing agent Type	-	FOAM type as per NFPA 10
2.	Extinguisher handling mode	-	Mobile – Trolley/ Wheeled mounted
3.	Class Of fire	-	A, B
4.	Capacity	kg	20 kg (minimum)
5.	Mounting type	-	Wheel type trolley
6.	Trolley	-	Carbon steel with corrosion resistant coating
7.	Wheel type	-	Toughened Rubber
8.	Mounting arrangement along with all necessary hardware/ plates for fixing extinguishers	-	To be provided
9.	Material of construction		

Sl. No.	Description	Unit	Technical Requirements
	a) Body	-	Seamless mild steel
	b) Nozzle and discharge fitting	-	Non-conductor of electricity
	c) Approval	-	UL Listed / FM Approved

Inspection and Testing

The scope of inspection shall comprise of but shall not be limited to the following:

- i. The requirements of NFPA for the various systems shall form the basis of the inspection test protocols. The Bidder shall submit an acceptance test procedure for approval.
- ii. After completion of work, site tests shall be carried out to demonstrate satisfactory performance of the entire system.
- iii. Representatives of the Employer, insurance carrier and local firefighting authority may witness the testing if required.
- iv. After successful placement in operation of the complete fire protection system, the Bidder shall submit a fire protection system report.
- v. The Bidder shall complete and submit the Inspection and Test forms required as per NFPA as follows:
 - a. Inspection and Testing Form based on NFPA.
 - b. Supplier's Material and Test Certificate as per NFPA.

Inspection:

- i. Prior to testing, the complete system shall be visually inspected for completeness.
- ii. Inspection of fire protection equipment, piping, valves and fittings shall comply with this specification unless otherwise specified in the equipment requirements.
- iii. Prior to system energization, a complete check of all wiring and connections shall be performed. Each electrical component shall be checked and confirmed as operational.

Tests at Site

Acceptance Tests:

All required acceptance tests shall be performed and complete the "Material and Test Certificate" as specified in NFPA standard. Visual and performance aspects of the acceptance tests shall be to the satisfaction of the Employer and shall be done in the presence of the Inspector.

Performance Tests:

Each fire protection equipment shall be performance tested to demonstrate satisfactory operation and to provide base data for the assessment of performance throughout the operating life of the equipment.

Unless otherwise specified in the equipment requirements, the program of performance test shall include at least the following:

- i. Determination of maximum continuous rating (worst case scenario)
- ii. Determination of normal operation and performance
- iii. Leak test

Data to be furnished by Vendor after award of contract:

- i. Detailed design / drawing submission schedule including erection, testing & commissioning schedules.
- ii. Quality assurance plan.
- iii. Material test certificates.
- iv. Operation and maintenance manual for all equipment.
- v. Technical data sheets for all equipment covered.
- vi. Detailed write-up, Layout drawings and equipment drawings etc.
- vii. Installation drawings and manuals for all equipment / systems.
- viii. Detailed write-up for shop tests and site performance tests.

- ix. Test certificates for type / routine and standard acceptance tests.
- x. As-built drawings for all equipment / systems supplied under this contract and all buildings / structures / works executed under this contract incorporating all changes / modifications up to the time of commissioning / handing over to the Employer.
- xi. Materials test certificates and performance test certificates for all equipment tested at works.
- xii. Drawings / data required to be submitted to statutory authorities.
- xiii. Any other document / details as required as per approved QAP.
- xiv. Current UL / FM certificates

3.3.4 Closed Circuit Television System (CCTV)

- i. The CCTV System shall be meant for gathering video information from the various areas of the plant with display and recording facilities with night vision and motion sensors as per requirement per requirement.
- ii. The location and type cameras Bullet (Fixed), Dome (Fixed) and PTZ (Pan Tilt Zoom) shall be as follows.
 - a. Inverter Stations
 - b. SCADA, Monitoring and control room.
 - c. 33kV Switchgear Sheds
 - d. All Entry/Exit Gates
 - e. Security/Guard room
 - f. All gates for entry
 - g. As per the Employer requirement
- iii. The CCTV system shall be designed as a standalone IP based network architecture.
- iv. System shall use video signals from different cameras at different locations, process the video signals for viewing on monitors at Control building and simultaneously record all the video streams using H.264 or better compression technique.
- v. A complete integrated CCTV system with all hardware and software as required shall be supplied to enable on-line monitoring and to generate a record to facilitate post event analysis. All components of the system shall be designed for continuous operation. The area under surveillance shall be monitored and controlled from the Control Room through workstation and mouse/keyboards. Bidder's offered CCTV system shall include but not limited to the details specified in subsequent paragraphs.
- vi. The CCTV system shall be high quality, high performance, network based, and digital video security systems and shall be designed to allow persons to be clearly seen at any position within the area of coverage. The camera locations shall be such that full coverage of the station shall be provided.
- vii. IP based Camera system shall be provided for CCTV monitoring. All cameras and CCTV system shall be connected to Industrial Ethernet switches through Fibre Optic cable for transferring camera video signals. Ethernet switches will then be connected to a network controller to a separate high-speed LAN that shall handle high-capacity video files.
- viii. Video imaging and associated equipment including cameras, lenses, camera housings / protection, integral dome cameras, etc. Transmission equipment including optical fibre cable, co-axial cables, control and power cables, conduits, tee-offs, splitters, ground isolation transformers, amplifiers, media converters for wireless/Fibre Optic transmission etc.
- ix. The CCTV System along with all its system components i.e., network switches, storage devices, servers, LAN switches, media converters etc. shall be powered from UPS system. Bidder shall also provide local power distribution boxes as required for sub distribution of UPS supply.
- x. Camera server shall be provided with sufficient storage space to store recordings of all cameras at 25/30 FPS at 1920X1080 (For HD cameras) using necessary compression techniques. All recordings shall have camera ID, Location, Date and time of recording.

- xi. Application Software for Video Monitoring, Recording & Management shall be used to display, store, control & manage the entire surveillance system. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitors for live video. The system shall support video analytics Video motion detection, Object tracking, Object classification Tracking
- xii. LED screen quantity shall be decided based on the number of cameras and in such a way that all cameras shall be monitored simultaneously, without any interruptions
- xiii. Bidder shall furnish the absolute (maximum) limit for the no. of system components i.e., Cameras, etc., that can be connected/handled by the offered system and any limitations/constraints in expanding the offered system.
- xiv. The system supplied shall be complete in all respects for reliable performance. The Bidder shall submit the detailed block schematic, video, signal & power wiring diagram, describing the connections between the network switch/camera server Systems and various cameras, monitors, keyboard, and joystick.
- xv. Bare copper 1x50mm² for grounding under the trenches. The system will be connected to the Plant general grounding. Each CCTV pole (if any) shall be connected to the station grounding system. For termination with the buried part of grounding grid a multiple under-ground connection is allowed, that shall be provided following the procedure for grounding conductor extensions.
- xvi. Fixed position cameras with variable focal length lenses facilities shall be employed as required to give the necessary coverage.
- xvii. Galvanized steel poles of 4m height shall be provided.
- xviii. CCTV system must be feed from the critical loads supply (UPS).
- xix. Security Logger located in the Control Building.
 - a. CCTV recording for at least 30 days shall be stored in the hard disk. The CCTV server shall have features to transfer CCTV recording storage to external hard disk through USB port. The CCTV recording stored on external hard disk can be retrieved and played back in CCTV server or any other computer on windows media player, without requirement of any additional software or hardware.
 - b. CCTV system shall be programmed to see live CCTV screen/recording on any popular web browser, without need of any additional software or hardware. For authentication of user, user id and password shall be required. User id and password can be changed from CCTC server only in administration mode.

Codes and Standards

IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60728	Cable distribution system primarily intended for sound and television operating between MHz and 1 GHz.
EIA	Electronic industry association standards.
IEC 60870-5-104	Standard for TCP/IP protocol
IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related system

Standards not indicated in the specification are acceptable subject to approval by the Employer if they are established to be equal or superior to the standards indicated in the specification. In case of conflicts between the standards and this specification, this specification shall govern.

Design Criteria

IP Based Fixed Camera

- i. The IP Based Fixed cameras shall comprise minimum of an auto focus colour camera. The protection class shall be IP65 or better for outdoor & IP-55 for indoor. It shall feature back light compensation and line-lock synchronisation. It shall be possible to define presents and patterns/tours for the camera.

- ii. Camera lenses shall have a shall be at least 1/3 inch or better with Full HD resolution. The cameras shall be with Wide Dynamic Range (WDR).
- iii. For each camera, the operator shall be able to configure the parameters such as camera streamer type, resolution, video frame rate, choice of live levels of video compression, equally distributed from minimum to maximum compression, streamer IP address, streamer camera number, choice of frame rate or bandwidth limited streaming, unicast or multicast transmission of video, PAL camera format.

Video Recording

Network video recorders should be provided to record continuous videos from all cameras and continuous snapshots from critical cameras. High-capacity discs should be installed and the time between each snapshot should be chosen so that overwriting will not occur in less than 24 hours or as specified by the Employer. The emergency / contingency plan for the Solar plant should provide for the removal of discs after an event to prevent further overwriting and to allow for later analysis.

Network Array Storage

The storage capacity of each NVR/NAS shall be not less than 30 days with 15 FPS per camera. An alarm shall be initiated when storage capacity of any NVR/NAS reaches 80%. On failure of a storage element, transfer to the redundant storage element shall be automatic. The storage system shall have facilities to superimpose camera number and date/time data on the images.

Power Supply

- i. The system (cameras, monitors and recorder(s)) shall be connected to a power supply which will continue to operate in the case of a mains power failure. This supply can be the plant emergency generating set, instrument-vital, battery-based power supply, or a dedicated-vital power supply. The vital power supply should allow operation of the whole CCTV system for at least 4 hours.
- ii. The system with cameras shall be provided with UPS 230 V AC power supply. Provision of UPS is included in the scope of Bidder.
- iii. Bidder shall derive internally all required voltages to operate the devices and all the necessary cabling including patch connectors, patch leads, accessories, adapters, etc. will be in the scope of the Bidder.

Mounting of Camera

- i. Wherever possible, existing non-vibrating structures shall be used for mounting the camera, otherwise special structures shall be provided. The Bidder can also use the Lighting poles (If feasible) across the plant to mount the cameras, otherwise separate pole to be considered to mount the cameras. The location of the camera shall be selected so that the camera and its supporting structure will present the least obstruction and the risk of accidental damage will be minimized. Where it is necessary, protective rails or fences shall be provided. The cameras shall be easily accessible for maintenance with fixed or mobile access platforms. Swing-type poles are not recommended.
- ii. The apparent vibration of any object on the screen due to the vibration of the structure on which the camera is mounted shall be less than 2 mm with a frequency of less than 2 Hz.

Cabling

The instrumentation and control cables and Fibre optic cables shall be as per the Employer offered system requirements & IEC standards. Any special cable required for the system shall be in the responsibility of the Bidder. Conduits are to be provided for cables.

CCTV Monitor

- i. 24" monitor at for Central Control room with mouse, keyboard/joystick etc. shall comprise a high-resolution LCD/LED display with electronics housed in a rugged case. It shall provide a clear and well-defined picture display on the screen. All controls for brightness, contrast, etc. shall be provided on the front panel. The monitor shall feature loop through connections for coupling the video to other monitors.
- ii. Multiplexing shall be provided. Resolution shall be Full HD. Number of characters per line shall be minimum 80 and number of lines per display page shall be minimum 48. Total number of characters shall be minimum 256 graphic characters + ASCII. Minimum Sixteen (16) colours shall be provided. Anti-reflection feature shall be provided. All VDUs shall have dedicated keyboard.
- iii. Control Keyboard shall be a full-feature keyboard capable of performing programming functions, camera and monitor call-up, operation of sequences and patterns and alarm configuration/acknowledgement and the functions mentioned in for the front panel controls/indications above the unit shall be capable of multi-speed control of variable speed receivers/drivers. The keyboard shall be capable of connecting to the LAN.

CCTV Accessories

- i. Remote-controllable 'window' cleaning facility
- ii. Rain/Sun shield
- iii. Protective cover for the 'window'
- iv. Thermostatically controlled internal and/or 'window' heaters to avoid internal condensation or condensation on the window.

Technical Parameters

IP BASED FIXED CAMERA		
Sl. No.	Description	Technical Data
1.	Camera Locations	<ul style="list-style-type: none"> • PV Plant SCADA monitoring and control room • Inverter Stations • 33kV Switchgear Stations • All Entry/Exit Gates • Security/Guard room • All gates for entry into different plots • As per the Employer requirement
2.	Enclosure Type	Boxed/Dome (As per requirement)
3.	Sensor Type	1/4" CCD or 1/3" CMOS, Day / Night Camera
4.	IR cut filter or IR corrected lens	Required
5.	Lens Type - Zoom (Optical + Digital)	36x Optical Zoom and 12x Digital Zoom
6.	Resolution	1920x1080p
7.	Focal Length of Lens	*
8.	Light Sensitivity (AGC on)	0.01 Lux minimum
9.	Signal-to-Noise Ratio	> 50 dB
10.	White Balance	Auto/Manual
11.	Backlight Compensation	Auto/Manual
12.	AGC, Auto IRIS	Auto/Manual
13.	Privacy Masking	Required
14.	Compression/Digital Encoding	H.264 or better
15.	Max. Resolution PAL / NTSC	Full HD
16.	Horizontal Resolution	Full HD
17.	Max. Frame Rate/Video Capturing Rate	25/30 fps

IP BASED FIXED CAMERA		
Sl. No.	Description	Technical Data
18.	Video Output	1.0 V p-p / 75 ohm
19.	Light loss	*
20.	Presets	NA
21.	Patterns	NA
22.	Angle of View	*
23.	Range	* m
24.	Synchronisation modes	*
25.	F-STOP Range	F/1.4 to F/16
26.	Automatic gain control (AGC)	Min. 20 dB
27.	Network Interface/Speed	*
28.	Network support/Protocols	*
29.	Operating Temperature	40°C*
30.	Operating Relative Humidity	20 - 90% non-condensing
31.	Electronic shutter	* Sec
32.	Surge Protection	Required for video, power input/output, communication, etc.
33.	Protection Class	Min. IP-55 for Indoor, Min. IP-65 for Outdoor,
34.	Standards UL, CE	Required
35.	Type: photocell with integrated IR LED array (refer notes)	Built in camera or Separate source *
36.	Wavelength	*
37.	Beam angle	*
	Other Requirements	
38.	User definable sectors / zones (minimum 8)	Required
39.	Advanced Troubleshooting and diagnostics via diagnostic LEDs and on-screen displays	Required
	Accessories	
40.	Name Plate / Metal Tag	SS Name Plate
41.	All Installation Hardware	As per project requirement
42.	Sunshade & Wiping System	As applicable
	Tests	
43.	Type Test	As per QAP & ITP
44.	Routine Test	As per QAP & ITP
	• NA Not Applicable	
	• *Supplier to indicate	
	Note: These are the minimum requirements. Supplier/Vendor must furnish other important data as applicable.	
Camera Server/Network Video Recorder		
Sl. No.	Description	Technical Data
1.	Video Resolution	Full HD -1080P,
2.	Video Frame	25/30 fps (PAL)

IP BASED FIXED CAMERA		
Sl. No.	Description	Technical Data
3.	Recording Mode	Time and events, alarm, manual trigger, continuous video.
4.	Processor	Hexa core or Octa-core /3.5 GHZ/16 MB cache/128bit /10000rpm.*
5.	OS	Latest, standard 64 bit/*
6.	RAM	16 GB (min)
7.	Network	*
8.	IOPS	*
9.	Signal System	PAL
10.	Video Inputs	IP mode access
11.	Video Outputs	*/1 no. composite video and 1 SVGA.
12.	Video Compression	H.264 or better
13.	Alarm Inputs	*/Minimum 4 nos.
14.	Alarm Output	*/Minimum 4 nos.
15.	Pan / Tilt / Zoom Control	To be provided over serial link to the receivers; control keys on front panel / discrete keyboard to be provided.
16.	Image Rate Settings/Update Rate	Selectable from 1 to 50 images per second per camera in duplex mode.
17.	Hard Drive Storage Space	*/Minimum 4TB. (Internal Hard disk), SATA 3.5" 1000RPM.16 MB cache
18.	Connectors	To be provided for composite video inputs and outputs (BNC), alarm inputs and outputs, com ports, USB ports (4 Nos.), port for SVGA monitor, port for connecting to Ethernet TCP/IP LAN, parallel port for printer and port for power connections.
Network Array Storage (NAS)		
Sl. No.	Description	Technical Data
1.	Capacity:	Min. 30 days data storage
2.	Configuration	*
3.	RAID Support	RAID 0, 1, 10, 5, and ,10,30,60 protection on a per-Storage Pool basis
4.	Expandability:	*
5.	High Performance	*
6.	Sophisticated networking	*
7.	Mounting	Desktop
8.	Redundancy	Required
	• NA Not Applicable	
	• *Supplier to indicate	
	Note: These are the minimum requirements. Supplier/Vendor must furnish other important data as applicable.	

Test and Inspection

CCTV System shall be subjected to test as per approved quality plans/ test procedures to fully demonstrate to the Employer's satisfaction, each equipment/ subsystem/ system as well as software modules (as applicable) furnished, fully meet the functional parameter and other requirements of the specification and Employer's approved drawings/documents. The Bidder shall bring out in his proposal all such tests. Bidder shall be responsible in obtaining test certificates related to calibration of all the hardware and Instruments and submit for Employer approval.

Drawings / Documents for Approval

- i. Technical documentation consisting of engineering, manufacturing, erection, commissioning, operation, and maintenance package.
- ii. Electrical and Mechanical datasheets
- iii. General Electrical and Mechanical Arrangement drawing
- iv. All relevant technical literatures and catalogues
- v. CCTV Configuration diagram
- vi. CCTV Control philosophy
- vii. Interface details with other required System
- viii. Camera location drawing (Indoor & outdoor)
- ix. Bill of quantities for shipment and erection
- x. Preliminary CCTV supports or foundations drawings with loads
- xi. Supports or foundations required design criteria
- xii. Equipment lists
- xiii. Power Consumption & Heat Dissipation Data (UPS Sizing details)
- xiv. Quality documentation including certificates according to the relevant codes and standards.

3.3.5 Lighting System**Lighting System**

This specification covers design engineering, supply, erection, testing and commissioning of lighting system with LED luminaires for the complete plant and not limited to the areas listed below (Indoor and Outdoor):

- i. Inverter stations including IDT area.
- ii. Inverter station and including IDT Area
- iii. PV Plant SCADA, monitoring and spare room buildings.
- iv. Entry and exit gates including security cabins.
- v. Duty guard cabins

Codes & Standards

EN 61347-2	Particular requirements for D.C. or A.C. Supplied electronic control gear for LED modules
EN 62384	D.C. or A.C. supplied electronic control gear for LED modules.
EN 61000-3-2	Luminaire EMC specification. Electromagnetic compatibility (EMC)

General Technical Requirements

- i. The lighting system for indoor areas of Solar Power Plant shall be designed in such a way that uniform illumination is achieved.
- ii. All LED luminaires shall be supplied with proper diffuser to avoid direct visibility of LED.
- iii. All lighting fixture suitable for indoor and outdoor shall be of LED Type without control gear. outdoor LED fixture shall have IP65 or better rating.

- iv. Coefficient of utilization maintenance factor (of 0.7 or less for indoor lighting and 0.65 or less for outdoor lighting).
- v. Tubular swaged type poles with junction boxes, cables, conduit, control gear and wiring etc. shall be provided for area lighting.
- vi. The distribution of lighting fixtures / receptacles shall be such that the loading on each phase of the LDB is approximately equal. Loading per circuit shall preferably be limited to 2000W.
- vii. All the lamps indoor and outdoor lighting fixture shall be energy efficient LED luminaire with luminous Efficacy of 110 lumen/W or better.
- viii. Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires, the following colour wires shall be used.
 - a) R – Phase - Red
 - b) Y – Phase - Yellow
 - c) B - Phase - Blue
 - d) Neutral - Black
- ix. Adjacent light fixtures in inverter station/PEB shall be provided with alternate phase supply.
- x. Colour designation of LED shall be cool day light minimum (5700 K) type for indoor LED luminaires. further for outdoor type luminaires, the colour designation shall be 5000k. the Led luminaires shall have minimum life of 25000 burning hours with 80% of lumen at the end of life
- xi. Wall mounted switches shall be provided at the entrance to equipment / office rooms. Occupancy sensors & lighting panels with auto / manual mode shall be provided for all indoor areas. Occupancy sensor with separate panels for separate lighting zones shall be provided at each entry-exit.
- xii. Adequate numbers of power sockets 5/15 A shall be provided in all indoor areas. Details shall be finalized as per Employer's requirement. Receptacles with decorative cover plates shall be used in office / control rooms
- xiii. Each outgoing lighting circuit of indoor Lighting panel shall be provided with RCBO of required rating and at incomer MCCB shall be provided of required rating. Whereas for outdoor lighting panel incomer shall be provided with MCCB and outgoing feeders shall be provided with MCB.
- xiv. 20A, 240V, single phase industrial receptacles shall be provided in Transformer area to provide 240V supply outlets for small power services such as drilling, grinding etc.
- xv. Suitable nos Ceiling fans are to be provided in all indoor areas. (Also, to be provided where ACs are considered The Bidder shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and board for mounting switch, suspension rod, canopy and accessories. The wall mounted fans shall be of 400 mm sweep. Exhaust fans shall be of 300mm size. Winding of the fans shall have Class-E insulating material. Winding shall be of copper wire.
- xvi. Building peripheral lighting shall cover all walls of the building and at least 3 meter parallel to building wall.
- xvii. All fixing / locking screws, washers, nuts, brackets, studs etc. shall be zinc plated and passivated. All supports / fixing / mounting structures, Hardware & accessories shall be GI only.,
- xviii. Colour rendering index:
 - a. For outdoor/ Industrial interior area lighting, CRI \geq 70
 - b. For office room/ control room etc., clean interiors, CRI $>$ 80
- xix. Lighting pole shall be tubular type, galvanized steel (minimum 910gm/sq.mm), joint less, supplied with base plate (with minimum 300mm PCD, 12mm thick), foundation bolts (SS-316 or, better), necessary fixing-bracket for fixing the luminaire. Lighting pole shall have integral junction box (minimum IP 55). In each lighting panel, 4 pole TPN Surge Protection Device, type-2 shall be provided. The System shall be capable of withstanding the appropriate wind load etc considering prevailing soil/ site condition considering all accessories mounting on pole.
- xx. SS 304 grade Integral Junction Box shall be minimum of 100 x 400 mm (H x W) and shall be minimum at 1200mm from base of pole.
- xxi. For outdoor lighting, XLPE insulated, armoured, FRLS aluminium / copper conductor cables shall be provided.

- xxii. The light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.
- xxiii. Outdoor panels / JB's / MKs /DBs etc shall be completely weather-proof with a sloping extended SS304 / Aluminium canopy for protection against rain and providing a degree of protection of IP 55.

Illumination Levels

Average LUX level to be maintained in various areas shall be as under:

Sl. No.	Area	Average Lux
1.	SCADA cum Office Room and Meeting Room, Conference room, etc.	300
2.	33kV Sub-pooling station (PEB)	250
3.	Inverter Station (Outdoor area)	150
4.	Battery Room, Aux. Panel Room, ICOG (indoor area)	200
5.	Kitchen cum Pantry	150
6.	Spares Room	100
7.	Toilets	50
8.	Transformer Yard	50
9.	Periphery	10 (excluding Periphery Road Lighting)

Emergency Light Points

- i. Emergency Light points with LED lamps of 15-20 W (at 240 V) shall be provided for following areas:
 - a. Inverter Stations
 - b. Security and Guard rooms
 - c. Sub-Pooling Stations
 - d. PV SCADA, Monitoring and Spare room buildings.
- ii. These lights shall operate on AC/DC changeover supply from the UPS distribution Board. Emergency AC lighting system shall be fed from normal supply and from emergency supply from UPS only during normal supply failure. Automatic change over scheme with sensing devices shall be incorporated in each lighting distribution board. Manual change over with interlock shall also be provided. Separate wiring and distribution board shall be provided from these lights. Separate modular switchboards for Emergency lighting shall be provided. Colour of the switchboard shall be different from normal switchboards.
- iii. The location of emergency lights shall be strategically decided to enable proper evacuation of personnel with help of Exit lamps. Emergency Light shall also cover the Fire Alarm and manual call point area.

Receptacle units

- i. 240V, 50 Hz, 3 pin Power Receptacles 6A and 16A shall be provided in all buildings. Inside a building, receptacles shall be provided for hand tools, water coolers etc. Minimum 2 Nos. of 6A and 1 No. 16A receptacles shall be provided in each room. 16A receptacles shall be provided for exhaust fans wherever required. Receptacle units shall consist of socket outlet with associated switch, neon indicating lamp and plug. The socket outlet and MCB shall be flush mounted within a galvanized 1.2 mm thick CRCA sheet steel enclosure. 1 no. 63 Amp, 3-ph welding receptacle shall be provided for each Inverter Transformer yard.

- ii. All receptacles shall be of heavy-duty type, suitable for fixing on wall/column and complete with individual switch. The outdoor Receptacles shall have IP 55 (minimum) protection. Receptacles shall be housed in a box made out of 1.5 mm thick Stainless Steel of Grade 304 with hinged doors with suitable locking arrangements. Door shall be lined with good quality gasketing.
- iii. The enclosure shall be with extended rain canopy and removable gland plate entry from bottom. Composite receptacle with switch modules housed in a box shall be with degree of protection IP 66.

Lighting wires / cables

The wires for wiring in lighting system shall be 1100 V, 1 core, PVC insulated, with stranded copper conductors. The minimum area of conductors shall be 2.5 sq.mm for light fittings / Industrial fans and 4 sq.mm for receptacles. In outdoor areas such as transformer yard and road lighting, cable wiring shall be adopted. The cables for outdoor lighting shall be 1.1 kV grade, with single / multicore stranded copper conductor, insulated with PVC inner sheath, armoured, FRLS PVC outer sheathed. Cables below 6sq.mm size shall be with copper conductor only. Minimum cable size shall be 4 sq mm and 6 sq.mm, for wiring of lighting equipment and receptacles respectively where cable wiring is specified.

Conduits

- i. Non-metallic conduits and their associated fittings shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm diameter for concealed installation.
- ii. Steel conduits shall be seamed by welding and hot dip galvanised unless otherwise specified. They shall be supplied in standard lengths of 5 m.
- iii. Separate conduits shall be provided for normal and emergency lighting.
- iv. Each conduit shall be limited to one lighting circuit.
- v. All conduits shall be FRPVC, and surface mounted in general. In office rooms and control rooms, conduit shall be concealed/wall mounted type. Conduit fill criteria shall not be more than 50%. Conduits should have the minimum number of bends in their run with pull boxes at suitable locations. Conduits shall be sloped to avoid water accumulation and draining into the equipment at its end.

Lighting distribution board and lighting panels

- i. Outdoor LDBs for area lighting shall have ON/OFF operation through real time-based timer in addition to manual control. In this case, incomer to LDB shall have suitably rated contactor in addition to MCCB and same shall be controlled by photocell and timer.
- ii. Panel shall have adequate space at least 20% free space shall be provided for mounting of components including cable entry, DIN channel etc.
- iii. All accessible live connection / metals shall be shrouded, and it shall be possible to change individual MCBs and RCBOs from the front of the boards/panels without danger of contact with live parts.
- iv. All wiring shall be carried out with wires of 1.1 KV grade, stranded copper conductors. The insulation shall be flame retardant. Power circuits shall be wired with stranded copper conductors of adequate sizes to suit the rated current, the minimum size shall be 2.5 sq. mm. Unless otherwise specified, control alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 sq. mm.

Earthing

Light fittings shall be earthed by 12 SWG GI wires, run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit.

Earthing for Light Poles

GI flat of adequate size shall be laid / buried in ground at a depth of 600 mm along with lighting cables and from this strip, two (2) Nos. GS flat riser shall be tapped off for earthing of light poles and junction boxes on the poles. The earth conductor shall be connected to the nearby main earthing grid at the first and last poles of each feeder circuit and at some intermediate poles. In case the main earth grid is far away from the pole, local earth pit shall be provided for pole earthing.

Local rod earthing shall be provided for each of the light poles and the same shall be connected with two (2) Nos. GS flat from the pole.

Testing and Commissioning

Before a completed installation is put into service, installation tests stipulated in applicable standards and codes of practices shall be carried out by the Bidder in the presence of the Employer's representative.

Data to be furnished after award of Contract.

Drawings / Documents for approval:

- i. Lighting design calculations for all the areas covered under the scope.
- ii. Lighting layout drawings.
- iii. Circuit distribution scheme.
- iv. Single line diagrams
- v. Descriptive and illustrative literature on the lighting fixtures.
- vi. Performance data of each fixture giving utilization factor, light distribution curves and technical data of fixtures & accessories.
- vii. General arrangement drawings of lighting distribution boards, lighting panel, and fixtures showing outline dimensions, fixing details, size and locations of cable entries and earthing terminal.
- viii. Diagrams showing wiring inter connection between all the accessories of the fixtures.
- ix. Quality Plan

Drawings / Documents for information:

- i. Type and routine test certificates of all luminaries and standard accessories e.g., ballast, capacitors, lamps etc.
- ii. Engineering data and O&M manuals.
- iii. The manual shall furnish catalogue numbers of all components liable to be replaced during the life of the fixtures.
- iv. Any special instructions regarding assembling and handling of the fixtures.

3.3.6 Installation Works

Scope of work shall include following items / equipment / service to be supplied, stored, fabricated, installed, connected-up / wired, tested and commissioned by the Bidder in the plant area specified hereafter:

- i. PV Modules
- ii. MMS system
- iii. Module cleaning system works.
- iv. String Combiner Box
- v. Inverters
- vi. Inverter Duty Transformers, Auxiliary Transformers
- vii. 33 kV switchgears
- viii. LV Switchgears, ACCBs, ACDBs, etc.
- ix. UPS System
- x. 110V Battery and Battery Charger, DCDB
- xi. Earthing and Lighting system
- xii. Cable laying system
- xiii. Erection, Testing and commissioning of Critical equipment shall be done in supervision of OEM.
- xiv. Miscellaneous works

PV Modules

PV modules shall be unloaded, stored and transported within solar PV plant with utmost care and shall be installed as per manufacturer's recommendations and instruction manuals.

String Combiner Box

- i. Bidder shall ensure that combiner box post must be plumb and properly aligned to level in accordance with site specific construction plan. Combiner boxes shall be mounted as per specified height and ground clearance not less than 600mm. Bidder shall use specified mounting hardware or hardware that has been approved by Employer's engineer.
- ii. Sufficient cable loops shall be left beneath the combiner box to allow proper termination of DC cables within combiner box. Termination of all input cables shall be done with pin type cu lugs and properly inserted within spring cage type terminal block of DC fuse holder and terminal block.
- iii. Termination of all DC output cables shall be properly torqued and torque marking shall be provided. Ensure that all connections show torque marks.
- iv. Combiner Box shall be grounded as per drawing details. SPD shall be earthed through the minimum 16sq.mm Cu cable and terminated to nearest DC earth grid riser. Termination distance for SPD earth shall not be more than 2m.
- v. All combiner boxes shall be labelled as per project drawing requirements.

Testing:

- i. All combiner boxes shall be fully tested on site prior to putting into service to ensure that all items are in required working condition, correctly installed and free from damage. An experienced and qualified testing Engineer shall be engaged by the Bidder to perform the site testing and commissioning.
- ii. Following minimum tests shall be carried out on all the combiner boxes.
 - a. Each individual string shall be visually inspected for its orientation and proper interconnections with other modules.
 - b. String Voc open-circuit and string Isc short-circuit current tests shall be conducted for 100% of the strings, unless otherwise approved by Employer.
 - c. Open-circuit Voc voltage and short-circuit Isc current tests shall be conducted for 100% of the combiner boxes.
 - d. Polarity test shall be carried out on each string. The value of open circuit voltage Voc shown by meter should be positive for required polarity. If a reversed polarity connection is detected in any one part of the system, DC polarity re-testing shall be done after reconnection. After testing the polarity of each cable, the polarity label and the circuit label shall be checked.
 - e. The DC system test shall be recorded in an electronic log file.

Inverters**Central/String Inverters**

- i. The inverters shall be mounted / fixed on channels through mounting holes provided at the base of the inverter. If the inverter is provided with clamping plates, it shall be placed on the foundation before the fixing holes are drilled. Bidder shall ensure that Inverters are plumb and properly aligned to level in accordance with site specific construction plan.
- ii. Visual inspections shall be performed to confirm that all Inverters are appropriately installed, mounted, aligned and connected and are free of damage, corrosion, heavy soiling and construction debris and to identify any visually observable defects, other faults that require correction prior to proceeding with further testing. All Inverters shall be labelled as per project drawing requirements. A visual inspection log shall be completed for each of the inverter.
- iii. Clearance to be maintained with respect to other panels shall as per approved drawings and relevant standards. Bidder shall obtain a specific approval on Inverter room general arrangement drawing from the Inverter manufacturer in order to ensure no default on manufacturer warranty terms.
- iv. Inverters shall be mounted as per specified front, side and rear clearances. Bidder shall use specified mounting hardware or hardware that has been approved by Employer's engineer.
- v. Sufficient cable loops shall be left prior to entering DC cables within Inverter station to allow proper termination of DC cables. Termination of all the cable inputs shall be done with bimetallic tubular lugs.
- vi. All DC input terminations shall be adequately torqued with appropriate torque marks as evidence.

- vii. Bidder shall ensure visibility of cable tags / labels within the specified distance of termination for both positive and negative conductors.
- viii. Inverter shall be grounded as per inverter manufacturer's recommendations. Inverter negative pole shall be suitably grounded with a minimum of 75x6mm GI strip or 150mm² copper cable only.
- ix. Termination of all AC and DC cables shall be done with suitable double compression glands, bimetallic lugs, washers, nuts and bolts. All terminations shall be fastened with proper torque values.

Testing:

All Inverters shall be fully tested on site prior to putting into service to ensure proper working condition, correctness of installation and free from damages. Testing and commissioning of inverters shall be conducted only under the supervision of manufacturer's representative or authorised and trained engineer of manufacturer.

Following minimum tests shall be carried out on all the Inverters prior to commissioning:

- i. Open-circuit VOC voltage shall be conducted for 100% of the combiner boxes inputs to Inverters.
- ii. Polarity test shall be conducted out on each PV module string. The value of open circuit voltage VOC shown by meter should be positive for proper polarity. In case VOC is negative, then DC terminations should be reversed.
- iii. Depending upon the inverter type and the instruction manual, the routine tests and acceptance criteria may differ. Unless otherwise specified by the inverter manufacturer, the following minimum tests shall be performed for inverter commissioning:
 - a. Functional test on exhaust fans.
 - b. Clockwise phase sequence availability for auxiliary power.
 - c. Checking that cable connections for firmness.
 - d. Checking inverter cabling for conformity to schematic diagrams.
 - e. Checking of suitability of termination of incoming and outgoing cables / bus duct as per project drawings.
 - f. Checking AC grid voltage. AC voltage measurements between the external conductors should be approximately the same as the nominal voltage of the inverter.
 - g. Checking the internal AC power supply.
 - h. Inserting fuses or links (if applicable).
 - i. Checking of status indicators by switching on the voltage supply by turning on the grid monitoring circuit breaker (if applicable) and the external voltage supply circuit breaker. Status indicators should not show any fault.
 - j. Checking of power export to the grid (if the irradiation level is above the inverter threshold) and for any abnormal noise.

Miscellaneous works

The Bidder shall also supply the structural steel, fabricate and install steel supports, to form:

- i. Mounting arrangement for String combiner boxes and other local devices.
- ii. Supporting arrangement for transformer cable boxes as per relevant drawings.

General Note

- i. The Cable glands shall be weatherproof Double compression type made of heavy-duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 microns. Cable glands shall conform to BS:6121.
- ii. All installation shall be as per Seismic Zone -V of IS1893: part1-2016.

3.3.7 HVAC System**HVAC System**

The design, manufacture, supply, transportation, receipt, handling, storage at site, erection, testing and commissioning of air conditioning and ventilation system shall comply with all latest versions of standards, statutes, regulations and safety codes in the locality where the equipment is proposed to be installed.

Areas to be air conditioned

PV Plant SCADA and Monitoring Room and / or any other area where temperature is required to be controlled to maintain the maximum designed temperature with 100% redundancy.

Hi-Wall Split Air Conditioners

The Hi Wall Split Unit shall be provided and would be located inside the area to be air conditioned.

The Hi wall Split Unit would essentially comprise the following:

- i. Indoor unit complete with fans, filters, cooling coils, expansion valves etc.
- ii. Outdoor unit complete with outdoor fans, condenser coils etc.
- iii. Refrigerant piping shall be copper and connected between the indoor and outdoor units, insulation for suction line.
- iv. Necessary drain piping up to the nearest floor drain for each hi wall split unit with thermal insulation
- v. Complete Electrical Supply system like MCC, cabling, control Wiring, etc. to be provided by Bidder.

Areas to be ventilated**PEB Buildings (wherever applicable):**

In PEB buildings, Ventilation system shall consist of multiple axial flow supply air fan units. The air being supplied is free from dust particles and shall be supplied with pre-filters and fine filters.

Ventilation of PEB buildings shall be designed in such a way that the temperature rise of the rooms does not exceed the maximum designed temperature of equipment and other auxiliaries. Accordingly, adequate quantity of supply air fan and exhaust fan shall be suitably chosen to remove the heat from the PEB buildings. The air quality supplied by the ventilation system shall be as per the recommendations of equipment manufacturers. All exhaust and fresh air fans shall be provided with thermostat control.

Codes & Standards:

The HVAC system shall conform to the latest applicable standards. Some of the applicable standards are listed below:

Codes	Description
ASHRAE	American Society of heating, refrigeration & air conditioning engineers
ARI 430	Central station Air Handling Units
ARI 410	Forced Circulation Air-Cooling and Air Heating coils
ASTM A653/A653M-20	Galvanised Steel Sheets
IEC 60034-1	Three phase induction motors
IEC 60665	Propeller type AC ventilation fans
IEC 60665	Electric axial fans
UL 555	Fire dampers
IEC 60335	Power cables
IEC 60228	Control cables

Design Criteria

- i. The following are the various input data to be considered in the design of air conditioning and ventilation system.
 - a. Outside design conditions: Site Specific
 - b. Inside design conditions to be maintained inside air-conditioned areas:
- ii. The mechanical ventilation system shall be designed based on maintaining inside temperature not exceeding design temperature of individual electrical equipment or 3 deg. C above outside dry bulb temperature whichever is higher.

Technical Parameters

Sl. No.	Description	Technical Requirements
1.0	Material of Construction	
1.1	Non ductable split air conditioners:	As per manufacturers standard (5 Star rating, Inverter Type)
1.2	Air Distribution system:	
	a) Duct construction method	
	b) Ducting sheet material	GSS
	c) Back draft dampers	
	i. Casing sheet thickness	18G GSS
	ii. Blade thickness	24G GSS
	d) Supply air louvers	
	i. Minimum percentage of free area	35-37%
	ii. Casing sheet thickness	18G GSS
	iii. Blade thickness	24G GSS
	iv. Face velocity	2.5 m/s
	e) Bird screen	
	i. Size	10 sq mm
	ii. Wire mesh	16 G wire mesh
1.3	Axial or Propeller Fan:	
	a) Casing	Mild steel plate

Sl. No.	Description	Technical Requirements
	b) Impeller	The impeller shall have blades of an aerofoil design
	c) Shaft	EN 8
	d) Inlet Cone / Outlet cone	Mild steel
	e) Noise	Shall not exceed 85 dB(A) measured at a distance of 1.5 meters from the source in any direction
1.4	Pre-filter:	
	a) Designation	Filters for ambient ventilation system
	b) Type	Cassette type / Flanged type
	c) Whether cleanable	Yes
	d) Efficiency	90% down to 10 microns
	e) Maximum filter face velocity	2.5 m/s
	f) Maximum allowable pressure drop for design flow rate in	
	i. Clean condition	6 mm WC
	ii. Clogged condition	12 mm WC
	g) Filter Media	High Density Poly ethylene (HDPE) media.
	h) Frame	18 G GSS

Data to be furnished by vendor after award of contract

Drawings / Documents for Approval and or information:

- i. Technical Data sheet
- ii. General Arrangement drawing showing overall dimensions, location of various devices, etc.
- iii. Heat rejection/ transfer calculation.
- iv. Equipment Warranty certificates
- v. Instruction manuals

3.3.8 Quality Health, Safety and Environment (QHSE)

This specification establishes the Environment, Health and Safety (EHS) management requirement to be complied by the Bidders during construction. Requirements stipulated in this specification shall supplement the requirements of EHS Management given in relevant Act (s) / legislations. General Conditions of Contract (GCC), Special Conditions of Contract (SCC) and Job Specifications. Where different documents stipulate different requirements, the most stringent shall be adopted.

Policy

The Bidder should have a documented QHSE policy to cover commitment of their organization in line with Client QHSE and other relevant policies to ensure Quality, health, safety and environment aspects in their line of operations.

Bidder shall develop, implement and monitor QHSE management system as per ISO 9001; ISO 14001, ISO 45000 and IFC Principal standards, Labour and Working Condition, Security, Grievance redressal, Environmental and Social Impact assessment and management plan, and other applicable policies.

Risk Assessment and Environmental Aspect Impact

The Bidder shall establish, implement and maintain procedure(s) for the hazard identification, risk assessment and determination of necessary controls related to human health and safety, Environmental aspect and Impact related to the site activities.

Legal Aspects

All applicable licenses, NOC's and permissions are being provided by the Employer and the Bidder shall have to comply and adhere with all the requirements to maintain such approvals. Bidder shall also comply strictly with the regulations such as child labour prohibition, payment and wages, workmen welfare and other applicable legislations.

Objectives and Management Plans

QHSE Plan in accordance with the policy shall be developed separately for construction, operation, maintenance and decommissioning phase, same shall be implemented, monitored and reported.

Bidder shall develop QHSE objective and target in line with Employer's QHSE objective and targets. (Copy of Employer's QHSE objective and target shared).

Roles, Responsibilities and Authorities

Bidder shall display Organization structure along with roles, responsibility and authority on QHSE and Social activities. Bidder shall be fully responsible for planning and implementing QHSE and social requirements. Bidder as a minimum requirement shall designate / deploy the following to co-ordinate the above:

QHSE person over Nos. of workers and work area deployment

- i. A suitably qualified Quality person (manager) for relevant scope of work e.g., Electrical / Civil etc. with not less than 8 years of experience shall be deployed to implement, monitor, manage and report quality aspect of project activities along with his team per shift of eight hours.
- ii. A suitably qualified HSE person (Manager) with not less than 8 years of experience shall be deployed to implement, monitor, manage and report HSE and Social aspect of project activities along with his team per shift of eight hours.
- iii. In addition of above following are minimum QHSE manpower requirement:
 - a. Up to 100 - Designate one qualified and minimum 4 years experienced HSE (Health Safety & Environment) supervisor in each shift of eight hours
 - b. Above 100 & up to 200 - Deploy one additional qualified and minimum 6 years experienced HSE Engineer/ officer in each shift of 8 hours.
 - c. Above 200 - One additional HSE (for every 50 or less) engineer/officer as above in each shift of 8 hours.
 - d. One qualified and minimum 4 years experienced HSE officer and Quality officer for each work-front and each scope of work spread in 200 acres of per shift of 8 hours.
 - e. Bidder shall indemnify & hold harmless Client & either representative free from all liabilities arising out of non – fulfilments of QHSE requirements.

Communication, Training and Awareness

The Bidder shall promote and develop consciousness for Quality Health Safety and Environment among all personnel working for him. Regular awareness and training programs, toolbox talks, site meetings etc. shall be arranged on QHSE activities to cover hazards involved in various operations during construction and associated records shall be retained for audits of Client.

All mandatory and regulatory signs shall be displayed at appropriate and prescribed locations at site, in compliance with legal requirement. QHSE promotion signage shall be displayed in addition to above at appropriate location.

Bidder shall promote QHSE through various mean and medium at site and among workmen. QHSE awards, Celebration of Safety week and Environment Day, QHSE training, emergency response training to workmen are minimum requirement and each shall be conducted once in a year. Report of the same with photographs shall be submitted to Employer.

Documentation

The Bidder shall prepare the documents related to QHSE management for implementation and monitoring of QHSE requirements. This shall be submitted to Client for approval. The documents shall be updated with new system introduction and changes in the process/ procedure. These documents shall be safeguarded and produced during the time of audit.

Employer shall permit/ provide appropriate and required space for display of Employer's policy, certificates and other such information at project site/office if the infrastructure is shared or owned by Employer.

Copy of valid IMS (Integrated Management System) or relevant QHSE certificates, details of award if any, shall be submitted to Employer.

Emergency Preparedness and Response

- i. All potential emergency situations including the circumstances having impact over community shall be identified, and an emergency preparedness plan shall be developed. Required infrastructure, equipment and training shall be provided. Mock drill shall be conducted as per Emergency Response Plan (ERP). Employer representative shall be informed while conducting mock drill and shall be allowed to participate in such drills.
- ii. Emergency response team (ERT) shall be identified / trained and deployed in a way that at any point of time (24 x 7) member of ERT are present at site.
- iii. Bidder shall identify potential for fire incidents and shall develop a management plan. Adequate and required firefighting arrangements shall be made available at site.
- iv. Contract shall arrange suitable first aid measures such as First Aid Box, certified first aiders, Stand by Ambulance and regular training of first aiders.
- v. The Bidder shall install fire protection measures such as: adequate number of steel buckets with sand and adequate fire extinguishers as per the local fire department norms and to the satisfaction of Client. Suitable weather and fall protection shall be done for all fire extinguishers, if installed in open.
- vi. Emergency escape route, emergency assembly area shall be marked at site, restricted entry and keep away from EMF (Electric magnetic field) area e.g., Substation, Transformers etc.as applicable shall be marked at appropriate location. Use of mobile phone / communication device shall be restricted in high EMF zone, e.g., Sub-station, high voltage electric panels etc.
- vii. Suitable signages shall be fixed for identification of emergency equipment. Monthly Inspection shall be carried out for Emergency equipment. Defective and unfit equipment shall be replaced with fit equipment. Bidder shall keep 10% extra (buffer) stock of fit to use emergency equipment as compared with required /planned emergency equipment.

Monitoring and Measurement

The monitoring for implementation shall be done by regular inspections and compliance to the observations thereof. The Bidder shall get similar QHSE and Social requirements implemented at his sub-Contractor(s) work site/office. However, compliance of QHSE and Social requirements shall be the sole responsibility of the Bidder. Any review / approval by Client shall not absolve Bidder of his responsibility / liability in relation to all QHSE and Social requirements.

Incident Reporting

Bidder shall notify all reportable and serious incident to Employer within 4 hours over phone/ text message / email and a formal report shall be shared which should include, What, When, Where, to Whom and How, about the incident within 8 (eight) hours.

All near miss, first aid, emergency occurrence, good practices, training, mock drill, environmental incident, community complaint etc. shall be shared as monthly report in prescribed format.

Government/ Regulatory notice shall be shared with Employer and shall be treated as reportable incident.

Investigation and Non-conformance

Bidder shall allow/ permit and co-operate with Client's representative or it's designated representative to

- i. Conduct QHSE audit.
- ii. Conduct Incident /accident investigation for reportable incident or near miss having potential to cause reportable incident.

Gap/s if any identified in the audit will be shared with Employer. Suitable management plan/ corrective and preventive action plans shall be developed, agreed and implemented/ closed within agreed time. Evidence and report for the same shall be submitted with Client.

- i. Qualified QHSE Person shall be available and represent Bidder along with its site Head or designated representative of similar capacity during QHSE Audit/ Inspection/ Investigation.
- ii. Bidder shall share all QHSE, Legal permission and other related documents during QHSE audit, Inspection and other related activity. These documents will be treated as confidential documents and will be used only for audit/ inspection / Investigation purpose.
- iii. With regular audits/ inspections, Bidder shall determine the QHSE deficiencies and factors that are contributing to these occurrences/ incidences.
- iv. Bidder should agree to share its internal QHSE Audit reports as and when required for review and action plan status for the same.
- v. Bidder should proactively share stakeholder, community complaints and Incident reports, Corrective and preventive action plan, mitigation plan, management plan for the same and status of closure shall be submitted accordingly.
- vi. Non-Conformance on QHSE brought out during review/ audit by Client's representatives shall be resolved forthwith by Bidder. Compliance report shall be provided to Client.
- vii. QHSE Committee/ Workmen grievance committee/ Community Grievance committee shall be formed, and regular meetings shall be held. Employer's representative, if any shall be notified in advance and shall be allowed to join such meeting.
- viii. The Bidder shall ensure participation of his Resident Engineer / Site-in- Charge in the Safety Committee / QHSE Committees/ Workmen grievance committee/ Community Grievance committee meetings arranged by Client. A notice for same shall be provided by Bidder, minimum one week in advance. The compliance of any observations shall be arranged urgently. He/ She shall assist Client to achieve the targets set by them on QHSE during the project implementation.
- ix. Client Reserves right to notify Bidder on violation of QHSE agreement and impose monetary penalty as below.

- a. On, behavioural violation on QHSE e.g., Unsafe Act, not attending QHSE meeting without valid reason, delaying closure of gaps identified in internal and third-party audit, not submitting required reports, failing to report incidents as in Sl. No. 29 on time etc. -Fine up to INR 5000/- per violation.
- b. Delay in closure of QHSE audit action points without valid reason- Client can implement required actions for closure of QHSE action items and deduct payment from Bidder on actuals or hold payments. This will be done by providing 3-time notice within 45 days. (Not applicable for legal and regulatory requirements).
- c. Legal requirements shall be complied 100% and deviation is not acceptable
- x. All fatal accidents and other personnel accidents shall be investigated by a team of Bidder's senior personnel for root cause & recommend corrective and preventive actions. Findings shall be documented, and suitable actions taken to avoid recurrences shall be communicated to Client. Client shall have the liberty to independently investigate such occurrences and Bidder shall extend all necessary help and co-operation in this regard.

General Environment, Health and Safety Compliances

Bidder shall follow and comply to the welfare and wages and other requirement as per during construction during operation and maintenance irrespective of its applicability.

- i. Provision for suitable and assessable drinking water, toilets, clean and designated eating place, first aid, first aid equipment and materials, rest area etc. shall be provided at workplace for all workmen.
- ii. Workmen camp shall not be constructed within or in radius of 500 meters of project boundary. Bidder shall ensure that workmen camp is established and has required facility for sanitation, safe drinking water, fire prevention and protection, housekeeping, etc.
- iii. Children shall not be allowed in project area. Suitable arrangements shall be made for stay and food of workmen children at workmen camp when they are not accompanied by parents.
- iv. Workmen shall be verified for communicable disease and background (crime history) before they are deployed at work. In case police verification is not meeting the timelines, project site head shall develop inhouse mechanism for such verification.
- v. Appropriate medical check for workmen including vertigo test for workmen working at height shall be done annually.
- vi. Induction and training of workmen and visitors shall be conducted and documented before working/visiting the site.
- vii. The Bidder shall provide safe means of access to any working place including provisions of suitable and enough scaffolding at various stages during all operations of the work for the safety of his workmen and Client. Bidder shall ensure deployment of appropriate equipment and appliances for adequate safety and health of the workmen and protection of surrounding areas.
- viii. Bidder shall ensure availability and supply of all required best/agreed quality PPE (Personal Protective equipment) at site. Damaged PPE shall be destroyed and replaced immediately. Bidder shall also ensure use of safety belt, protective goggles, gloves etc. by the personnel as per job requirement. All these gadgets shall conform to relevant IS specifications or equivalent.
- ix. Bidder shall ensure that a proper Safety Net System shall be used at appropriate locations. The safety net shall be located not more than 30 feet (9.0 metres) below the working surface at site to arrest/reduce the consequences of possible fall of person working at different heights.
- x. Bidder shall ensure that flash back arresters are used at torch and Gas cylinder while using Gas cutters at site. All safety precautions shall be taken while use of gas cutters for example Cylinders shall be mounted on trolleys, hoses shall be checked for leakage with soap water, hot permit shall be used, fire prevention mechanism shall be in place, only industrial gas cylinders shall be used etc.
- xi. Bidder shall assign work to his workmen, tasks commensurate with their qualification, experience and state of health for driving of vehicles, handling and erection of materials and equipment's. All lifting equipment's shall be tested certified for its capacity before use. Adequate and suitable lighting at every

- workplace and approach there to, shall be provided by the Bidder before starting the actual operations at night.
- xii. Hazardous waste management, e-waste management, Batteries management, Municipal waste management, Construction and Demolition waste management shall be done in accordance with applicable law, relevant law shall be complied 100% even in case of ambiguity of its applicability.
 - xiii. Hazardous and/or toxic materials such as solvent coating or thinners shall be stored in appropriate containers.
 - xiv. All hazardous materials shall be labelled with the name of the materials, the hazards associated with its storage, handling and use and necessary precautions to be taken.
 - xv. Bidder shall not dump, release or otherwise discharge or dispose of hazardous materials and substance. An awareness training shall be given to all employees on hazardous materials.
 - xvi. Appropriate personal protective equipment's such as gloves, goggles, aprons, chemical resistant clothing and respirator shall be used while handling hazardous material, if any.
 - xvii. Chemical spills shall be contained and cleaned up immediately to prevent further contamination.
 - xviii. All personnel exposed to physical agents such as ionizing radiation, ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with the type of exposure involved.
 - xix. All the construction vehicles used at site shall have fitness and Emission Test certificates so that the vehicle exhaust is under acceptable and permissible legal and industrial good practice
 - xx. To avoid dust generation due to vehicular movement, a dust prevention and control management plan shall be developed. These control measures may include Water sprinkling considering water availability in the project area. Gary water shall be used for sprinkling on best effort basis.
 - xxi. DGs and other equipment used at site shall confirm to applicable Air and Noise and other relevant legal requirements /standards.
 - xxii. Reasonable Canteen facilities / eating area shall be made available at appropriate location depending upon site conditions.
 - xxiii. Suitable facilities for toilet, drinking water, proper lighting (minimum 200 lux for workplace and minimum 100 Lux for pathway) shall be provided at site and labour camps, commensurate with applicable Laws.
 - xxiv. Bidder shall ensure that the wastewater generated during the construction works shall not be disposed of without treatment. Bidder can provide septic tank with soak pits or transport the wastewater to the nearest STP in tankers. The treated wastewater confirming permissible limits of State pollution control board for disposal on land can be used to control dust.
 - xxv. Bidder shall ensure storage and utilization methodology of materials that are not detrimental to the environment. Wherever required, the Bidder shall ensure that only the environment friendly materials are selected.

Workmen includes all person deployed at site for construction/ operation and other project related activities.

Housekeeping

Bidder shall ensure that a high degree of housekeeping is maintained and shall ensure inter alia the followings wherever applicable:

- i. All surplus earth and debris are removed/disposed-off from the working areas to identified location(s) in compliance with construction and demolition waste regulation.
- ii. Unused/ Surplus Cables, Steel items and steel scrap lying scattered at different places within the working areas are collected and stored in designated location(s) and disposed-off with approved recycler.
- iii. All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be collected and stored in designated storage area (waste storage area/ scrap yard). Roads shall be kept clear and materials like pipes, steel, sand boulders, concrete, chips and bricks etc. shall not be allowed to rest on the roads to obstruct free movement of men & machineries.
- iv. Fabricated steel structural, pipes & piping materials shall be stacked properly for erection.
- v. Water logging on roads shall not be allowed.

- vi. No parking of trucks / trolleys, cranes and trailers etc. shall be allowed on roads which may obstruct the traffic movement. A traffic management plan shall be developed and implemented, to eliminate risk of accident in nearby community. Drivers, cleaners, workmen shall not be allowed to rest under parked vehicle or cook food in or around vehicle. A designated resting place (shade) for drivers, cleaners and workmen shall be provided.
- vii. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.
- viii. Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the premises and on road to avoid public nuisance.
- ix. Only properly designed steel scaffolding materials shall be used for working at heights.

Details of EHS Management System by Bidder

On Award of Contract

The Bidder shall, prior to start of work submit his Quality Health Safety and Environment Manual and/ or procedures and QHSE Plans for approval to Client.

The Bidder shall participate in a meeting with Client to finalize QHSE Plans including the following:

- i. Job procedure to be followed by Bidder for activities should cover- Handling of equipment, Scaffolding, Electric Installation, describing the risks involved, actions to be taken and methodology for monitoring each activity.
- ii. Client review / audit requirement.
- iii. Organization structure along with roles, responsibility and authority on QHSE activities.

During Job Execution

Implement approved Quality, Health, Safety and Environment management procedure included. Bidder shall also ensure to:

- i. Arrange workmen compensation insurance, registration under, third party liability insurance etc., as applicable.
- ii. Arrange all QHSE permits before start of activities (as applicable) like hot work, confined space, work at heights, storage of chemical / explosive materials and its use and implement all precautions mentioned therein.
- iii. Submit timely the completed checklist on QHSE activities, Monthly QHSE report, accident reports and investigation report etc. as per Client requirements. Compliance of instructions on QHSE shall be done by Bidder and informed urgently to Client.
- iv. Ensure that Resident Engineer/ Site-in-Charge of the Bidder shall attend all the Safety Committee/ QHSE meetings/ Workmen grievance committee/ Community grievance committee meeting arranged by Client. Only in case of his absence from site that a second senior most person shall be nominated by him in advance and communicated to Client.
- v. Display at site office and work locations- caution boards, list of hospitals, emergency services available.
- vi. Provide posters, banners for safe working to promote safety consciousness.
- vii. Carryout audits / inspection at sub-contractor works as per approved QHSE Plan and procedures.
- viii. Document and submit the reports for Client review.
- ix. Assist in QHSE audits by Client and submit compliance report.
- x. Generate & submit QHSE records/ report as per QHSE Plan.
- xi. Appraise Client on QHSE activity

3.3.9 Commissioning Tests

General

This section covers the installation and commissioning requirements of all major equipment of the project.

- i. Tests on all equipment shall be conducted as per latest revisions of relevant IEC Standards.

- ii. Verification of commissioning Tests shall be according to the latest published testing procedure 'IEC 62446: All parts.
- iii. The inspection by Bidder and issue of Inspection Certificate there on shall in no way limit the liabilities and responsibilities of the Employer in respect of the agreed quality assurance program.
- iv. The commissioning activities shall be completed by aligning with first time charging procedures by BPSO and relevant regulation / guidelines.

Pre-Commissioning Works

- i. On completion of erection of the equipment, each item of the equipment shall be thoroughly cleaned before charging. The equipment shall then be inspected jointly by the Bidder and the Employer for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site.
- ii. The Bidder shall submit detailed test procedures to the Employer for its approval, at least 60 Days prior to the anticipated Commercial Operation Date.
- iii. The Employer shall review / approve the Detailed Test Procedures and the approved Test Procedures shall be adhered by Bidder at site.
- iv. The Bidder shall be responsible for satisfactory working of complete integrated system and guaranteed performance.

Site Tests and Commissioning Checks

General

- i. All the equipment shall be tested at site to make sure and to prove suitability of their condition for required performance.
- ii. The test indicated in subsequent pages shall be conducted after installation. All tools, accessories and required instruments shall be arranged by the Bidder. Any tests other than those indicated that is considered necessary by the manufacturer of the equipment mentioned in the commissioning manual shall also be conducted at site.
- iii. In addition to tests on individual equipment, some tests / checks are to be conducted / observed from overall system point of view. Such checks are highlighted under miscellaneous tests, but these shall not be limited to as indicated and shall be finalized in consultation with the Employer before charging the system.
- iv. The Bidder shall be responsible for satisfactory working of complete integrated system and guaranteed performance.
- v. All Tests must comply with the requirements of all applicable standards and codes, including the Grid Code.
- vi. If any inverter or Plant fails to pass any Test as per Schedule, repeat Tests shall be carried out until all inverters and the whole Plant pass all Tests.
- vii. All checks and tests shall be conducted in the presence of Employer / Employer's representative and test results shall be submitted to Employer with one copy to Electrical Inspector. Test results shall be filled in proper proforma.
- viii. After clearances from Electrical Inspector, system / equipment shall be charged in step-by-step method.
- ix. Based on the test results, clear observations shall be indicated by the Bidder with regard to suitability for charging of the equipment.

Trial Run Test

After the successful test of each equipment as per standard test procedure, the entire control system shall be put on trial run test on actual site conditions and operation of the system.

Acceptance Test

The acceptance test on the system shall be carried out by the Bidder as per mutually agreed test procedures to establish satisfactorily functioning of the system as a whole and each equipment as part of the system.

The site tests and acceptance tests to be performed by Bidder are detailed below:

General Checks

- i. Check for physical damage.
- ii. Visual examination.
- iii. Check from name plate that all items are as per order / specification.
- iv. Check tightness of all bolts & nuts, clamps and connecting terminals using torque wrenches.
- v. For oil filled equipment, check for oil leakage, if any. Also check oil level and top up if necessary.
- vi. Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.
- vii. Check cleanliness of insulator and bushings.
- viii. All checks and tests specified in drawings and manuals furnished by the manufactures, as well as all tests specified in the relevant code of erection.

Commission Checks for Equipment

- i. Inspection of all equipment of DC system.
- ii. Inspection of all equipment of AC system.
- iii. Inspection of all Cables.
- iv. Inspection of safety equipment such as surge arrestors and earthing.
- v. Inspection of ESE Lightning Arrestor.
- vi. Inspection of the PV modules support structure.
- vii. Inspection of the support structure foundations.
- viii. Testing to confirm that all works have been carried out in accordance with applicable Laws and the Grid Code.
- ix. Testing to confirm proper connection and labelling of all components.
- x. Inspection of security systems such as fences and alarms.
- xi. Inspection of weather monitoring system.
- xii. Inspection of CCTV surveillance system and
- xiii. Inspection of complete as-built documentation for the Plant.

Commissioning Tests

- i. The commissioning Tests shall be carried out off-grid as well as in connection with the Transmission System.
- ii. During commissioning Tests, the Bidder shall demonstrate that the Plant (including each inverter) and all other relevant equipment operates in accordance with:
- iii. Equipment manufacturer specifications.
- iv. Grid Code and other relevant national and international norms and standards.

PV array

The Tests on the PV array shall be conducted according to IEC-62446.

The start-up tests shall be the first step for provisional acceptance of plant. These tests shall essentially include:

- i. Establish power (Wp): Prior to conducting any tests, the Bidder must establish the total installed power of the plant. Total DC installed capacity of the Plant shall be calculated and established as the sum of the nameplate rating(s) of the installed modules, which shall be checked to arrive at peak power at STC (Irradiance: 1000 Watt/m, AM: 1.5, cell temperature: 25°C).
- ii. Open circuit voltage (Voc): This test verifies that strings are properly connected (module and string polarity) and that all modules are producing the expected voltage according to the module data sheet. To measure Voc, the following procedure must be used:
 - a. Array junction box is opened.
 - b. Array Junction box fuses leading to the sub main junction box are removed.

- c. The voltage is measured with a calibrated, industry accepted instrument (PV Analyser) from the negative bus bar to the module side of the string diode, for each string.

Inverter

Generally, the inverter shall be commissioned and tested according to the manual provided by the inverter manufacturers. Inverters shall be tested under different operation modes including but not limited to:

- i. Loss of auxiliary power.
- ii. Anti-islanding.
- iii. Maximum power point tracking.
- iv. Total harmonic distortion.
- v. Active / reactive power control.
- vi. Fault Ride through condition (LVRT / ZVRT and HVRT).
- vii. Negative grounding system.
- viii. Night-time reactive power compensation.
- ix. Automatic wake up and shut down.
- x. Closed loop plant controller and
- xi. Reverse polarity test
- xii. Test of basic network management functions (including frequency and automatic voltage regulation).

MV / LV Equipment

All medium voltage and low voltage equipment shall be tested according to relevant IEC and the manuals provided by the equipment manufacturer including but not limited to:

- i. MV switching equipment for protection of feeders and transformers.
- ii. Grounding connection.
- iii. Auxiliary LV power supply.
- iv. UPS system
- v. IR-camera tests for MV equipment.

I&C Equipment

All instrumentation and control equipment shall be tested according to the manuals provided by the equipment manufacturer, including but not limited to:

- i. SCADA system.
- ii. Weather monitoring system and
- iii. Plant security and surveillance system.
- iv. Manual cleaning system Any other I&C Systems shall be checked as per OEM recommendation.

HVAC System

All equipment of HVAC system, viz., Air conditioners, Exhaust fans, etc. shall be tested according to the manuals provided by the equipment manufacturer and demonstrate desired performance of these equipment.

Fire Alarm and Firefighting system

All equipment of Fire Alarm and Firefighting system, viz., Fire alarm panel, Fire / smoke detectors, Firefighting equipment etc. shall be tested according to the manuals provided by the equipment manufacturer and demonstrate desired performance of these equipment.

Inverter Duty Transformer Testing

Following testing shall be done but not limited to:

Pre-commissioning tests for Inverter duty transformer at site

- i. SFRA
- ii. Tan Delta
- iii. DGA

- iv. Comprehensive oil testing
- v. IR Value
- vi. Winding resistance at all taps
- vii. Ratio at all taps
- viii. Comprehensive scheme testing (Buchholz, OTA, WTI, PRV/PRD, MOG, etc.,)
- ix. Comprehensive testing of NIFPS (First time charging of Transformer shall be allowed only after successful testing of NIFPS)
- x. Bushing CT Testing if applicable
- xi. Any other testing required as recommended by the OEM.

HT Switchgear

Following testing shall be done but not limited to:

- i. Relays and meters testing by secondary injection
- ii. Verification of Relay settings and configuration and downloading of same
- iii. CTs, PTs Testing by Primary injection
- iv. IR Testing of power circuit
- v. Comprehensive scheme testing
- vi. Hipot test and timing test of breaker
- vii. ABT Metering system (Tariff metering, CTs, PTs and ABT Meters) as per requirement of concerned competent authority.
- viii. Any other testing required as recommended by the OEM.

33KV Cable

Following testing shall be done but not limited to:

- i. Hipot testing
- ii. IR before and after Hipot testing
- iii. Phase sequence, Continuity and resistance measurement
- iv. Visual check of cable termination and tightening.
- v. Any other test required as per recommended by OEM.

SCB to Inverter Cable

- i. Hipot testing
- ii. IR before and after Hipot testing
- iii. Continuity and resistance measurement
- iv. Visual check of cable termination and tightening.
- v. Any other test required as per recommended by OEM.

LT Cables

- i. IR Testing
- ii. Phase sequence, Continuity and resistance measurement
- iii. Visual check of cable termination and tightening.
- iv. Any other test required as per recommended by OEM.

3.4. Civil and Structural Works**3.4.1 Scope**

- i. This specification covers the general requirements for the Civil & Structural design engineering, construction, fabrication, procurement, supply, transportation to site, storing at site, erection, installation, testing, commissioning, performance testing of all the facilities as listed below on Engineering Procurement and Construction (EPC) basis as per the specification mentioned in this document. Employer will provide the preliminary study report for topographical; Geotechnical Investigation & Hydrology details which is only for information to the Bidder. Bidder to carry out their own study for the same and any risk/ambiguity pertaining to above study (land, soil and water) shall not be responsibility of Employer.
- ii. The scope of work covered in this specification consists of collection of all site related data, labours, fuel, oils, equipment/machinery for the complete solar plant including switchyard within Solar PV Plant line in complete manner deemed to be included in the scope of Bidder.
- iii. For Ground Mounted Solar PV Project, all the material, installations, fixtures, accessories etc. to be provided shall be as per the relevant IS or any other relevant international standards and guidelines and manuals issued by relevant agencies in Bhutan. These shall be of best quality and of standard manufacturer as approved by the Employer, when there are no standard specifications. The Bidder must keep the records of purchase and consumption along with original purchase bills of Cement and Steel and other bought out material as per the Employer's procedures and rules. The Bidder must provide best workmanship with skilled manpower for all the civil items as per the standard specifications/ best practice as approved by the Employer.
- iv. Industrial Sign Boards (Safety Board, Hazard Board, Electrical SLD, earthing layout, artificial respiratory sign board for each inverter station and for each sub pooling station) and Safety Signs, Bidder shall install and fix industrial sign boards and safety signs as per relevant safety regulations.
- v. Bidder is responsible for all the engineering, procurement, supply of all materials, fabrication and construction of civil and structural works pertaining to PV solar plant and switchyard works within solar PV plant side.
- vi. The IS codes referred in this specification shall be latest as on the date of contract.
- vii. Civil & Structural scope shall include but not limited to the following items of work.
 - a. Conducting contour survey of the total area, Topo survey, Water Test, Hydrology study & soil investigation with field and laboratory tests, submitting draft and final report to Employer including all field data in soft copies for approval.
 - b. Earthwork for site grading, cutting, filling & levelling of land including cutting and removal trees and vegetation along with necessary statutory permissions/clearances
 - c. Design, construction, and erection of complete Module mounting structures
 - d. Design, Construction for MMS foundation.
 - e. Design and construction of PEB/RCC Building for Inverter or supporting foundation arrangement in case of containerised solution.
 - f. Design, Construction, and erection of 33kV system and foundation as required for evacuation within the Solar PV plant boundary.
 - g. Design & Construction of foundations of transformers, burnt oil pit, switchgears, combiner boxes, earth pits, ESE Lightning Arrestor, Weather monitoring system, Fencing, main gate, security cabin etc.
 - h. Design & Construction of Cable support for carrying cables for Solar PV plant to Switchyard and related Civil works.
 - i. Design, Construction, and erection of Transformer Fence as per the layout and main/ security gate(s).
 - j. Design & Construction of approach road as required for easy access to site for safe and easy transportation of equipment and material at the site during and after construction for O&M of the plant.

- k. Design & Construction of Main Control Building with minimum dimension as specified in relevant section of this document and toilet facility as per the direction of Employer. It shall be inclusive of all furniture as per requirement.
- l. Providing suitable storm water drainage arrangement to divert storm water and to nearby storm water drainage network as applicable.
- m. Bidder to visit the site and obtain all necessary information pertaining to site condition and project related activities before quoting for the project.
- n. Design & Construction of foundation of water storage tank to cater the day-to-day requirement of drinking water and permanent water supply for module cleaning and other needs of SPV power Plant & during entire O&M period.
- o. Design life of all above structures shall be minimum 25 years.
- p. Providing, supplying, and laying Hume pipes for road crossings while laying power cables, control cables, pipelines etc. These pipes shall withstand the necessary vehicular loads, during the entire life cycle.
- q. All other statutory approvals and permissions not mentioned specifically but are required to carry out hassle free construction and operation of the plant is in the scope of Employer.
- r. Construction Power & construction Water as required for construction and completion of this contract are to be arranged by the Bidder at his own cost. However, arrangements for the construction power and water shall be facilitated by the Employer.
- s. All other temporary facilities like worker accommodation, sanitary facilities, first aid facilities, site office, Storage sheds etc. shall be provided by the Bidder.
- t. All approvals, equipment, item and works which are not specifically mentioned in this document but are required for successful completion of work including design, construction, commissioning, operation & maintenance of the Power Plant in every respect and for safe and efficient construction & erection, operation and guaranteed performance are included in the scope of the Bidder.
- u. Submission of following documents and drawings, data to Employer for review and approval in hard copy and softcopy/AutoCAD copy/ STAAD file from time to time as per project schedule.
- v. General Arrangement (GA) layout or Plot Plan or PV Array layout of the entire project shall include roads, storm water drainage, Sanitary and Sewerage system, buildings, sheds, security gate, fire protection system, etc.
- vi. Completed design and details of Ground Mounted Solar PV Plant including foundation for MMS
- vii. Detail Design of MMS including fabrication drawings, connections and its relevant documents.
- viii. Bidder shall consider applicable Design basis criteria for buildings, foundations, supporting structure, roads, drains, any other foundations etc.
- ix. Bidder shall submit drawings/documents including but not limited to Design calculations for all structures including buildings, foundations, roads, storm water drains etc.
- x. Bidder shall submit Architectural, Structural & services GA drawings and Good for Construction (GFC) drawings for all types of structures and buildings.
- xi. Bidder shall submit all the drawings/documents related to Structural Fabrication.
- xii. Bidder shall restore the site facilities/landscape etc., after the construction phase to its original condition.
- xiii. Bidder shall submit As-built drawings / documents and deviation list from good for construction (GFC) drawings. All drawings shall be fully corrected to comply with the actual "as built" site conditions and submitted to Employer after commissioning of the project for record purpose.

3.4.2 List of Facilities and Buildings

Following is the list of minimum facilities and buildings but not limited to the following only. Bidder shall provide all facilities/buildings that are required for smooth and efficient performance of proposed solar power plant.

- i. RCC Building/PEB Building or Supporting Foundation structure for Inverter Area
- ii. Inverter Yard (Transformer, burnt oil pit, NIFPS pit (if applicable), Fencing and other foundation)

- iii. Inverter combiner boxes foundations (if applicable)
- iv. String Combiner Box (SCB) foundation as applicable
- v. Main Control Building
- vi. 33kV System structures and other associated works including their foundations
- vii. Complete Ground Mounted Solar PV plant Structure and associated works
- viii. Inverter Yard Cable tray and foundation
- ix. ESE LA foundation
- x. Earthing pits
- xi. Weather Monitoring foundation works
- xii. Foundation for Water Storage Tanks
- xiii. Roads
- xiv. Storm Water Drainage & Sewerage System, as applicable
- xv. Plumbing and Sanitation
- xvi. Structural steel work and foundation
- xvii. Site Office with facilities as required during execution stage
- xviii. Foundations for Lighting Poles
- xix. All the civil works for Module cleaning system including structural sheds
- xx. Dewatering works
- xxi. Site enabling and site infra works
- xxii. Site Survey and Investigation works
- xxiii. All the civil works which are not mentioned above but required for successful commissioning of Ground Mounted Solar PV Plant

3.4.3 Land Development for Site Activities

The Bidder is responsible for making the site ready and easily approachable by clearing of bushes, felling of trees (if required with appropriate approval from concerned authority), levelling of ground (wherever required) etc. for commencing the project. Site grading level shall be fixed with due reference to site drainage of the whole area, existing drainage pattern, maximum flood level (from topography survey) and system requirements. If the land pocket needs any filling, it is to ensure that the filled area is filled with good quality earth and well compacted as per the relevant IS standards.

3.4.4 Foundations

The Bidder is responsible for the detailed soil investigation and subsequent foundation design of the structures in the plant. The foundation of buildings and other important structures shall be approved by Employer prior to construction. The Bidder shall provide the detailed design calculations of the foundation. The foundations shall be designed considering the weight & distribution of the structure/assembly and designed to withstand wind speed and seismic factors applicable for the proposed site and as per relevant IS code.

No foundation shall be allowed to rest directly on backfilled or swelling type of soil. Final founding level shall be as per foundation design, recommendation given on soil investigation report and as per Employer's approval. Minimum depth of foundation shall be 1 m below NGL.

3.4.5 Excavation, Back-Filling and Disposal of Earth

- i. Excavation for foundations, trenches, pits, sumps, underground tanks, roads, boundary wall, pathways shall be considered in all types of hard & soft soil, weathered & soft rock, hard rock etc. using appropriate mechanical equipment.
- ii. Ground shall be level to prevent water logging, soil erosion, etc

- iii. Back filling shall be carried out either with good quality excavated earth as approved by Employer or good quality earth brought from borrow areas. Backfilling shall be carried out in layers with minimum 95 % proctor density and required test. Poor quality excavated earth and surplus excavated earth shall be disposed outside the plant premises at unobjectionable areas irrespective of any lead. Employer shall obtain all local statutory approvals for bringing earth from outside and disposal of earth outside.
- iv. If blasting is required for excavation, the Bidder shall carry out control blasting with the help of licensed charger by obtaining all necessary approvals from local statutory authorities.

3.4.6 Module Mounting Structure

General

Module Mounting Structures (MMS) made of Metallic structures having adequate strength and appropriate design, to withstand various loads on the MMS including design wind pressures. Modules shall be mounted on noncorrosive support structures.

Design shall be based in accordance with the site climatic conditions and seismic loads, soil characteristics, thermal loads caused by expected fluctuations of materials and ambient temperatures and the minimum required design wind speed.

- i. The design shall allow easy installation and replacement of any position PV module in the table. The Bidder shall specify installation details of the PV modules, on the support structures, with appropriate design, and drawings.
- ii. The Bidder shall submit the detailed design calculations and drawings for MMS structure, bill of materials and their specifications / standards to the Employer for approval before fabrication commencement.

The Bidder shall use shorter table with suitable pitch considering the ground gradient.

Codes & Standards

- i. The work to be executed under this specification shall be in accordance with the applicable section of the latest version of the relevant IS standards including amendments, if any, except where modified and /or supplemented by this specification.
- ii. Equivalent National and International standard/code would also be acceptable for Module Mounting structures (MMS).
- iii. Some of the applicable codes and standards are as mentioned below.

IS 875: Part 1 & 2	Code of practice for the design loads for buildings and structures
IS 875: Part 3	Code of practice for the design loads for buildings and structures-Wind Loads
IS : 1893	Criteria for earthquake resistant design of structures
IS 811	Cold formed light gauge structural steel sections
IS 2062	Hot rolled Medium and High tensile structural steel
IS : 209	Zinc Ingot
IS 2629	Recommended practice for hot-dip galvanizing of iron and steel
IS 800: 2007	Code of practice for use of structural steel in general building construction
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
IS 1868	Anodic Coatings on Aluminium and its Alloys
IS 15961	Hot dip aluminums-zinc alloy metallic coated steel strip and sheet (plain)
IS 9172	Recommended design practice for corrosion prevention of steel structures.

ISO-12944	Corrosion protection of steel structures by protective paint systems for C5-M zone for very high saline zone
IS 4923	Hollow steel sections for structural use.
IS 1161	Steel tubes for structural purposes
IS 4736	Hot-dip zinc coatings on mild steel tubes

Design Parameters

- i. The Basic wind speed shall be 47 m/sec, $k_1 = 1$, $k_2 = 0.98$, $k_3 = 1.26$ and $k_4 = 1$.
- ii. Seismic zone shall be V and details design shall be as per IS: 1893 and other relevant codes and standards.
- iii. Suitable material for corrosion category compliance as per Corrosion map of India, EN ISO 14713, EN ISO 1461, EN ISO 12944-5 or ASTM 123. Corrosion category shall be C2. Reference report is provided along with tender documents.
- iv. Cleaning – Water based cleaning system.
- v. Minimum ground clearance to be maintained at module edge with maximum angle shall not be less than 500mm. However, this will be decided based on final document shared by Bidder and approved by Employer.

Module Mounting Arrangement

- i. The module mounting structure design shall be appropriate, safe, and innovative. It shall follow the existing land profile or graded profile. The structure shall be designed to allow easy replacement of any module and shall be in line with the site requirements. Design drawings with material selected and their standards shall be submitted for prior approval of Employer.
- ii. The support structure & foundation shall be designed with reference to the recommendations provided in the approved soil investigation report and considering total Project life of at least 25 years.
- iii. The structure should be safe and shall be designed for simple mechanical and electrical installation and allow easy replacement of any PV modules and easy access to the O&M staff. It shall support SPV modules at a given orientation & tilt, absorb and transfer the mechanical loads to the ground properly. Welding of structure at site shall not be allowed.
- iv. The Ground mounting structure system which constitutes a photovoltaic array(s) shall be designed to withstand the extreme fair wind (positive pressure) and adverse wind (negative pressure) on design tilt angle of solar photovoltaic array(s). The design calculations shall be supplemented with neat sketch and reference to various clauses of technical specification and Indian standards.
- v. Following wind pressure generated loads shall be considered in the analysis and design.
 - a. Load on members, fittings & panels.
 - b. Load due to fair wind direction on design tilt angles of solar mounting structural a member.
 - c. Load due to adverse wind direction on design tilt angles of solar mounting structural a member.
 - d. Load on side face of mounting structural members.
 - e. Any other load envisaged, including and not limited to snow load.
- vi. Wind pressure coefficient, load and load combination shall be as per Indian standards (latest revision) such as IS: 875, IS: 800. An increase in allowable stresses of structural material should not be considered during design and analysis.
- vii. The limiting permissible vertical deflection for structural steel members shall be as given below.
 - a. Maximum vertical deflection of purlin = $\text{Span}/180$
 - b. Maximum vertical deflection of rafter (cantilever & simple span) = $\text{Span}/180$
 - c. Maximum lateral deflection of column post = $\text{Height}/200$.

Top of concrete or height of collar for MMS foundation shall be minimum 150 mm above NGL.

Following types of foundation may be provided based on the recommendations of soil investigation report.

(a) Bored cast In-situ pile (Min. 300mm dia.)

However, the type of foundation shall be decided based on final geotechnical investigation report and based on Employer's approval. The foundation proposed for the plant shall meet all the safety and risk envisaged for the plant.

The Bidder shall plan for pile load test like pull out, lateral and compression are required to be conducted for each plot at strategic locations, immediately after receiving LoI. The same shall be furnished for approval of the Employer, based on the results of above-mentioned tests, final approval for design of pile shall be provided.

MMS frames, post, base plate, assembly of the array structures, etc. shall conform to Indian standards as mentioned in the list of code.

- i. IS: 2062 (Latest) - Hot Rolled Medium and High Tensile Structural Steel
- ii. IS: 811 (Latest) - Cold Formed Light Gauge Structural Steel Sections
- iii. IS: 1161 (Latest) - Steel Tubes for Structural Purposes
- iv. IS: 4923 (Latest) - Hollow steel sections for structural use

MMS column post shall be of MS hot dip galvanized. Material for other components in MMS may be Galvalume AZ150(Anti corrosive Aluminum-zinc alloy metallic coated). Sections in accordance with IS 801-1975/ IS 811- 1987. Galvanization shall be measured with elcometer or the material can be sent for testing laboratory as and when required. Inner side galvanization with same specification of any hollow components of module mounting structure is mandatory. Hot dip galvanization shall be as per IS: 4759 or relevant Indian standard and the coating thickness of minimum 60 microns shall be maintained. In case offered support is made up of Aluminum, anodized coatings on aluminum as per IS: 1868 (Gr AC25) shall be provided for mounting structure. The minimum thickness of MMS column post shall be 1.6 mm and the minimum thickness of light gauge members like the purlin shall be 0.85 mm and rafter, beam, etc. shall be 1.2 mm conforming to IS 1079/ IS 2062.

Bidder may also propose new light gauge structural steel or structural aluminum members other than specified in specific Indian standards code and subjected to approval by Employer. All materials shall be fabricated in shop such that welding in the field shall not be required.

The Contractor shall design the structure height considering highest flood level at the site. The minimum clearance between the lower edge of the module and the ground shall be the higher of (i) 300mm above highest flood level at the site and (ii) 500 mm.

Bidder shall ensure that before galvanization the steel surface shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such foreign material as are likely to interfere with the galvanization process. The Bidder shall also ensure that inner side shall also be galvanized.

All fasteners (nuts, bolts and washers) shall be of Stainless steel (SS304) for Module connection and other shall be of HDG for all other connection. All bolts shall be tightened with designed torque mechanically. All fasteners shall be designed for increased local wind pressure on panels as per IS: 875 (Part-3).

The Bidder/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagram and drawings.

Module mounting structures shall be so designed that it will occupy minimum space without sacrificing the output from Solar PV panels in the area.

The design and the calculations for the MMS and the foundation system shall be submitted along with calculations and bases/ standard, Bill of Materials, entire specifications, STAAD PRO/equivalent Analysis Report, Shadow analysis report showing the effect of shadow of various structures and buildings on the energy output of PV Array as per the Engineering Information Schedule for prior approval of Employer/ Engineer before the commencement of construction and shall be based on the soil Geotechnical Investigation report.

Further details related to structures and foundations have been mentioned in the chapter on civil works of these specifications.

The Structure shall be analysed and designed in accordance with finite element method and the fundamental principles of Engineering using commercially available software (such as STAAD pro or similar), with dead loads

and imposed loads considered as per IS 875 (Part 1 & 2) respectively, and with wind loads considered as per IS 875 (Part 3) Analysis shall be done as per appropriate load combinations as per IS codes.

Seismic factors for the site to be considered while making the design of the foundation/ramming etc. or any technology. The design of array structure shall be based on soil test report of the site and shall be approved from the Employer/ Consultant. Before final approval of drawing/design pile foundation for any type of structure pile load test shall be conducted and result shall be submitted to Employer.

All nuts & bolts or clamps shall be of Stainless steel for a module to structure connection, and other structural bolts shall be of minimum grade HDG 5.6. Which should suffice the design life for 25 years and Corrosive Category proposed C2 for the project and conform to Indian / international codal provisions.

Module mounting structures shall also be earthed through proper separate earthing.

Quality Control

Bidder shall submit the MQAP, FAT and FQP for the MMS for Employer's Approval during detailed Engineering.

Operation and Maintenance Requirements

Bidder shall annually carry out the following for the MMS:

- i. Labeling and identification
- ii. Thermography Inspection

Bidder shall check the following inspection during O&M:

- i. Correctly mounted and fixed or not.
- ii. Fixation bolts in place with correct torque value
- iii. Shall be perfectly sealed with no water infiltration.
- iv. Check whether all cables are properly connected or not, shall perform the pull-out test.
- v. No surface damage or corrosion
- vi. No natural or organic disturbing elements shall be present.

Documents / Drawings Required

The following drawings / details shall be furnished during detailed engineering. However, the specific design calculations shall be submitted during drawings approval.

- i. Design Basis Report
- ii. Engineering report locating the MMS as per terrain and yield assessment for various combinations.
- iii. Installation Manual
- iv. Operation and Maintenance manual.
- v. Warranty Certificate
- vi. Company Credentials with Customer Testimonials.
- vii. List of Special tools and tackles required.
- viii. Structural (MMS) General arrangement drawings (AutoCAD)
- ix. Structural Fabrication/ Parts Drawings (AutoCAD)
- x. Erection Procedure GA for MMS (AutoCAD)
- xi. BOM of MMS in Structural section wise pattern.
- xii. Detailed BOM of the Structural materials & connection details
- xiii. Post galvanization repair procedure
- xiv. Any execution procedure if required.
- xv. QA Plan for MMS
- xvi. Check list for MMS
- xvii. Block diagram
- xviii. Erection sequence drawings along with method of statement
- xix. List of recommended spare part list

- xx. Grading analysis & levelling requirement of site as per Topography along with Estimate of cut and fill quantities.
- xxi. Pull Out Test Procedure
- xxii. Post rejection procedure
- xxiii. Post head rectification procedure
- xxiv. Concrete Pile Procedure

Bidder shall provide the engineering support to locate the MMS as per site terrain & for yield assessment for various combinations.

3.4.7 33kV System Civil Works

The 33 kV design shall be based on final approval Electrical GA and Loading as applicable for the site.

All the works associated with completion and successful operation of 33kV system including associated design and preparation of all civil & structural drawings and execution of all associated civil works. The specifications are intended for general description of work, quality and workmanship. The specifications are not however exhaustive to cover minute details and the work shall be executed according to relevant latest Indian Standards Specifications. This specification covers design, preparation of general arrangement drawings, construction and fabrication drawings, supply of materials and construction of all civil, structural and architectural works. The materials specification for the switchyard items shall be same as the material specification mentioned for other buildings unless otherwise noted.

33kV System works like pole/Transmission line structures including other civil foundation works including fencing to be considered in scope of work.

All structures, Equipment supporting structures, cable trenches, Roads, Culvert, Drains, fencing with gates, gravel filling & anti-weed treatment, disposal of soil, levelling/dressing and other related works are covered in the specification. Structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads (static and dynamic), wind loads/snow loads, seismic loads and temperature loads. In addition, loads and forces developed due to differential settlement shall also be considered. Dead loads shall include the weight of structure complete with finishes, fixtures and partitions and shall be taken as per IS: 875 (Part - I). Imposed loads in different areas shall include live, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads. For consideration of imposed loads on structures, IS: 875 (Part – II) shall be followed.

Seismic forces shall be considered in line with relevant IS-1893 code provisions. It shall be made of structural steel conforming to Grade IS: 2062 and duly galvanized minimum 60 micron conforming to IS: 2629 and IS: 4759.

The analysis shall be carried out with combined model of critical configurations and latest version of structural analysis software like STAAD. All bolts for connections shall be of minimum 12mm dia. conforming to IS: 12427, minimum property class 5.6 as per IS: 1367 (Part 3). Nuts shall conform to IS 1363 (Part 3) of minimum property class 5. Foundation bolts shall conform to IS: 5624, and property class shall be 4.6 as per IS: 1367 (Part 3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point/critical sections.

IS: 802 (all parts and sections) "Code of practice for use of structural steel in overhead transmission line towers" shall be used for design of all structures in 33kV system.

Structures shall be designed for the worst combination of following loads:

- i. Dead loads (load of wires/conductors, insulators, electrical equipment and structural members)
- ii. live loads,
- iii. Wind load on bus bars, shield wires, insulator strings, electrical equipment, structural members etc. as per IS:802,
- iv. seismic loads,
- v. loads due to deviation of conductor (gantries shall be checked for + 30 deg. deviation in horizontal plane and \pm 20-degree deviation in vertical plane).

- vi. loads due to unbalanced tension in conductor/wire,
- vii. Torsional load due to unbalanced vertical and horizontal forces,
- viii. Erection loads,
- ix. Short circuit forces including snap in case of bundled conductors, etc.
 - x. The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space.
 - xi. Short circuit force and wind shall be considered to act simultaneously for the purpose of structure design.
 - xii. Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.
- xiii. The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries for both normal and short circuit condition.
- xiv. The factor of safety for the design of members for switchyard structures shall be considered as 2.0 for normal condition and 1.5 for short circuit condition. The F.O.S. for foundation shall be 10% more than factor of safety for supporting structure i.e. 2.2 for normal condition and 1.65 for short-circuit condition

All steel work used in construction structures including nuts, bolts and washers shall be galvanized as per cl. 5.5 of IS:802 (Part 1/Sec 1).

Earth pit construction shall be of brickwork covered with Minimum M20 grade concrete slabs. 33kV System shall be surrounded by barbed wire fencing.

All the works related to 33kV system shall be as per applicable codes, standards and guidelines. The completed design and detail shall be worked out based on detailed study of the project plant

3.4.8 Transformer Yard Civil Works

Transformer and equipment's foundations shall be founded on isolated spread footings depending on the final geotechnical investigation report. Transformer foundations shall have its own soak pit which would cover the area of the transformer and cooler banks and additional width of minimum 500mm on all sides for man movement, to collect any spillage of oil or oil drainage in case of emergency. The oil pit shall be filled with granite stones of 40 mm size uniformly graded. The Bidder shall be required to furnish a performance guarantee of three years for the anti-weed treatment. The transformer foundation work shall be carried out as per requirement of relevant standards and codes. The soak pit shall accommodate 1/3rd of the total transformer oil volume and shall be connected to a separate burnt oil pit through discharge pipe and shall be suitably sized.

The individual oil pits shall be connected to an oil collection pit by pipe with slope 1:100 which shall be sized to accommodate oil volume of the largest transformer connected to it(excluding free board above inlet pipe), without backflow. The oil pit shall be connected to oily water drainage system. The discharge pipe shall be designed considering rainfall intensity also. The above requirements shall be applicable based on type of transformer - Oil type transformer / Dry type transformers. Burnt oil pit shall be RCC type. The sizing and arrangement shall be as per applicable regulations and codes and standard.

The area around the transformer and equipment's shall be covered with gravel and PVC coated galvanised chain link fence of height min 1.8 m with fence posts and gates shall be provided. All fence posts shall be 50X50X6 MS angles spaced at 2.5m c/c distance and all other specification mentioned for Fencing and gate shall be followed. M.S. angle posts shall conform to IS: 2062. All structure steel shall be hot dip galvanized with galvanization coating thickness of 60 micron. In addition, a small gate, 1.2 m wide shall be provided for man entry. Transformer track rails shall conform to IS: 3443. The requirement of fire barrier wall between transformers shall be as per Electricity Rules and IS: 1646 recommendations. The transformer shall be placed minimum 500 mm above NGL and higher as applicable during detail engineering.

Burnt oil and NIFPS pits shall be RCC tank with membrane type internal water proofing. It shall have C.I manhole cover (750 x 750 mm) and rungs to enter the pit.

3.1.10. Main Control Building (RCC/PEB Building)

33kv switchgears, auxiliary transformer, distribution boards, UPS with battery, 110V DC system, PV plant SCADA monitoring & spare room, Conference room, etc shall be either of RCC or PEB. The detailed specification of RCC & PEB are mentioned in D14 & 12.8 respectively. It shall consist of Air-conditioned SCADA Room and include all other facilities like spare room, pantry, required Toilet and urinals as per statutory and Employer's requirements. It shall include conference room at one location, O&M office and Stores room at both blocks along with Toilets and Pantry facilities and furniture. It shall match as per Bhutan Architectural Requirements.

Dimension of all rooms shall be based on area covered by electrical / I&C equipment's including working space, utility and other facility and reserved space and / or required for future installation of equipment if any.

The building shall be constructed with conventional RCC framed structure with brick / solid concrete blocks partition walls. The Finished Floor Level (FGL) FFL of building shall be minimum 1.2 m above NGL. Equipment rooms shall be sized and designed as per the OEM recommendations to ensure desired life of equipment.

It shall have entry lobby and portico with roof. It shall be designed to have clear view through glass windows on all sides. Suitable access shall be provided.

Bidder shall furnish the architectural and construction drawings of the proposed building to the Employer for approval, prior to construction. The layout, design, and drawings for all RCC structure, etc. and foundation system shall be approved from Employer before start of works. The Bidder has to meet the Architectural requirements as per the Bhutanese Architectural guidelines. A Reference drawing for Bhutanese architectural and building requirements shall be provided along with the tender documents for reference.

The minimum detailed specifications of buildings shall be as described below.

- i. The building shall have conference room. Minimum size of Conference shall be 24 sq.m carpet area. Conference room shall have minimum 1- Conference table, 10 nos. revolving chairs, 43" HDMI / Wi-Fi enabled TV Screen and 1 – sufficient size cup board. It shall have sufficient power socket of 16 A and 6 A as required.
- ii. The building shall have main O&M Office having separate room for workstation and shift in charge along with attached Toilet and Pantry. Minimum carpet area of O&M office (housing workstation and Shift in charge room) shall be 18 sq.m. The minimum toilet area shall be 3.5 sq.m. It shall have minimum 1 - Cubical, 4- Workstations ,7-Nos.-revolving chairs, tables, cupboard and other facilities in shift in charge as required for O&M and Pantry. It shall have minimum 4 locks having 5 lockers.
- iii. Technicians Rooms shall be provided in MCR. The minimum carpet area shall be 16 sq.m. It shall have minimum 1 office table with 4 chairs. 2 lockers with lock and key arrangement. It shall have heavy duty slotted angle racks (minimum 2 Nos.) with minimum thickness of 10 gauge and approved make as directed by Employer. It shall have sufficient power socket of 16 A and 6 A as required. The flooring of Technician room shall be as per Employer's requirement.
- iv. The building shall have storeroom. Minimum carpet area for storeroom shall be 20 sq.m. It shall have 4 nos. of cupboard with lock and key arrangement. It shall have heavy duty slotted angle racks (minimum 10 Nos.) with minimum thickness of 10 gauge and approved make of MEK Engineering/or as approved by Employer. It shall have sufficient power socket of 16 A and 6 A as required.
- v. Outdoor Semi-covered storage yard of 100 sq.m shall also be provided in addition to the storeroom for storage of major items during operation phase.
- vi. Plinth protection 1000 mm wide and 100 mm thick shall be provided around the buildings in PCC M15 grade. Garland drain shall be provided all around the building. Building peripheral drains shall be stone/brick masonry/concrete works. These side drains shall be connected to nearest drain network.
- vii. Switchgear/Inverter rooms shall have Granolithic or cement concrete flooring with non-metallic floor hardener. SCADA room shall have Heavy duty vitrified ceramic tiles. Battery room shall have 50/75 thick acid/alkali resistance tile flooring and dado up to 2100 mm with compatible cement

- mortar. Lobby shall have Heavy duty vitrified ceramic tiles and skirting of 150 mm matching with floor tiles.
- viii. 20 mm thick Kota stone/Granite shall be provided for steps. Storeroom shall have 50 mm thick cement concrete flooring with non-metallic floor hardener.
 - ix. Flooring for Air-conditioned areas shall be provided with vitrified ceramic tiles of size 600X 600 mm of min 9 mm thickness, laid with 3 mm ground joints as per approved pattern.
 - x. The floor finish for toilet shall be vitrified ceramic anti-skid tiles and Dado glaze ceramic tiles up to 2.1m shall be used. The normal size of Ceramic tiles shall be 300 mm X 300 mm X 9 mm and shall comply with IS: 15622.
 - xi. The SCADA/Conference/O&M office room shall be provided with false ceiling of 15 mm thick mineral fibre board, in tile form of size 600mm x 600mm, along with galvanised light gauge rolled form supporting system in double web construction pre painted with steel capping, of approved shade and colour, to give grid of maximum size of 1200x600 mm as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts(if required), return air grills (if required), light fixtures, etc., all complete. The SCADA cabin shall be fitted with split type air conditioning units. However, Employer's approval shall be obtained.
 - xii. Mandatory spare room size and requirement shall be decided during detailed engineering.

Roof of the Building shall consist of Cast-in-situ RCC slab with an approved water proofing system suitable for local climatic conditions with 10 years of leak-proof guarantee. The roof of the building shall be waterproofed with approved Polymeric membrane type waterproofing and laid as per manufacturer's recommendation. The roof shall be designed for minimum superimposed load to 150 kg/m². Also, Chajja, canopy shall have water proofing as explained above. Architectural requirement of roof above the RCC slab shall be provided as per the Bhutan Building regulations. A Reference drawing for Bhutanese architectural and building requirements shall be provided along with the tender documents for reference.

- i. For efficient disposal of rainwater, the runoff gradient for the roof shall not be less than 1:100 and the roof shall be provided with projection of minimum 600mm all-round. This gradient can be provided either in structure or subsequently by water-proof screed concrete of grade M20 (using 10 mm down-graded coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface. The roof of building shall project out by at least 750 mm all around the building from its external walls with and parapet wall above the roof beam. Height of parapet wall shall be minimum 600 mm above top of roof level.
- ii. Cage ladder shall be provided to access the roof of the building.
- iii. Required number of tables, printer tables, desk, water filter, revolving chairs etc., shall be as per approved by Employer. Bidder shall provide the list of all furniture details/plan for Employer approval.

Main Control Building shall be Preferably of PEB Type, Bidder to refer Clause 12.8 for PEB Specification.

Inverter Platform (RCC/PEB building)

- i. Inverter Building shall have Inverters, 33kv switchgears, battery banks, SCADA panel, NIFPS, UPS with battery, 110V DC system, Various LT Panels, various distribution boards, Auxiliary transformers (if applicable) etc. and provided based on manufacturer recommendation, easy passage of O&M persons and cable trench layout required.
- ii. In case of Outdoor inverter (containerized solution) platform shall be Min. 1600mm from NGL. Cable bending radius and other relevant factors to be considered during platform design. This shall be reviewed during detailed engineering.

- iii. In case of RCC/PEB Building it shall be constructed as per approved Electrical GA. HVAC shall be planned as per design temperature.
- iv. RCC staircase as required shall be provided. Width of staircase shall be minimum 750 mm. This shall be further reviewed during detail engineering.
- v. The other equipment shall be housed in containerised solution based on manufacturer's recommendation.
- vi. Flooring, including preparation of surface, cleaning etc. shall be of Granolithic or cement concrete flooring as per IS: 2571 with non-metallic floor hardener with glass/PVC strips.

3.1.11. PEB Specification (Applicable Main Control Building/Inverter Building)

- i. If Bidder is going for PEB option than minimum requirement specified herewith shall be considered.
- ii. The specification covers the general requirements and the specific technical requirements for the Pre-Engineered Building works (PEB), which are not covered by any of the other technical specifications but are required to be carried out for the satisfactory completion of the work. It shall be noted that all Codes of Practice and Standards shall be those of latest issue.
- iii. The Bidder shall design the building as per latest version of IS: 800 and the technical requirements furnished by Employer. Fabrication & erection shall start only after getting approval on design & drawings from the Employer.
- iv. The Bidder shall be fully responsible for the complete structural design, fabrication, transportation to site and safe erection of the building at site, within the agreed time frame and Structural Stability Certificate for the structure for intended life period. Any approval from Employer shall not relieve the Bidder from the responsibilities for correctness of his designs and drawings.

Some of the major and mandatory requirements are as indicated below:

- a. The layout shall be designed for a life of 25 years as per requirement of Equipment and as per clearances required. The Bidder shall have to get the structural design done as per the prevailing Indian standard codes and International Standard. The structural design of shed shall be submitted to Employer for approval before actual starts of the work.
- b. The general arrangement and architectural drawing of insulated roofing & cladding system for providing general idea about work to be performed under the scope of the contract shall be submitted to Employer.
- c. The PEB shall have robust water tightness at all joints and connections. The building shall have a high-class durability and performance during the adverse weather conditions.
- d. PEB shall be complete with painting, metal facia, metal gutter, rainwater down comers, sun-shades, openings, etc., along with associated structural steel, cladding and roofing work insulation, Trims & Flashings. Each item of PEB like panels, masonry, plastering, flooring, foundation, fittings etc. shall be suitable for complete life of solar plant.
- e. The design basis and construction methodology for PEB shall also be submitted to Employer for approval before start of works.
- f. Generally straight/ uniform / tapered solid web Steel portal frame shall be provided, as per Employer's requirements.
- g. Roof slope shall be as per local site condition matching with Bhutan's architecture. Preferably roof shall not be steeper than 1:10 to horizontal. Roof shall be non-piercing type.
- h. Nylon safety net shall be provided below roof sheeting as a safety measure during the roof sheeting erection.
- i. A suitable arrangement of rainwater down takes shall be provided to collect the rainwater discharge from the roof to the ground level. The downspout shall be provided at appropriate locations.
- j. Rainwater down take pipes shall be provided up to ground level and up to nearest storm water chamber. All the necessary fittings, bends, elbows, etc. shall be provided by the Bidder. The connection of rainwater down takes to the PVC pipe provided in the nearest inspection chamber below ground shall be provided by the Bidder.

- k. The cage ladders shall be provided wherever required as per the Employer's requirement. The colour of the cage ladder and staircase structure shall match the sheeting colour and patterns.
- l. The supporting arrangement for all rolling shutters shall be provided by the Bidder. For fixing the rolling shutters, the Jamb headers shall be clamped to plinth beams below using mechanical fasteners. Thickness of supporting members of jamb headers shall not be less than 6mm.
- m. Roof shall be solid steel web portal frame with double skin insulated roofing composed of 0.5 mm TCT Plain Galvalume sheeting of minimum 550 MPA yield strength, seating above the purlin members. The sheeting shall be fixed to purlin with "Standing Seam" system. The roof shall be totally non-pierced type. The material of PEB shall be compatible as per C2 corrosion category. Also, it shall be meeting the adverse site temperature condition.
- n. Side sheeting shall be provided for the entire perimeter and full height. Insulated wall cladding, or roofing shall consist of double skin metal cladding composed of 0.5mm TCT galvalume sheeting of minimum yield strength of 550 MPa with Poly Urethane Foam (PUF). PUF must be made of continuous method PU foam and must be CFC free, self-extinguishing, fire retardant type with density 40 +/-2 kg/m³ and minimum thermal conductivity shall be as per adverse site condition of maximum and minimum temperature as defined in project information. The PUF panels shall be a factory-made item ready for installation at site.
- o. The PEB Panel shall be made of Sandwich insulated panels 80 mm or higher thickness with Poly Urethane Foam (PUF) as filler material between polyester pre-coated cold rolled steel. PUF insulated panels Metal Sheet for Roofing and side cladding consist of external sheet as troughed permanently colour coated sheet & internal sheet as plain permanently colour coated sheet.
- p. The type and locations of inner vertical bracing will be decided during detailed engineering. Bracing system shall be provided for the columns in the entire building, wherever required as per design. The access as demarcated in the general arrangement drawings shall be free of bracing. On grids having rolling shutters, portal bracings up to rolling shutter level shall be provided and above cross angle bracings may be provided.
- q. Bidder shall plan the bracing bays and shall take approval from Employer on patterns and location before going for detailed engineering.
- r. Rod / Angle / pipe / tube bracing shall be provided for the roof, wherever required as per design. The vertical bracings shall be of angle / channel / pipe / tube members only.
- v. Primary members fabricated from plates shall conform to IS: 2062 min Grade E250 Quality BR/ ASTM A572-12 Grade 50 with minimum yield strength of 345 MPa. Steel shall be semi-killed/killed. Minimum thickness of steel plates shall be 6 mm. Hot rolled primary structural members and Rod /Angle bracing shall conform to IS: 2062 Grade E250 Quality A.
- vi. A secondary member for Purlins and Girts shall conform to the specification of IS: 811 or ASTM: A1003-12 made from steel sheets conforming to ASTM: A1011- 12b Grade 50 having minimum yield strength of 345 MPa. The minimum thickness of secondary members shall be 3 mm.
- vii. Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind columns, beams, truss members, base pates.
- viii. Secondary structural framing shall include the purlins, girts, eave struts, bracing, flange bracing, base angles, clips, flashings and other miscellaneous structural parts. Suitable wind bracings sag rods to be reckoned while designing the structure.
- ix. Sealant used for cladding shall be butyl based two parts poly sulphide or equivalent approved, non-staining material and be flexible enough not to interface with fit of the sheets. Any gap between floor and wall PUF panel shall be grouted with Fosroc-GP2 or equivalent material.
- x. Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations.
- xi. Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of wall. Material shall be 26 gauge (0.455mm) thick conforming to the physical specifications of sheeting.

- xii. Gutters and down-comers shall be fabricated out of same material as that of sheeting. It shall be brought down to the ground level for smooth discharge of water.
- xiii. Steel bolts, nuts and washers complying with relevant IS codes. High Strength Bolts for Primary Connections IS: 1367 (Part III) Gr. 5.6. Bolts for Secondary Connection are: 1367 (Part III) Gr. 4.6. Anchor/foundation Bolts shall conform to IS: 5624 and relevant IS code.
- xiv. The external wall of Inverter room facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.
- xv. Door frames shall be of T-iron frame of mild steel Tee-sections. All doors shall be provided necessary fittings like hinges, handles, mortise locks, tower bolts, stopper, hydraulic door closer, etc. of CP brass complete.
- xvi. Internal doors shall be anodized aluminium provided with extruded built up standard tubular sections, appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, including necessary filling up of gaps at junctions with required PVC/neoprene felt etc. including hinges / pivots and double action hydraulic floor spring of approved brand and manufacture IS: 6315 marked, lock, handle and all necessary fittings as per the details submitted by Bidder in shop drawing and approved by Employer.
- xvii. The door entrance shall include pressed steel single leaf door. The structural steel shall conform to IS: 7452 and IS: 2062. The holdfasts shall be made from steel flats (50 mm and 5 mm thick). The fixtures, fastenings and door latches are to be made with same materials.
- xviii. Window frame shall be anodised aluminium section frame of size 92x31 mm, minimum 16 gauge (1.519mm) thick as per approved design. Tinted glass and aluminium grill shall be provided.
- xix. Ventilators shall have anodized aluminium frame of minimum size 62x25 mm and 16 gauge thick as per approved design. Ventilators/duct shall be provided with bird guard. Size of opening at wall for ducts shall be as per Inverter manufacturer and min 18-gauge (1.214mm) GI sheet ducts shall be supported with suitable means, as approved during detailed engineering. All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, tinted for preventing solar radiations. Suitable sunshades made out of approved colour sheet will be provided to all external windows and doors. The minimum projection for the sunshades will be 600 mm and 300mm wider than the width of the opening.
- xx. Rolling shutter (Hand operated) shall be fabricated from 18-gauge (1.214mm) steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS:2108 and shall be designed to withstand wind load without excessive deflection. Metal rolling shutters and rolling grills as IS: 6248.
- xxi. In case of Employer's approval, the arrangement shall be modified as per Bhutan Architectural requirement.
- xxii. The structural steel shall be either hot-dipped galvanized, conforming to IS: 4759 or relevant Indian standard or Epoxy painted. Minimum thickness of galvanization shall be 60 microns for all the structures 300 mm above ground/NGL.
- xxiii. Self-Weight of Structure including Purlins, Sheeting, Girts, Bracings, lighting fixture, fire sprinkler pipes, fire header pipe, and turbo ventilators to be considered as Dead load etc. Live loads shall be as per IS: 875.
- xxiv. Point load of 0.15 kN shall be considered at centre span of each purlin. Miscellaneous collateral load of 0.5 kN/m² on projected plan area of the building shall be considered for design of Portal beams and columns.
- xxv. The basic wind speed of the site and values of K1, K2, K3 and K4 and other pressure coefficients shall be as per IS: 875-(Part 3) latest version. It shall be as per Pd defined in specification.
- xxvi. The Seismic forces shall be considered as per IS: 1893 (latest version).
- xxvii. The limiting permissible vertical and horizontal deflection for structural steel members shall be as per IS 800 codes (latest version) where 'h' is height of building at eaves from FGL.

3.4.9 Anti-Termite Treatment

Anti-termite treatment shall be provided injecting chemical emulsion for pre-construction and creating a chemical barrier (through Bidder approved by Employer) complying to IS 6313. Using Chlorpyrifos Emulsifiable 1.0 % concentration by weight under and all-around foundation pits, wall trenches, basement excavation, top surface of plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, surrounding of pipes, water conduits or at places suggested by Engineer etc. complete (Plinth Area at ground floor only shall be measured). Performance guarantee for at-least 10 years from handing over date shall be submitted to Employer.

3.4.10 Reinforced Concrete and Allied Works

- i. All RCC works shall be design mix as per IS: 456.
- ii. All necessary test related to materials of concrete mix like cement, sand, steel, aggregates etc shall be carried out regularly as per relevant IS/Bhutan Standard. Test related to concrete like compressive strength, workability etc shall be carried out as per relevant IS Codes. Bidder shall carry out any special treatment below foundation, below RCC cable trenches, below RCC floor slab/plinth as required for strengthening sub-base of foundation base on soil characteristics.
- iii. Type of Cement for superstructure and substructure shall be (43/53 Grade) Ordinary Portland Cement, Fly-ash based Portland Pozzolana Cement or Portland Slag cement, subject to recommendations of soil report.
- iv. Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.
- v. Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.
- vi. Reinforcement steel shall be of high strength deformed TMT steel bars of grade minimum Fe-500D conforming to IS: 1786.
- vii. All RCC structural elements shall have minimum grade M20 with 20/40mm downgraded coarse aggregates. Based on Table-5 of IS456:2000, it may be suitably selected with respect to corresponding exposure condition.
- viii. Unless stated otherwise, plain cement concrete below foundations, trenches and wherever specified shall be M7.5 grade of concrete with 20mm downgraded coarse aggregates.
- ix. The Bidder shall carry out the design mix of all possible grades & cement make envisaged in the project with and without admixtures. The design mix shall be approved by Employer before start of work. Mix design shall comply to the duration from mixing to placing of concrete.
- x. In case Geotechnical investigations require any special kind of cement or higher grade of concrete, the same shall be provided. The foundation system shall be made which transfer loads safely to the soil for the module mounting structures, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. Foundation shall not be placed on back filled soil and foundation depth shall be minimum 1000mm below natural or existing ground level.
- xi. All loads shall be considered in line with IS: 875 (latest revision). A seismic load for design shall be in accordance with IS: 1893 (latest revision). and relevant Standards. IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must be complied for reinforcements. IS: 5525 (latest edition) and SP: 34 shall be followed for reinforcement detailing.
- xii. A minimum 75 mm thick PCC shall be provided below RCC wherever RCC is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS: 456.
- xiii. Clear cover to main reinforcement shall be as per the exposure condition as specified in IS: 456.

- xiv. Bidder shall provide all test documents & test certificate for material complying with requirement of structure and same shall be carried out at third party test laboratories approved by Employer. Reinforcement steel shall be tested in conformance to IS:1786. Sampling shall be done at the rate of minimum 2 Nos/Cast/Heat.
- xv. Testing for cement shall be as per approved MQP.
- xvi. Manufacturer Test Certificates (MTC) for all materials shall be provided. In addition to that, the materials shall be tested in conformance to relevant applicable standards at NABL accredited laboratories.
- xvii. Bidder shall use local material as available in Bhutan and as approved by Employer.
- xviii. Reinforcement: Reinforcement fixing shall be as per IS 2502. Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing; supporting, and fastening the reinforcement. Spacers shall be cast from concrete of the same quality as that in which they will be embedded. Concrete block spacers shall be cast in metal moulds with an approved means of separating blocks and of ensuring that the blocks are of the proper size. Coated binding wire shall be incorporated into the blocks to enable them to be securely attached to vertical or horizontal bars and the Bidder shall demonstrate both that the blocks are of the requisite strength and that the means of attachment to the reinforcement are adequate.
- xix. Formwork: Formwork shall be designed and constructed so as to remain sufficiently rigid during placing and compaction of concrete and shall be such as to prevent loss of cement slurry. The face of formwork in contact with concrete shall be cleaned and treated with form release agent. Striping out formwork shall be as per IS:456 standards. Formwork shall be in good condition to have good surface of concrete. Approved quality make and same grade of Concrete spacer block shall be provided as a cover in concrete structure.
- xx. Waterproof Ply shuttering of adequate thickness shall be used for above ground & underground water tank work with heavy-duty supporting system as approved by Employer.

Concrete placement:

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5 m height in a single pour in walls, columns, and similar members.

The Bidder shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

Compaction and mechanical vibration of concrete: As concrete is being placed it shall be compacted by mechanical vibrators complying with IS:2505, IS:2506, IS:2514 & IS:4656, to obtain a dense material free from honeycombing from water and air holes. The Bidder shall ensure that the vibrators are used in such manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

Finish of concrete: The concrete face shall have the finishes indicated on the drawings or in the present specification. The finished surface of the concrete shall be sound, solid and free from honeycombing, protuberances, air holes or exposed aggregate or exposed reinforcement. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces.

3.4.11 Curing

Concrete shall be protected from loss of moisture for not less than 7 days after the concrete is placed. Trowelled surfaces, except those that receive a separate finish or coating, shall be cured with a membrane curing compound. Float finished surfaces, except those that receive a separate finish, may be cured with either a membrane curing compound or with water. Only water curing shall be used if the surface receives a separate finish.

Water curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. Water curing shall begin within 12 hours in dry weather and within 24 hours in damp weather. The rate of water

application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water may be interrupted for surface rubbing. The concrete surface shall not be permitted to dry. After the rubbing has been completed, rubbed surfaces shall be covered with burlap and kept saturated for the remainder of the curing period. Ponding method of curing to be adopted for slabs and floors

Membrane curing:

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface or as soon as possible after finishing without causing damage to the surface. Membrane curing compound shall be spray applied at a coverage of not more than 7.4 square meters per litre. Membrane curing shall not be used on surfaces that shall be covered at a later date with mortar, concrete, damp—proofing, tile, or any coating. Membrane curing shall not be used on cast-in-place concrete bases for field erected tanks.

3.4.12 Masonry Work

- i. All brick works shall be done using at least class designation 3.5 of approved quality as per IS: 1077, IS: 2212 and IS: 3495. All concrete blocks shall be of minimum compressive strength of 3.5 N/mm² and shall be of Grade-A as per IS: 2185. All stone masonry work shall be ashlar masonry work with stone of minimum compressive strength of 3.5 N/mm². The stone masonry work shall be in line with IS: 1597, IS: 1122 and IS: 1126.
- ii. The cement mortar for all kind of masonry work shall be in the ratio 1 cement: 4 sands by weight.
- iii. Bricks/blocks required for masonry work shall be thoroughly soaked in clean water tank for approximately two hours. Brick shall be laid in English bond style. Green masonry work shall be protected from rain. All masonry work shall be kept moist on all the faces for a period of seven days.
- iv. The external wall for the building shall be 230mm thick brick walls or 200mm thick concrete block walls and internal wall 230 & only toilet partition wall shall be 115mm brick walls or 200/100mm thick concrete walls as per requirements. The external wall of control room facing the transformer area shall be minimum 350mm or as per IS: 1646 (latest edition) - Code of practice for fire safety of buildings (general): electrical installations.
- v. Walls of 115/100 thick shall be constructed with CM 1:4 with horizontal RC band at every 1m interval in vertical direction. RC band shall be with M15 grade concrete with 4-8mm bars and 8mm stirrups at 200c/c.
- vi. Suitable damp-proof course shall be provided of M15 using 6 mm down stone chips with a water proofing admixture. The thickness of damp-proof course shall be minimum 40 mm.

3.4.13 Plastering

- i. All external surfaces shall have 18 mm sand faced water-proof cement plaster in two coats along with adding waterproofing admixture (dosage as per manufacturer's recommendation), under layer 12 mm thick cement plaster 1:5 and finished with a top layer 6 mm thick cement plaster 1:6.
- ii. White cement primer shall be used as per manufacturer's recommendation. At least one coat of plaster shall be applied to interior walls by hand or mechanically, to a total thickness of 12 mm with cement to sand ratio of 1:6.
- iii. Plastering shall comply to IS: 1542, IS: 1661, IS: 1630. Oil bound washable distemper on smooth surface applied with minimum 2 mm thick putty for control room.
- iv. Putty conforming to IS: 2402 and IS: 1661 shall be used for punning. Underside of concrete floor shall have 6mm thick plaster in cement mortar 1:3.
- v. To avoid cracks all concrete/masonry joints shall be fixed with 24-gauge chicken wire mesh before plastering.

3.4.14 Windows, Doors, Ventilators and Rolling Shutters

- i. Doors and windows on external walls of the buildings shall be provided with RCC sunshade over the openings with 300 mm projection on both sides of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings except for main entrance door to the control room where the projection shall be 1500mm.
- ii. Aluminium framed doors, Windows and ventilators shall conform to IS: 1081 with necessary glass panels including of all fixtures and painting etc. complete on the external faces. All internal doors and windows shall be made of heavy-duty aluminium sections. All sections shall be 20 microns anodized. Sections of doorframe and window frame shall be adopted as per industrial standards and approved by Employer. Door shutters shall be made of aluminium sections and combination of compact sheet and clear float/ wired glass as per the requirement of Employer. Fire doors shall be provided wherever necessary as per the statutory requirements.
- iii. Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However, for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20 m. All doors of toilet areas shall be PVC.
- iv. All accessible ventilators and windows shall be provided with min. 6mm thick float glass, tinted for preventing solar radiations, unless otherwise specified. For single glazed aluminium partitions and doors, toughened float glass of 10 mm thickness shall be used. All glazing work shall conform to IS: 1083 and IS: 3548. The glass to be used shall be from approved brand / manufacturer and as approved by Employer. The glass should be free from distortion and thermal stress.

3.4.15 Painting & Finishing

- i. The paint shall be anti-fungal quality of approved brand suitable for masonry. All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush, then same shall be finished off with roller. For painting on concrete, masonry and plastered surface, IS: 2395 shall be followed. Minimum 2 finishing coats of paint shall be applied over a coat of approved and compatible primer.
- ii. The following minimum painting specifications shall be followed unless noted otherwise by the Employer.

SCADA room/O&M Office/Conference Room	Acrylic Emulsion
All other rooms in plant	Oil bound distemper
External faces of walls	Exterior emulsion paint
Walls of battery room	Chlorinated rubber paint on exposed walls above Dado. 2100 mm high Dado of Acid / Alkali Resistant tiling.
All Ceiling	Oil bound distemper (office rooms without false ceiling), Acid resistant resin-based Epoxy coating (Battery rooms), and Whitewashing (all other areas)

- iii. All metal surfaces and support structures shall be thoroughly cleaned of rust, scale, oil, grease, dirt etc. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking the finishing coat.
- iv. The type of surface preparation, type of primer, intermediate and finishing paint shall be according to the codes and standard.
- v. A standard colour scheme for the different buildings/structures shall be prepared by the Bidder and the approval of the Employer shall be obtained, before commencement of work.
- vi. For painting of steel doors, ventilators IS 2338, IS 1477 (Part I & II) shall be followed.

3.4.16 Structural Steel

All structural steel design shall be carried out as per IS 800. Structural steel shall conform to IS 2062, Pipe shall be as per medium/high grade of IS 1161, Chequered plates shall conform to 3502 and Hollow steel sections for structural use shall conform to IS: 4923. For all Hot dip Galvanised Structures, Galvanization shall be measure with elcometer or the material can be sent for laboratory testing as and when required. No averaging is allowed for measuring the thickness of galvanization. Inner side galvanization with same specification of any hollow components of module mounting structure is mandatory

Structural Steel/Steel Sheet Painting: All non-hot dip galvanized structural steel (excluding Module Mounting & SCB structure)/Outdoor metal containers/ Enclosure/ Rolling shutter items shall be provided with paint designed for a minimum maintenance-free life of fifteen (15) years (high durability) as per ISO 12944 and IS 800 or equivalent for its corrosion category. For finishing coat suitable color pigment shall be added. All paints including primer shall be of the reputed brand/manufacturer and as approved by the Employer. The method of application shall be as per the recommendations of the manufacturer. Corrosive category and requirement shall be as specified in Project information Section of this Tender.

3.4.17 Grouting

Non-shrink flow-able grout shall be used for grouting work below base plate of columns and equipment base frames. The minimum thickness of grout shall be 25 mm. non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than the base concrete and minimum grade shall be of M30.

3.4.18 Plumbing and Sanitation

- i. UPVC/CPVC pipes of Grade I PVC 1120 conforming to ASTM D-1785 and fittings conforming to ASTM D-2466/2467, of approved make and brand shall be used for water supply. PVC pipes (Minimum Pressure 6 kg/cm²) conforming to IS 13592 and fittings conforming to IS 14735, of approved make and brand shall be used for sanitation. The make and brand shall be approved by Employer.
- ii. Toilet shall be designed as per number of occupancies as directed by Employer for minimum persons or as directed by Employer; and constructed with following finish
 - a. Door: PVC Door
 - b. Ventilators: Mechanical exhaust facility
 - c. Plumbing fixtures: Approved make
 - d. Sanitary ware: Approved make
 - e. EWC: 390 mm high with health facet, toilet paper roll holder and all fittings
 - f. Urinal (430 x 260 x 350 mm size) with all fittings.
 - g. Wash basin (550 x 400 mm) with all fittings.
 - h. Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
 - i. CP brass towel rail (600 x 20 mm) with C.P. brass brackets
 - j. Soap holder and liquid soap dispenser.
 - k. GI pipes (B class) or UPVC/CPVC of approved makes
 - l. Overhead water tank equivalent of 1,500 litre capacity with required pumping facility
- iii. Gully trap, inspection chambers, septic tank and soak pit shall be provided for designed occupancy.
- iv. Water supply for internal piping shall be concealed and external buried piping shall be provided with sand cushion.

3.4.19 Water Supply

- i. Suitable arrangement of water shall be ensured to cater the day-to-day requirement of drinking water and cleaning needs of Solar Photovoltaic panels during entire O&M period.

- ii. For operation people, potable water storage tank (six layer) either Sintex or equivalent conforming to IS: 12701 shall be provided over the roof of the control room. The capacity of the tank shall 1500 litres, complete with all fittings including float valve, stop cock etc.
- iii. The Bidder shall estimate the water requirements for cleaning the photovoltaic modules at-least once in every week in order to operate the plant at its guaranteed plant performance.
- iv. All necessary arrangement for wet cleaning of the solar panels shall be in the scope of the Bidder and accordingly the Bidder must provide all the necessary equipment, accessories, tool & tackles, pumps, tankers, tractors and piping arrangement which are required for the same based on module cleaning specification section A-7.

3.4.20 Roads

- i. All roads shall be WBM to carry safe and easy transportation of equipment and material at the project site shall be made. The road shall provide easy and fast approach to each facility of the plant. These roads are to be designed optimally to carry the crane load with all necessary chambers, gradients, super-elevation, and radius of curvatures for the easy movement of cranes, trucks and public transport as per Urban Road Standards 2002. The thickness of a single compacted (WBM) layer shall not be less than 75 mm.
- ii. Internal road work shall be done prior to construction commencement to ensure proper access for construction and transportation of equipment/materials to the work locations.
- iii. Road works from main road to inverter Station, PV Plant & SCADA Building, and any other approach as required shall be in scope of Bidder. These roads shall be WBM road as per codes. Internal roads shall connect to all inverter stations, ensuring easy and approachable to various facilities, gates, & module cleaning stations, etc. The methodology of road design and construction with material specifications shall be in line with Pavement Design Manual and shall be submitted for approval before start of works.
- iv. All Roads are to be constructed with sufficient carriage width of minimum 3.5 m width for access Internal and approach road. Shoulders of 0.75m wide on both side of road. The final finished roads shall have a camber of 1 in 50. The camber slope shall be 2.5% for bituminous roads and 4% for gravel & earth surfaces.
- v. The minimum road section shall be as per local codes and regulation. The thickness of road section shall withstand the traffic loads for the entire life of plant. The road section shall be designed by Bidder based on the design parameters specified by the Employer after award of work. The curve radius, widening, Vertical alignment shall be as per Urban Road standard 2002 for design speed of 20-30km/hr.
- vi. Locally available good, borrowed soil, minimum 125 mm thick shall be provided for shoulder. The minimum thickness of subgrade (Borrowed earth) shall be 150 mm compacted thickness on a well compacted ground (minimum 95 % proctor density), 200 mm compacted thickness of GSB layer and followed by minimum 150 mm compacted thickness of WBM shall be provided. The finishing coat over WBM shall be 20 mm with quarry dust. The WBM road shall be done after major construction works completed as directed by Employer. However, Bidder to design the road as per CBR and provide minimum layer thickness as mentioned above in case lower thickness required. In no case the thickness shall be less than specified in table 8.1 of Urban Road Standards, 2002 and thickness of Premix carpet shall be minimum 25mm. The allowable tolerances shall be within the values mentioned as per Cl. 13.4 in standard.
- vii. Sub-grade under road and its shoulders shall be compacted to achieve 95% or more of standard proctor's MDD. CBR value of the sub grade level shall be minimum 4%. If actual CBR is less than 4% in a particular stretch, then the same material shall be modified with increase in GSB thickness.
- viii. NP-3 Hume pipe/Culvert shall be provided across the road as required for drainage, electrical requirement, trenching works with sufficient soil cover in case of hume pipe to avoid damage. At road crossing hume pipe shall have RCC encasement all round.

- ix. River stream if found to be passing through allotted land parcel, The design parameters of the bridges shall be as per General Specification for Bridges, DoR-SB001:2015 or with Hume pipes to carry the design traffic loads. The design & drawing of the same has to be submitted for approval prior to the commencement of execution.
- x. The GSB & Sub grade shall be laid & compacted as per 21.7.2 and aggregate physical requirements shall be as per table 21.5, 21.6 & 21.7 of SBRW 2012. The laying of wearing course shall be in line with Cl 21.7.4.

Borrow Earth Material

- i. Earth material used for filling shall be selected earth material as per technical specification and approved by the Engineer irrespective to lead and lift from working site and free from organic and other objectionable matter. All clods of earth shall be broken or removed.
- ii. Expansive soil shall not be used.
- iii. Soil having plasticity index less than 20 and maximum proctor laboratory dry density more than 1.5 gm/cc shall only be used. Adequate dewatering facilities like dewatering pumps, pipes etc. shall be arranged by the Bidder for this work including for excavation in borrow areas at his own cost.
- iv. The materials used for filling up of the site and for road embankment formations shall be well graded soil or any other material approved by the Engineer-In-Charge. The fill material shall have a maximum laboratory dry density of not less than 1.5 gm/cc when tested as per IS: 2720 (Part 8). The maximum particle size of coarse material in the mixture of fill shall not be more than two-thirds of the compacted layer thickness.
- v. The following types of materials shall be considered unsuitable for fill:
 - a. Materials from swamps, marshes and bogs.
 - b. Materials susceptible to spontaneous combustion.
 - c. Materials in a frozen condition.
 - d. Clay having liquid limit exceeding 70 and plasticity index exceeding 20.
 - e. Expansive clay with free swell index exceeding 50% when tested as per IS:2720
- vi. The Bidder shall give the samples of the earth proposed to be used for filling with the following characteristics of the material to the Engineer for approval prior to collection and use along with the laboratory test results. The filled-up soil shall be uniform in its composition and engineering properties for all layers of filling.
 - a. Grain size distribution as per IS: 2720 Part 4
 - b. Liquid Limit and Plastic Limit as per IS: 2720 Part 5
 - c. Moisture – Density relationship as per IS: 2720 Part 8

Compaction

- i. The Compaction shall be done as per 8.4.5 of Pavement Design Manual. In case of any disagreement between the below mentioned parameters & Pavement Design Manual, the stringent condition of the above shall prevail.
- ii. The fill shall be constructed in layers, each layer being compacted to the required density before the next layer is laid. The compacted thickness shall be 250mm or less for each layer.
- iii. Compaction shall be carried out using steel wheeled or rubber tyred rollers as appropriate. The Bidder shall determine the number of passes of the roller required as appropriate. The Bidder shall determine the number of passes of the roller required to achieve the required density by first conducting trials over a test stretch. Vibrating roller shall be used if it allows faster compaction. The number of passes shall be reviewed and adjusted in consultation with the Consultant/Employer, as required during the course of the work.
- iv. All lumps and clods in the fill material shall be broken before rolling. The top surface of each layer shall be roughened before placing the subsequent layer to ensure proper keying in between layers.

- v. Prior to rolling, the moisture content of the material shall be brought to within $\pm 2\%$ of the optimum moisture content as obtained from the tests by addition or removal of water, accompanied by thorough mixing to ensure a uniform moisture content. Each layer shall be compacted to at least 95%, subgrade and embankments, of the maximum dry density as obtained from the modified Proctor Test.
- vi. Each layer shall be tested to ensure that the specified density has been achieved. At least two tests shall be carried out for every 3000sq.m of graded area of every layer. If the testing indicates that any part of the fill does not meet the requirements, that part shall be reworked by the Bidder at his own cost till the specified density is achieved.
- vii. The Bidder shall submit daily laboratory and observations report as per IS 2720 Part XVIII. This shall provide details of location of sample, time of collection, time it was placed in oven, the moisture content and density test results.

Safety sign

Safety signs and boards shall be in fluorescent Acrylic Night glow standing sign board, stick on the door, framed on walls, and hang on false ceiling with Solid 8mm GI rod and Clamps including foundation. Bidder shall submit relevant drawings to Employer for approval. For transformer yard, the sign board shall be made of Aluminium composite sheet. Letters on the board shall be proper illumination arrangement. All sign boards at open area and on road shall be placed on 400 X 400 mm and 600mm deep RCC foundations. Vertical posts shall be 65NB circular GI pipe, painting with epoxy paint with black and white Strip of 300mm with required Dry film thickness. Post shall be in two pieces. Short arm embedded in concrete pedestals and long armed above the ground shall be connected with short arm by bolt and nut connection Each room shall be provided identification name plate of 2mm thick stainless steel with black letter engraving on it. Shock treatment chart shall be printed in at least three languages i.e., Hindi, English and local language. The chart shall be fitted in wooden frame with glass on front side and hard board at back side. The chart shall be displayed in all electrical equipment room. Big size SLD of Plant, auxiliary system and earthing layout shall be printed in English and shall be framed and displayed at strategic locations for each of the sites as suggested / asked by Employer.

3.4.21 Chain Linked Fencing & Main Gate

- i. The objective to provide a fence is to demarcate the boundary and to keep away the unauthorized access to plant. The Bidder shall provide GI Chain Linked Barbed fencing all around the periphery of the plant along the property line or as directed by the Employer. The fence height shall be minimum 2.4 meter from the FGL or as specified in local by-laws whichever is stringent. The fence shall be provided with a rugged main entry gate. The construction of fence and the main entry gate shall conform to the relevant IS standards and practice.
- ii. All fence posts shall be 50X50X6 MS angles spaced at 3 m c/c distance. All corner fence posts will have two stay posts in orthogonal directions and every tenth post will have a stay post in the direction of the fence. All stay posts shall be 40X40X4 MS angles. Maximum spacing of stay posts shall be 30 m. Concrete foundations for the angle iron posts and stays shall be provided. Angle post shall be inserted within the concrete. All MS angles and members used in posts shall also be galvanized in line with relevant codal provisions. Suitable foundation/fencing arrangement shall be made in the fencing scheme to ensure intact fencing/safety in the water body/drains entry and exit points in the plot area. The same may be provided with a grid of MS angles of 50X50X6 sizes with foundation.
- iii. The main gate shall be either "Swing" type or "Sliding" type with guide track, castor wheel, all fitting and fixture like hinges, aldrops, locking arrangement, posts etc. The width (Min. 5m wide) of approach road shall cover the gate width at the main entrance with suitable transition. The numbers of gates shall be provided and its location shall be approved by Employer. All members used in gates shall be finished by cleaning of steel surfaces as per IS: 1477 (Part-II) and applying zinc chrome or zinc phosphate primer, followed by two coats of synthetic enamel paint. For finishing coat suitable colour pigment shall be added. All paints including primer shall be of approved brand / manufacturer and as approved by the Engineer-In-charge. The method of application shall be as per the recommendations of the manufacturer. One man movement passage gate (minimum 1.2m width) shall also be provided in one

- of the main gate.
- iv. Culverts and gratings shall be provided as per site conditions for proper drainage.
- v. Suitable foundation/boundary wall arrangement on culverts shall be made to ensure boundary wall safety in the water body/drains entry and exit points in the plot area.
- vi. All the drawings/ specifications for the peripheral wall and main entry gate design/ planning shall be submitted to Employer for approval prior to construction for their accord.

3.4.22 Storm Water Drainage

- i. The storm water drainage (Trapezoidal section with RR PITCHING / Excavated drain / Pipe Culvert Network) shall be planned as per outcome of area drainage study. It is recommended that the drainage for the plant shall be designed keeping the natural flow of water to the nearest exit point.
- ii. Storm water drainage network consists of Hume pipe (Class NP3)/culvert across internal road and also across peripheral road at outfall location to discharge storm water.
- iii. Invert level of the Hume pipe/ culvert should be existing ground level at that location.
- iv. Laying of Hume pipe (NP3) should be in line with IS.783.
- v. Stone pitching thickness 230 mm shall be provided on both upstream and downstream of pipe culvert to protect the culvert from scouring.
- vi. At outfall location, maximum water level in the pipe culvert should be higher than water level in connecting drain (outside plant boundary).
- vii. Pipe culvert shall be designed considering "maximum hourly rainfall intensity" at the site considering 25 years of return period as per recommendation of IMD. Also based on hydrology study report and IMD data worst condition shall be taken for design of drainage system. At no time for entire service life of 25 years, water stagnation shall happen, and care shall be taken to maintain slope and prevention of waterlogging. The surface run off coefficient shall be considered as per site soil condition as per hydrology findings. In the absence of that, run off coefficient shall be considered as 0.6 for the design of drainage system. The velocity within the pipe culvert shall not be less than self-cleansing and not more than erosion limit of lining material. The drainage scheme shall be designed considering the Employer's plot area and nearby catchment area contributing to the plot drainage.
- viii. The complete drainage scheme, type & design of pipe culverts shall be submitted to Employer for review and approval before start of drainage work at site.
- ix. The minimum & maximum flow velocity in pipe culvert shall be 0.6 m/sec and 2.40 m/sec respectively.
- x. Bidder shall also ensure that drainage from the plot does not encroach/flood into the adjacent property and adjacent solar plots.
- xi. All above parameters may be suitably adjusted based on inputs being made available by Bidder for reference purpose. Also, any specific reference mentioned for Drain design in any IS Code or IRC Code would also be acceptable subject to approval of overall design during detailed Engineering stage. All project drains would connect to the main drains as per detailed layout to be prepared during detailed Engg. stage.

3.4.23 Security Cabin

The Minimum size of watchmen's (duty Cabin) cabin is 1.5 m x 1.5 m size and height of 2.4m with appropriate roof at the top. Location of the duty Cabin will be as directed by the Employer or his representative.

The Prefabricated/RCC Security Cabin of size 3 m x 3.6 m at the main entrance gate shall be designed and constructed by the Bidder keeping in view the safety and security of the power plant. Security cabin shall have attached toilet facility of 1.5m x 1.2m and plumbing with proper sewage disposal shall be provided.

Material spec, drawing and design shall be provided for approval.

3.1.12. Cable Trenches and Civil Works for Module Cleaning System

- i. Trenches shall be constructed in reinforced cement concrete of minimum M-25 grade with minimum wall thickness of 125 mm. The top of outdoor trenches shall be kept at least 150 mm above the grade level so that rainwater does not enter the trench. Trench walls shall not foul with the foundations.

- ii. Outdoor Cable Trenches: RCC cable trenches with pre-cast RCC removable covers and lifting arrangement, edge protected with suitable galvanized angle iron designed to withstand self-weight of top slab + concentrated load of 150 kg at centre of span on each panel. The trench shall be designed for surcharge of 10kN/Sq. m unless noted.
- iii. Indoor Cable Trenches: RCC indoor cable trenches shall be provided with 50X50X6 mm angles grouted on the top edge of the trench wall for holding minimum 6 or 8 mm thick mild steel chequered plate covers (600 mm in length except at ends & bends) with lifting arrangement. Angle or channels shall also be grouted at distances of 600 mm across the indoor cable trenches to support the chequered plates.
- iv. Trench Drainage: The trench bed shall have a slope of minimum 1/500 along the length & 1/250 along the width. Suitable drain sump at lowest point of the trench shall be provided for pumping out the water.
- v. Vehicle load on precast slab to be considered if applicable.
- vi. All the civil and structural works required for module cleaning system shall be included in Bidder's scope of work.

3.4.24 FRP Water Tank

- i. Capacity of water tank shall be decided based of the module cleaning system requirement. FRP tank shall be designed as per BS 4994: latest edition with proper UV stabilizer to have minimum 25 years of service life in extreme weather conditions (Above ground and directly exposed to sunlight throughout its service life).
- ii. Accessories are also included in this scope of work i.e. lugs, edge angle, level indicator, cage ladder, railing with gate etc. for successful installation and operation of FRP tank for entire project duration.

3.4.25 Quality Control

- i. Bidder shall establish fully equipped quality control laboratory at site to conduct all acceptance test on all construction materials, concrete cube test, compaction of soil testing. This shall be housed with covered buildings. All testing equipment like Owen, Electric operated cube testing equipment, sieves for grading of sand and aggregates, flakiness and elongation index testing sieve, density of aggregates, abrasion testing equipment, impact testing equipment, bitumen testing equipment like thermometer, Marshall test apparatus. Other apparatus like cube moulds, sump cones. Vicat apparatus, moisture meter, dry film thickness gauge meter.
- ii. Bidder shall arrange for design mix of concrete for each grade of concrete from Employer approved laboratory or as per Bhutan Standard for testing and calibration laboratories.
- iii. Bidder shall arrange for gradation mix for road works, granular subbase, Wet mix macadam, Water Bound macadam, dense bitumen macadam, bituminous coarse etc.
- iv. All testing equipment's shall be periodically calibrated to the satisfaction of Employer and as per manufacturer manual and instruction.
- v. Bidder shall submit & get approval from Employer for field quality plan for all construction material & all civil activity (concrete, excavation, backfilling, masonry, plaster, Road work etc) as per relevant IS Code.

3.4.26 Inspection and Testing

- i. The Employer shall always have free access to those parts of the manufacturer's works which are concerned with fabrication of the steel work and shall afford all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of this specification.
- ii. Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch. Tolerance for fabricated structures shall be as per IS:7215.
- iii. Bidder to note that if any structure or part of a structure be found not to comply with any of the provisions of this specification, it shall be liable to rejection. No structure or part of the structure once rejected shall be resubmitted for test, except in cases where the Employer considers the defect as

- rectifiable.
- iv. Defects which may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the Employer.
 - v. All gauges and templates necessary to satisfy the Employer shall be supplied by the manufacturer.
 - vi. The Employer may, at his discretion, check the test results obtained at the manufacturer's works by independent tests at the Government Test House or elsewhere, the costs of such tests shall be borne by the Bidder.
 - vii. Before dispatch from fabrication shop, prototype of each structure shall be shop assembled and checked for fabrication tolerance. Also, if ordered, by the Employer, the same shall be presented for inspection.

3.4.27 Drawings & Documents

- i. The Bidder shall submit his detailed schedule for submission of all information, documentation, calculations, drawings, schedules etc within such periods or dates, which are required to guarantee a smooth handling of the project without delays.
- ii. After award of contract, the Bidder shall submit the designs, layout and construction drawings and detailed working drawings including fabrication drawings and bar bending schedules for all structures and items covered under the scope of this contract. The quality of the submitted documents must be in accordance with acceptable national practice and allow a speedy checking procedure.
- iii. The design drawings shall consist of general arrangement drawings showing location of tower and various equipment foundation along with cable trenches and all other related items / services required for the project. Subsequently detailed drawings along with design calculation shall be submitted by the Bidder for approval. Subsequent to approval of GA drawings, fabrication drawings for steel structures and Bar Bending Schedule for RCC structures shall be submitted before commencement of construction.
- iv. Detailed dimension drawings and design calculation for all civil and structural works shall be submitted to the Employer for scrutiny and approval. No construction shall commence prior to obtaining of written approval from the Employer. Any approval given by the Employer to the designs & drawings shall not relieve the Bidder of his responsibilities for the correctness of the same and for execution of the work in accordance with the terms of the specifications. Detailed drawings approved by the Employer shall supersede the general drawings when they differ from them.
- v. The drawings bearing the Employer's approval or drawings corrected in accordance with the comments of the Employer shall be deemed to be contract drawings and no variation there from shall be taken without the Employers written consent.
- vi. The successful Bidder shall submit documents in line with the scope of work for Civil Works including design basis and detail engineering drawings and as built drawings.
- vii. Unless otherwise stated, the Bidder shall be responsible for all necessary lists such as indents, rivet and bolt lists, material lists, Dispatch lists and lists for all bought out items.
- viii. Fabrication work shall not be taken in hand until the relevant shop drawings have been approved by the Employer. The Bidder shall consider any revisions in drawings furnished by the Employer at no extra cost.

3.4.28 Codes & Standards

Following codes and standards shall be applicable for complete plant as applicable the latest codes shall be used. Bhutanese standards / BS / American & other equivalent standards may also be used. In case of any conflict, Employer's decision/approval will be final.

General

IS: 875-I	Code of Practice for Design Dead Loads for Building and Structures
IS: 875-II	Code of Practice for Design Imposed Loads for Building and Structures

IS: 875- III	Code of practice for design loads (other than earthquake) for Buildings and structures
IS:1893	Criteria for earthquake resistant design of structures.
IS: 4326	Earthquake resistant design and construction of buildings

Foundations

IS: 1080	Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
IS: 1904	Code of practice for design and construction of foundations on soils general requirements
IS: 2911	Design & Construction of Pile Foundation – Code of Practice
IS: 2950	Code of practice for design and construction of raft Foundations
IS: 6403	Code of Practice for determination of bearing capacity of shallow foundations
IS: 8009	Code of Practice for foundation settlement calculations

Concrete Structures

IS: 456	Code of practice for plain and Reinforced concrete
IS: 3370	Code of practice for concrete structures for the storage of Liquids
IS: 3414	Code of Practice for design and installation of joints in Buildings
IS: 5525	Recommendation for detailing of reinforced concrete works
IS: 6313	Code of practice for anti-termite measures in buildings
IS: 1786	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement – Specification
IS: 1893-IV	Criteria for earthquake Resistant design of structure

Steel Structures

IS: 800	Code of practice for use of structural steel in general building Construction
IS: 801	Code of practice for use of cold-formed light gauge steel structure members
IS: 802	Code of Practice for use of Structural Steel in over Head Transmission Line Towers
IS: 806	Code of practice for use of steel tubes in general building Construction
IS: 808	Dimensions for hot rolled steel beam, column channel and angle section
IS: 811	Specification for Cold Formed Light Gauge Structural Steel Sections
IS : 812	Glossary of Terms relating to welding and cutting of metals
IS: 813	Scheme of symbols for welding
IS: 1079	Hot Rolled carbon Steel Sheet and Strip – Specification

IS 1161	Steel tubes for structural purpose
IS: 2062	Hot Rolled Medium and High Tensile Structural Steel - Specification
IS: 2721	Galvanized steel chain link fence fabric - Specification
IS: 4923	Hollow steel sections for structural use
IS: 1905	Code of Practice for structural use of un-reinforced masonry
IS: 3067	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
SP: 6	Handbook for structural engineers (all parts)
SP: 34	Handbook of concrete reinforcement & detailing
IRC:19	Standards Specifications and Code of Practice for Water Bound Macadam
IRC: SP – 72	Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads
IRC: SP – 20	Rural Roads Manual
IRC: SP – 50	Guidelines on Urban Drainage
IS: 1786	High strength deformed steel bars and wires for concrete reinforcement specification
IS: 4000	High strength bolt in Steel Structures-Code of practice
IS: 4736	Specification for Hot-dip zinc coating on mild steel tubes
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
IS 6623	High Strength Structural Nuts
ISO 9223	Corrosion of metals and alloys -- Corrosivity of atmospheres -- Classification, determination and estimation
ISO 9224	Corrosion of metals and alloys -- Corrosivity of atmospheres -- Guiding values for the corrosivity categories

Painting and Coating

IS:1868	Anodic coatings on aluminium and its alloys
IS 2395- I	Painting of Concrete, Masonry and Plaster Surfaces – Code of Operations and Workmanship
IS 2395-II	Code of practice for painting concrete, masonry and plaster surfaces: Schedule
IS 1477-I	Code of Practice for Painting of Ferrous Metals in Buildings: Pre-treatment
IS:1477-II	Code of practice for painting of ferrous metals in buildings: Painting
IS: 4736	Hot-dip zinc coatings on mild steel tubes
IS: 4759	Hot-dip zinc coatings on structural steel and other allied products – Specification

Water Supply and Sanitary

IS: 1172	Code of basic requirements for water supply, drainage and Sanitation
IS: 1239	Mild steel tubes and tubulars and other wrought steel fittings

IS: 1742	Code of Practice for building drainage
IS: 2470	Code of Practice for installation of septic tanks
IS: 4985	Un-plasticized PVC pipes for potable water supplies
IS:10124	Fabricated PVC fittings for potable water supplies

Others

IS:269	Ordinary and low heat Portland cement
IS:4032	Method of chemical analysis of hydraulic cement.
IS:6452	High alumina cement for structural use
IS:8041	Rapid hardening Portland cement
IS:8112	High strength ordinary Portland cement
IS:12330	Sulphate resisting Portland cement
IS:455	Blast furnace slag cement
IS:383	Coarse and fine aggregates from natural sources for concrete
IS:2386	Methods of test for aggregates for concrete
IS:2430	Methods of sampling of aggregates for concrete
IS:460	Test sieves
IS:516	Methods of test for strength of concrete
IS:1199	Methods of sampling and analysis of concrete
IRC37	Guidelines for design of flexible pavements.
IRC - 19	Standard specification and code of practice for Water Bound Macadam.
IRC 73-1980	Geometric design standards for Rural (Non-Urban) Highways.
IRC – 109	Guidelines for Wet Mix Macadam
IS : 458	Specification for Concrete Pipes.
IS : 783	Code of Practice for Laying of Concrete Pipes.
IS : 2720	Methods of Test of Soil (All parts).
Morth Spec	Morth Specification for Roads and Bridge works
AS 1214	Hot dip galvanized coatings on threaded fasteners
AS 1627.1	Preparation and pre-treatment of surfaces - Removal of oil, grease and related contamination
AS 1627.4	Preparation and pre-treatment of surfaces - Abrasive blast cleaning of steel
AS 1627.5	Preparation and pre-treatment of surfaces - Pickling
AS 2309	Durability of galvanized and electrogalvanized zinc coatings for the protection of steel in structural applications – Atmospheric

AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion using protective coatings
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.
CIVIL-SBRW-2012	Specification for Building and Road Sections
	Royal Government of Bhutan-Ministry of Works & Human Settlement Department of Roads Thimphu Pavement Design Manual
DoR-SB001:2015	General Specification for Bridges

4 Key Personal Requirement

Sl.No	Position	Minimum Qualification	Total Requirement (Nos)	Experience in Similar Works (Years)
1	Project Manager	Bachelor's degree in Civil, electrical or Mechanical engineering	1	5
2	Project Engineer (Civil)	Bachelor's degree in Civil Engineering	1	3
3	Project Engineer (Electrical)	Bachelor's degree in Electrical Engineering	1	3
4	Site Supervisor (Civil)	Diploma in Civil Engineering	1	3
5	Site Supervisor (Electrical)	Diploma in Electrical Engineering	1	3

5. Key Equipment Requirement.

Sl.No	Equipment Type and characteristics	Minimum Number Required
1	Tracked DTH drilling machine as applicable	3
2	Excavator	3
3	Concrete mixer (manual with 5 CFT capacity unmixed/3 CFT mixed)	3
4	Crane 5 ton	1
5	Dump truck	5
6	Needle Vibrator (3 HP)	3
7	Concrete mixer truck	4
8	Welding machine	2
9	Bulldozer	2
10	Clamp-meter	5
11	CB analyser	3
12	Digital ohmmeter	6
13	Relay and CT test set	3
14	Insulation resistance tester	3
15	AC hi-pot tester	3
16	Partial discharger test equipment	3
17	Earth tester	2
18	Multi-meter	6
19	I-V curve tracer	3

6. Performance Guarantee (PG) Test

6.1 General

The final acceptance test as to prove the Performance Guarantee shall be conducted at the site by the Contractor in presence of the Employer. The test shall be binding on all the parties of the contract to determine compliance of the equipment with the functional guarantee. Any special equipment, instrumentation tools and tackles and manpower, required for the successful completion of the PG test shall be provided by the contractor free of cost. The accuracy class of the instrumentation shall be as per relevant clause of the Technical Specification.

6.2 Salient Points about the PG Test Procedure and Results-

- (a) The bidder is required to quote the annual target generation in the function guarantee.
- (b) The maximum amount of liquidated damages for shortfall in generation during PG test shall not exceed 10% of the contract value.
- (c) The test shall be carried out for 60 days after the commissioning of the plant on discretion of the Employer.
- (d) For PG evaluation, the total daily irradiation (GHI) shall be greater than or equal to 3.5 kWh/sqm.
- (e) Any external interruption like grid failure, unplanned maintenance, switchyard downtime etc, then those time period shall be removed from the day for performance assessment purpose.
- (f) The PG test shall be conducted based on PG test procedure to be submitted by the contractor and approved by the Employer.

The test shall be repeated in case of outage of following equipment for more than 7 days-

- (a) Converter transformers
- (b) Power Conditioning Unit
- (c) SCADA and data logger combined
- (d) Pyranometers

6.3 Performance Guarantees

Subject to compliance with the foregoing preconditions, the Contractor guarantees as follows:

Sl	Performance Guarantees	Values
1	DC installed capacity (MWp)	
2	AC installed capacity (MWac)	
3	Annual Energy generation in First Year (GWh)	
4	Performance Ratio in First Year (%)	

6.4 Failure in Guarantees and Liquidated Damages

If the production capacity of the facilities attained in the guarantee test is less than the minimum guaranteed values specified in 6.3 (Performance Guarantee) above, the contractor shall pay liquidated damages as per the following formulae:

6.4.1 Failure to Attain

Liquidated damages = (Target - Actual) x 4.25 Nu/kWh x 25 years

Note: Target and Actual Generations shall be the values applicable for the actual test duration

6.4.2 Minimum Levels

Notwithstanding the provisions of this paragraph, if as a result of the guarantee test(s), the following minimum levels of performance guarantees (and consumption guarantees) are not attained by the Contractor,

the Contractor shall at its own cost make good any deficiencies until the facilities reach any of such minimum performance levels as below:

SN	Performance Guarantees	Values
1	DC installed capacity (MW _p)	120
2	AC installed capacity (MW _{ac})	85
3	Annual Energy generation in First Year (GWh)	197.68
4	Performance Ratio in First Year (%)	83

DRUK GREEN POWER CORPORATION LIMITED



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DrukGreen

(a **dhi** company)

**BIDDING DOCUMENTS
FOR
DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF 120 MW_p
JAMJEE SOLAR PV PROJECT**

**VOLUME IV
PRICE SCHEDULE
JANUARY 2025**



120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

- Section 1 - Notice Inviting Tender (NIT)
- Section 2 - Instruction to Bidders (ITB)
- Section 3 - Bid Data Sheet (BDS)
- Section 4 - Evaluation and Qualification Criteria (EQC)
- Section 5 - Information to Bidders (IFB)
- Section 6 - Bidding Forms (BDF)

VOLUME II – General Conditions of Contract and Contract Forms

- Section 7 - General Conditions of Contract (GCC)
- Section 8 - Particular Conditions of Contract (PCC)
- Section 9 - Contract Forms (COF)

VOLUME III - Employer's Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings



Preamble to the Price Schedule

1. The Price Schedule shall be read in conjunction with all other documents forming part of Bidding Documents.
2. The Schedules do not generally give full description of the Works and the Services to be performed under each item. Bidders shall be deemed to have read the Employer's Requirements and other sections of the Bidding Documents and reviewed the Drawings to ascertain the full scope of the requirements included in each item prior to filling in the prices. The entered prices shall be deemed to cover the full scope as aforesaid, including overheads and profit.
3. If Bidders are unclear or uncertain as to the scope of any item, they shall seek clarification in accordance with Instructions to Bidders (ITB-11) prior to submitting their Bid.
4. Prices shall be filled in indelible ink, and any alterations necessary due to errors, etc., shall be initialed by the Bidder.
5. Bid Prices shall be quoted in the manner indicated and, in the currencies, specified in the Instructions to Bidders in the Bidding Documents.
6. For each item, Bidders shall complete each appropriate column in the respective Schedules, giving the price breakdown, wherever required/considered necessary in the manner and the detail called for in the relevant Price Schedules.
7. Prices given in the Schedules against each item shall be for the scope covered by that item as detailed in Volume III - Employer's Requirements or elsewhere in the Bidding Documents.
8. Payments will be made to the Contractor in the currency or currencies indicated under each respective item.
9. The cost of items against which the Contractor has failed to enter a price will not be paid by the Employer, when executed, and shall be deemed to be covered by the other prices entered in Price Schedules.
10. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the Price Schedules, and where no items are provided, the cost shall be deemed to be distributed among the prices entered for the related items of work.

Schedule No. 1: Supply and Delivery of Plant and Mandatory Spares

Schedule No. 2: Design Services

Schedule No. 3: Installation and Other Services

Schedule No. 4: Grand Summary (Schedule Nos. 1 to 3)



Price Schedule No. 1: Supply and Delivery of Plant and Mandatory Spares

SN	Item Description	UoM	Quantity	Unit Price (Indicate Currency)		Total Price (in Figures)
				In Figures (DAP)	In Words (DAP)	Indicate Currency
1	Supply and delivery of PV Modules for Total PV Capacity of minimum 120 MWp	kWp				
2	Supply and delivery of Photovoltaic Inverters for total capacity of minimum 85 MWac	kWac				
3	Supply and delivery of PV Module Mounting Structures	kWp				
4	Supply of Remote Monitoring and Controlling System, connecting cables (if any), and associated other accessories to communicate with the grid	kWac				
5	Supply and delivery of DC cables, isolators, surge protection devices and other required equipment (as applicable)	kWp				
6	Supply and delivery of AC cables, LV cables, MV cables, isolators, surge protection devices and other required equipment (as applicable)	kWac				
7	Supply and delivery of inverter duty transformers, Auxiliary transformers including other switchgear protection systems.	kVA				
1	PV modules	No				
2	Module Mounting structures	Set				
3	PV Inverters	No				

SN	Item Description	UoM	Quantity	Unit Price (Indicate Currency)		Total Price (in Figures)
				In Figures (DAP)	In Words (DAP)	Indicate Currency
4	DC cables	M				
5	AC cables for MV voltage	M				
6	AC cables for LV voltage	M				
7	Optical fibres	M				
8	Surveillance camera	No				
9	Lighting LED one extra set for each installed LED	Set				
10	Protection circuit breaker LV	No				
11	Protection circuit breaker MV	No				
13	DC Connectors (Male and Female)	Set				
14	Fuses	No				
TOTAL PRICE to be carried forward to Schedule No. 4: Grand Summary						

Price Schedule No. 2: Design Services

SN	Item Description	Unit	Qty	Unit Price (Indicate Currency)		Total Price (in Figures)
				In Figures (DAP)	In Words (DAP)	Indicate Currency
1	Design and engineering of the Solar PV Plant including all civil works and electrical works	LS				
TOTAL PRICE to be carried forward to Schedule No. 4: Grand Summary						

Price Schedule No 3: Installation and other services

SN	Item Description	Unit	Qty	Unit Price (Indicate Currency)		Total Price (in Figures)
				In Figures (DAP)	In Words (DAP)	In Figures (DAP)
1	All civil works including clearing, grubbing, fencing, roads, drainages, cable trenches/ballast/trays, foundation for mounting structure, control buildings, inverter yards, cleaning system, LV/MV switchgear or other infrastructures/works as applicable.	LS				
2	All DC works including installation of mounting structure, PV modules, DC cables, protections and others as applicable	kWp				
3	All AC works including installation of on-grid inverters, AC cables, protections and others as applicable	kWac				
4	Installation of the SCADA monitoring system including fiber optics and others as applicable	kWac				
5	Installation of LV/MV switchgear systems including control and protections and others as applicable	kVA				
6	Commissioning and Testing of the solar PV plant	LS				
TOTAL PRICE to be carried forward to Schedule No. 4: Grand Summary						

Price Schedule No 4: Grand Summary

Schedule No	Title	Total Price (indicate Currency)
Schedule 1:	Supply and Delivery of Plant and Mandatory Spares	
Schedule 2:	Design Services	
Schedule 3:	Installation and other services	
	Grand Total	

DRUK GREEN POWER CORPORATION LIMITED



**BIDDING DOCUMENTS
FOR
DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF 120 MW_p
JAMJEE SOLAR PV PROJECT**

**VOLUME V
TENDER DRAWINGS**

JANUARY 2025



120 MW_p JAMJEE SOLAR PV PROJECT

VOLUME I - Bidding Procedures

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VOLUME II – General Conditions of Contract and Contract Forms

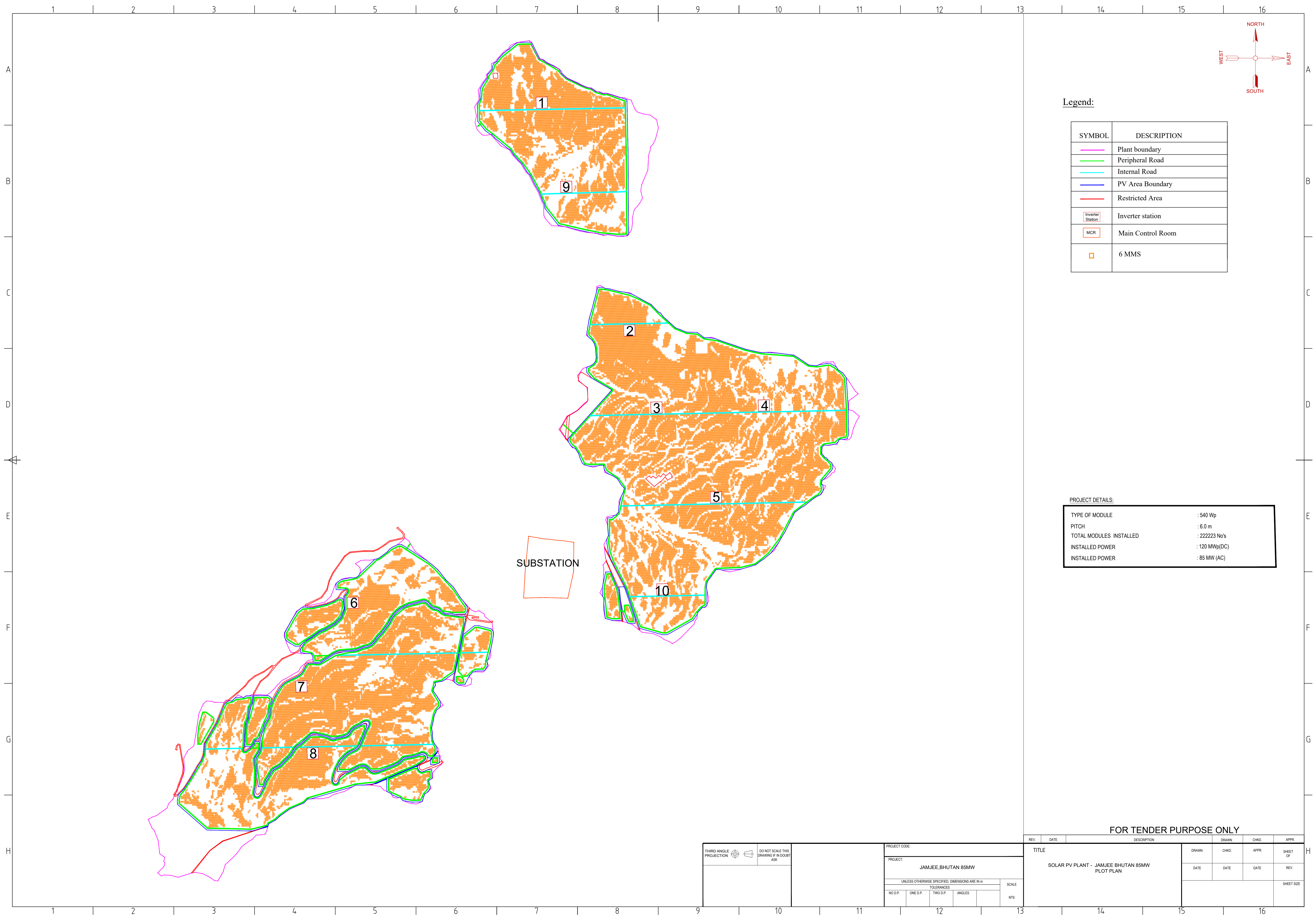
- Section 7 - General Conditions of Contract (GCC)
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VOLUME III - Employer's Requirements

VOLUME IV - Price Schedule

VOLUME V - Tender Drawings





Legend:

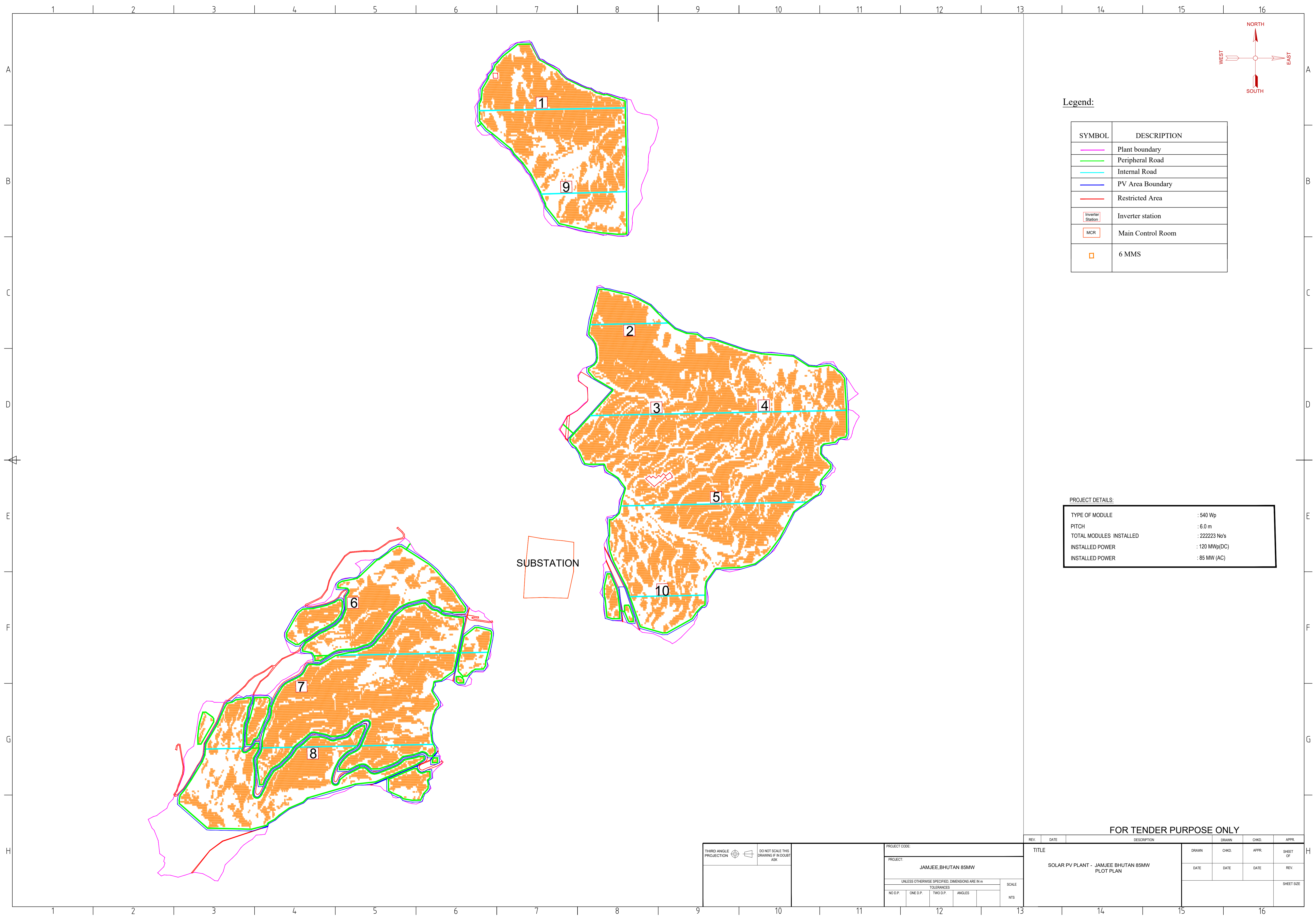
SYMBOL	DESCRIPTION
	Plant boundary
	Peripheral Road
	Internal Road
	PV Area Boundary
	Restricted Area
	Inverter station
	Main Control Room
	6 MMS

PROJECT DETAILS:

TYPE OF MODULE	: 540 Wp
PITCH	: 6.0 m
TOTAL MODULES INSTALLED	: 22223 No's
INSTALLED POWER	: 120 MW(DC)
INSTALLED POWER	: 85 MW (AC)

FOR TENDER PURPOSE ONLY

 THIRD ANGLE PROJECTION	 DO NOT SCALE THIS DRAWING IF IN DOUBT ASK	PROJECT CODE:				TITLE SOLAR PV PLANT - JAMJEE BHUTAN 85MW PLOT PLAN	REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.
		PROJECT:					DRAWN	CHKD.	APPR.	SHEET OF		
		JAMJEE, BHUTAN 85MW					DATE	DATE	DATE	REV.		
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN m						SCALE		SHEET SIZE				
NO D.P.	ONE D.P.	TWO D.P.	ANGLES	NTS								



Legend:

SYMBOL	DESCRIPTION
	Plant boundary
	Peripheral Road
	Internal Road
	PV Area Boundary
	Restricted Area
	Inverter station
	Main Control Room
	6 MMS

PROJECT DETAILS:

TYPE OF MODULE	: 540 Wp
PITCH	: 6.0 m
TOTAL MODULES INSTALLED	: 22223 No's
INSTALLED POWER	: 120 MW(DC)
INSTALLED POWER	: 85 MW (AC)

FOR TENDER PURPOSE ONLY

 THIRD ANGLE PROJECTION DO NOT SCALE THIS DRAWING IF IN DOUBT ASK	PROJECT CODE:		REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.
	PROJECT:		DATE	DATE	DATE	DATE	DATE	DATE
	UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN m		SCALE		SHEET OF		REV.	
	NO D.P.	ONE D.P.	TWO D.P.	ANGLES	SHEET SIZE			

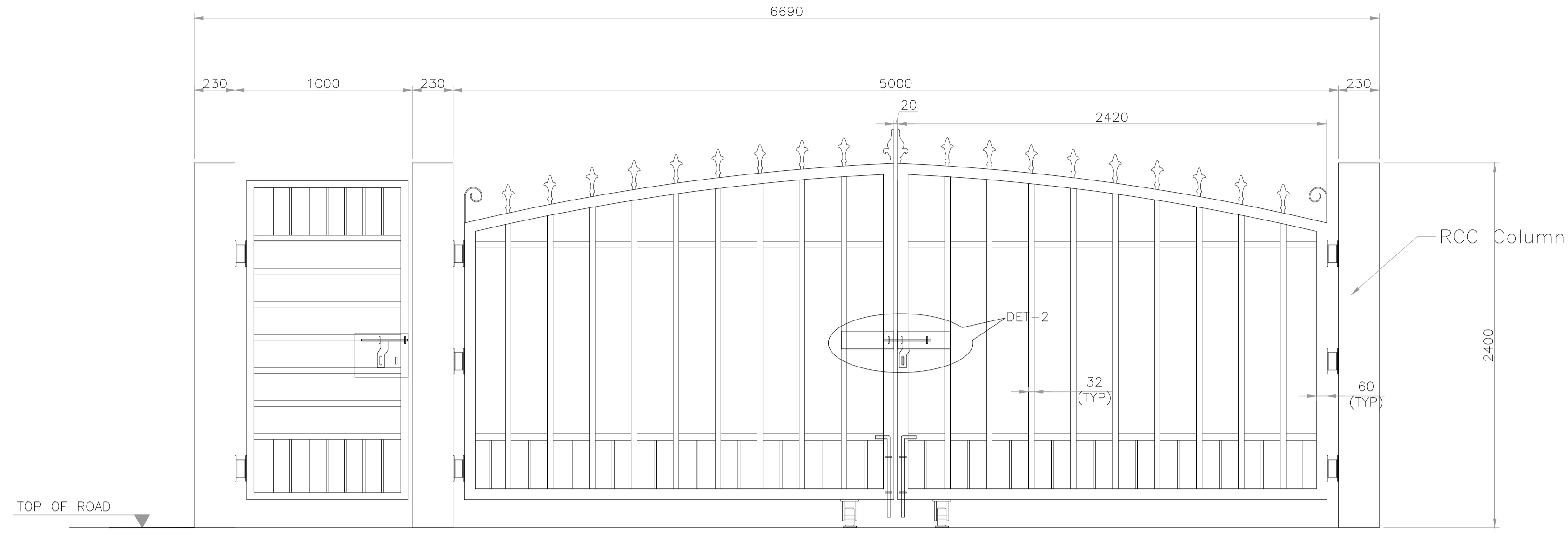
PROJECT:		JAMJEE, BHUTAN 85MW	
TITLE:		SOLAR PV PLANT - JAMJEE BHUTAN 85MW PLOT PLAN	

LEGEND

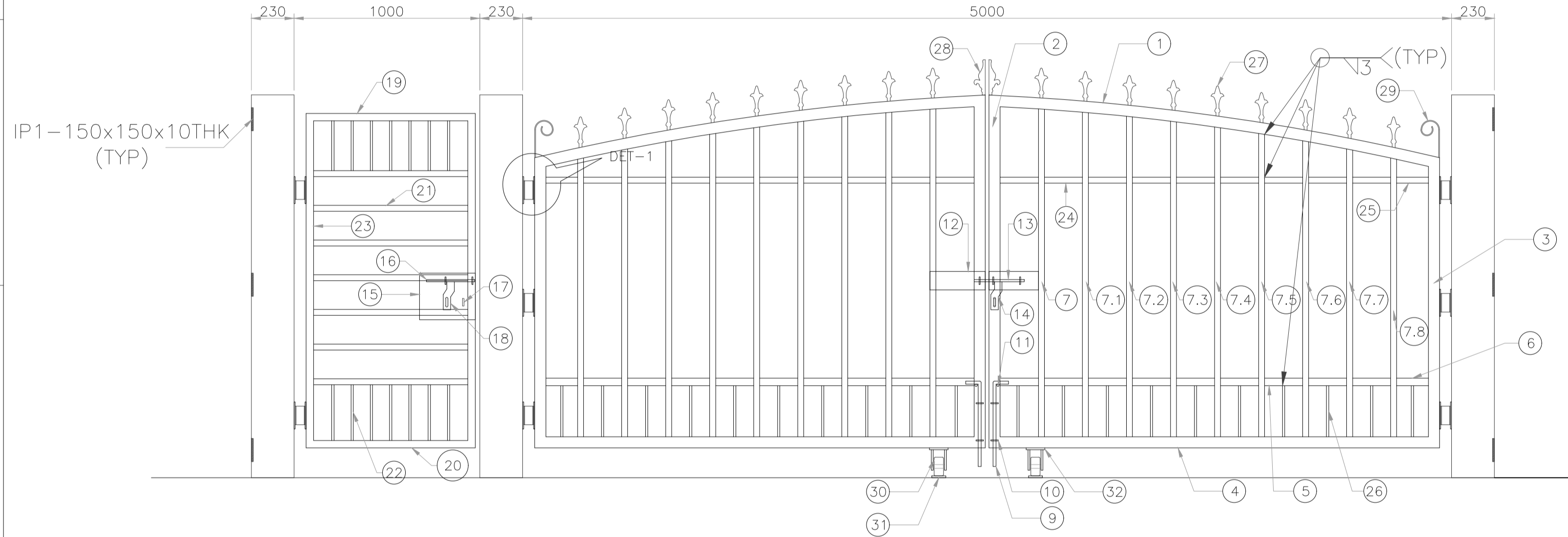
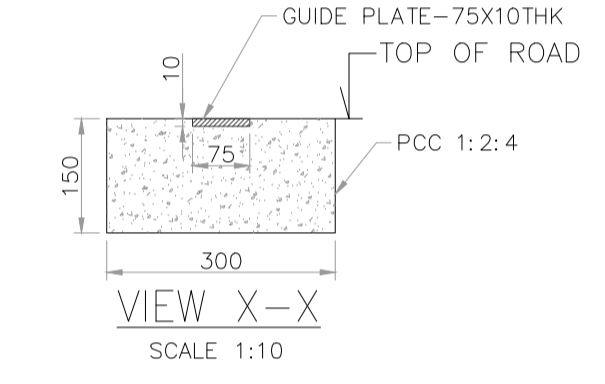
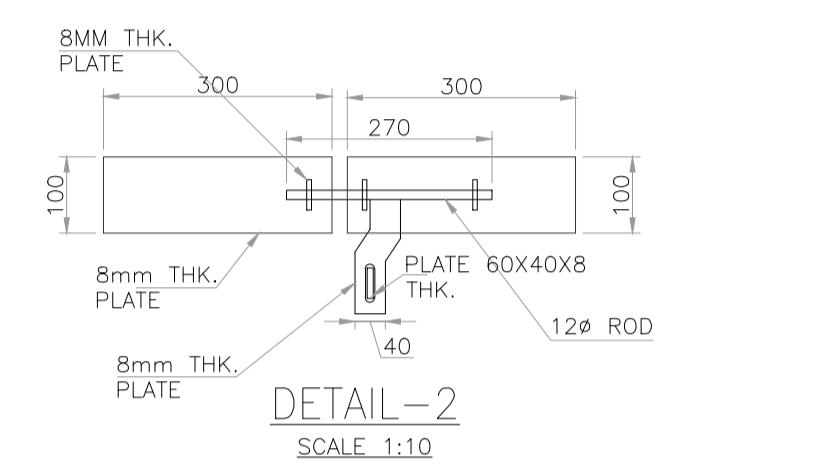
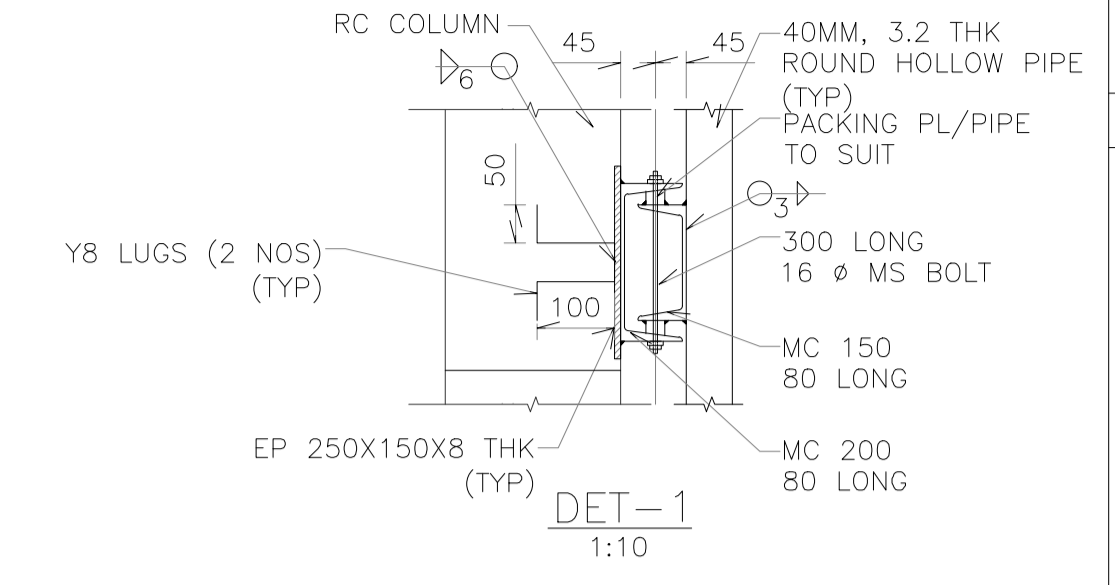
- CL — CENTER LINE
- TOC — TOP OF CONCRETE
- SECT — SECTION
- EL — ELEVATION
- LVL — LEVEL
- BOB — BOTTOM OF BEAM
- T&B — TOP & BOTTOM
- C/C — CENTER TO CENTER
- REIN. — REINFORCEMENT
- TYP — TYPICAL
- THK — THICK
- MIN — MINIMUM

NOTES:

1. EL (±)0.000 CORRESPONDS TO NGL.
2. ALL DIMENSIONS ARE IN MILLIMETER AND ELEVATIONS IN METER.
3. ALL STRUCTURAL MEMBERS ARE MILD STEEL AND YIELD STRENGTH SHALL BE 250MPA.
4. ALL STRUCTURAL STEEL SHALL CONFORM TO IS-2062 GRADE-A.
5. THE FABRICATION OF STRUCTURAL STEEL SHALL BE CARRIED OUT AS PER IS-800 AND AS PER SPECIFICATION.
6. PLATES SHALL BE OF MILD STEEL CONFORMING TO GRADE-A OF IS-2062:1992.
7. WELDING SHALL CONFORM TO IS-813,814,816.
8. ALL WELDS ARE 3MM, UNLESS OTHERWISE NOTED.
9. ALL STRUCTURAL STEEL SHALL BE PAINTED WITH TWO COATS OF PRIMER AND TWO COATS OF SUITABLE SYNTHETIC ENAMEL PAINT.
10. ONE COAT OF PRIMER AND TWO COATS OF SUITABLE SYNTHETIC ENAMEL PAINT SHALL BE PAINT AFTER ERECTION AT SITE.

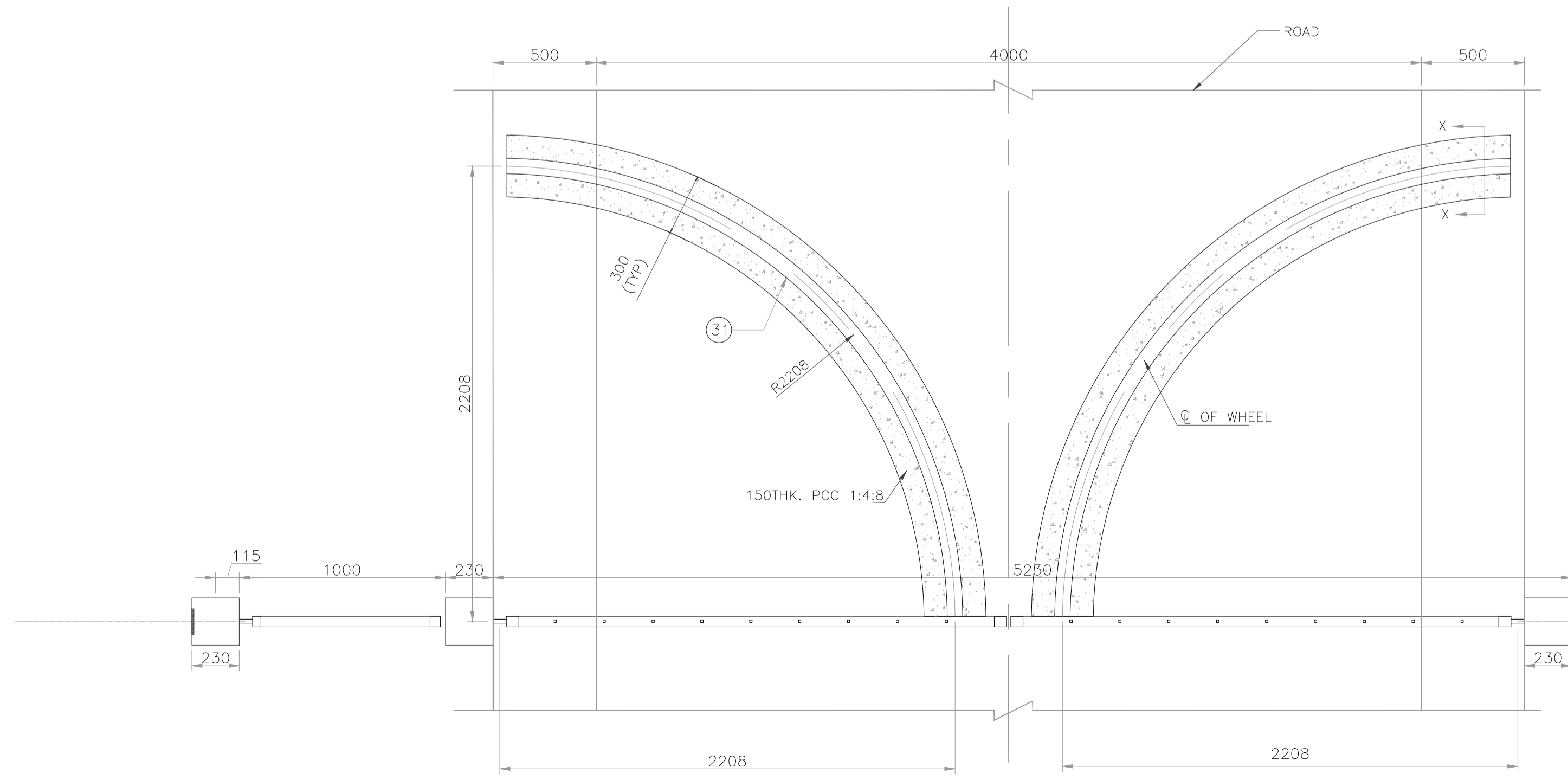


GA OF MAIN GATE



GATE DETAILS

BILL OF MATERIAL					
Item No	SECTION	QTY	UNITWT	TOTAL WT	REMARK
1	TOP RAIL RHS 60 X 40 X 4 - 2400 MM LONG	2	6.1Kg/M	29.28	
2	V. RAIL RHS 60X 40X 4 - 1900 MM LONG	2	6.1Kg/M	23.18	
3	V. RAIL RHS 60X 40X 4 - 1570 MM LONG	2	6.1Kg/M	19.15	
4	BOT. RAIL RHS 60 X 40X 2.6 - 2426 MM LONG	2	4.2Kg/M	20.38	
5	SHS 40 X 40X 4 - 205 MM LONG	18	4.80Kg/M	17.71	
6	SHS 40 X 40X 4 - 171 MM LONG	2	4.80Kg/M	1.64	
7	VERTICAL SHS 40 X 40 X 4 - 1764 MM LONG	2	4.80Kg/M	16.93	
7.1	VERTICAL SHS 40 X 40 X 4 - 1746 MM LONG	2	4.80Kg/M	16.93	
7.2	VERTICAL SHS 40 X 40 X 4 - 1724 MM LONG	2	4.80Kg/M	16.55	
7.3	VERTICAL SHS 40 X 40 X 4 - 1699 MM LONG	2	4.80Kg/M	16.31	
7.4	VERTICAL SHS 40 X 40 X 4 - 1668 MM LONG	2	4.80Kg/M	16.01	
7.5	VERTICAL SHS 40 X 40 X 4 - 1633 MM LONG	2	4.80Kg/M	15.68	
7.6	VERTICAL SHS 40 X 40 X 4 - 1593 MM LONG	2	4.80Kg/M	14.77	
7.7	VERTICAL SHS 40 X 40 X 4 - 1549 MM LONG	2	4.80Kg/M	14.87	
7.8	VERTICAL SHS 40 X 40 X 4 - 1500 MM LONG	2	4.80Kg/M	14.40	
8	SOLID 3" BALL BEARING HINGES 4" x 4" SQUARE CORNER (PAIR)	8	5.25Kg/M	5.25	
9	DROP BAR 16 DIA ROD - 540 MM LONG	2	7850Kg/CUM	1.70	
10	GUIDE PLATE X 75 X 10 X 6	4	7850Kg/CUM	0.57	
11	DROP BAR HOLDER 12 DIA ROD - 80 MM LONG	2	7850Kg/CUM	0.14	
12	GATE PLATE 200 100 X 6THK	4	7850Kg/CUM	3.77	
13	12 DIA ROD - 270MM LONG	2	7850Kg/CUM	0.48	
14	PLATE 150 X 60 X 6 THK	2	7850Kg/CUM	0.85	
15	GATE PLATE 300 X 250 X 8 THK	2	7850Kg/CUM	9.42	
16	12 DIA ROD - 260MM LONG	2	7850Kg/CUM	0.46	
17	PLATE 60 X 40 X 8 THK	4	7850Kg/CUM	0.60	
18	PLATE 150 X 60 X 6 THK	2	7850Kg/CUM	0.85	
19	TOP RAIL SHS 60 X 40 X 4 - 910 MM LONG	1	4.8Kg/M	4.37	
20	BOT. RAIL SHS 60 X 40X 4 - 910 MM LONG	1	5.1Kg/M	4.64	
21	HORIZONTAL SHS 32 X 32X 4 - 831 MM LONG	7	3.6 Kg/M	20.94	
22	12 SQ ROD - 300 MM LONG	7	7850Kg/CUM	2.37	
23	V. RAIL SHS 40 X 40 X 4 - 1800 MM LONG	2	4.2Kg/M	15.12	
24	HORIZONTAL SHS 32 X 32X 4 - 206.1 MM LONG	18	3.6 Kg/M	13.35	
25	HORIZONTAL SHS 32 X 32X 4 - 171 MM LONG	2	3.6 Kg/M	1.23	
26	12MM SQ ROD - 275 MM LONG	20	7850Kg/CUM	6.22	
27	FINAL 160 X 70 X 16	18	0.23 Kg/No	4.14	
28	GATE CENTRE	2	0.32 Kg/No	0.64	
29	GATE SCROLL	2	0.64 Kg/No	1.28	
30	DOUBLE BALL BEARING 100 X 50MM HEAVY DUTY WHEELS WITH ALL FITTINGS	3			
31	GUIDE PLATE - (75 X 10) LENGTH 2075MM	2	5.9 KG / Mtr	24.49	
32	PLATE 40 X 5 X 100MM	4	1.59	0.63	
TOTAL WEIGHT				377.31	Kg
				0.377	MT



TOP VIEW

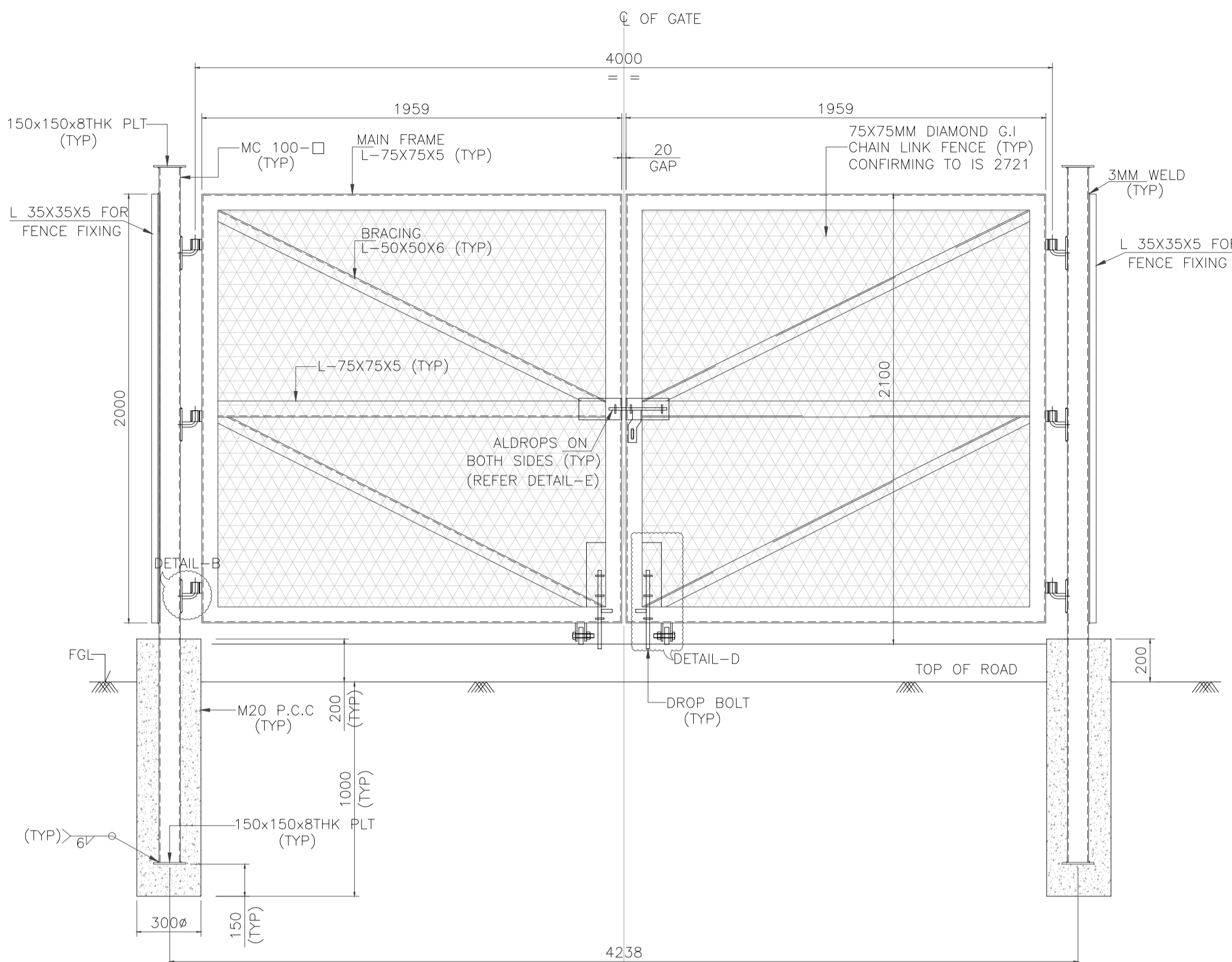
FOR TENDER PURPOSE ONLY

LEGEND

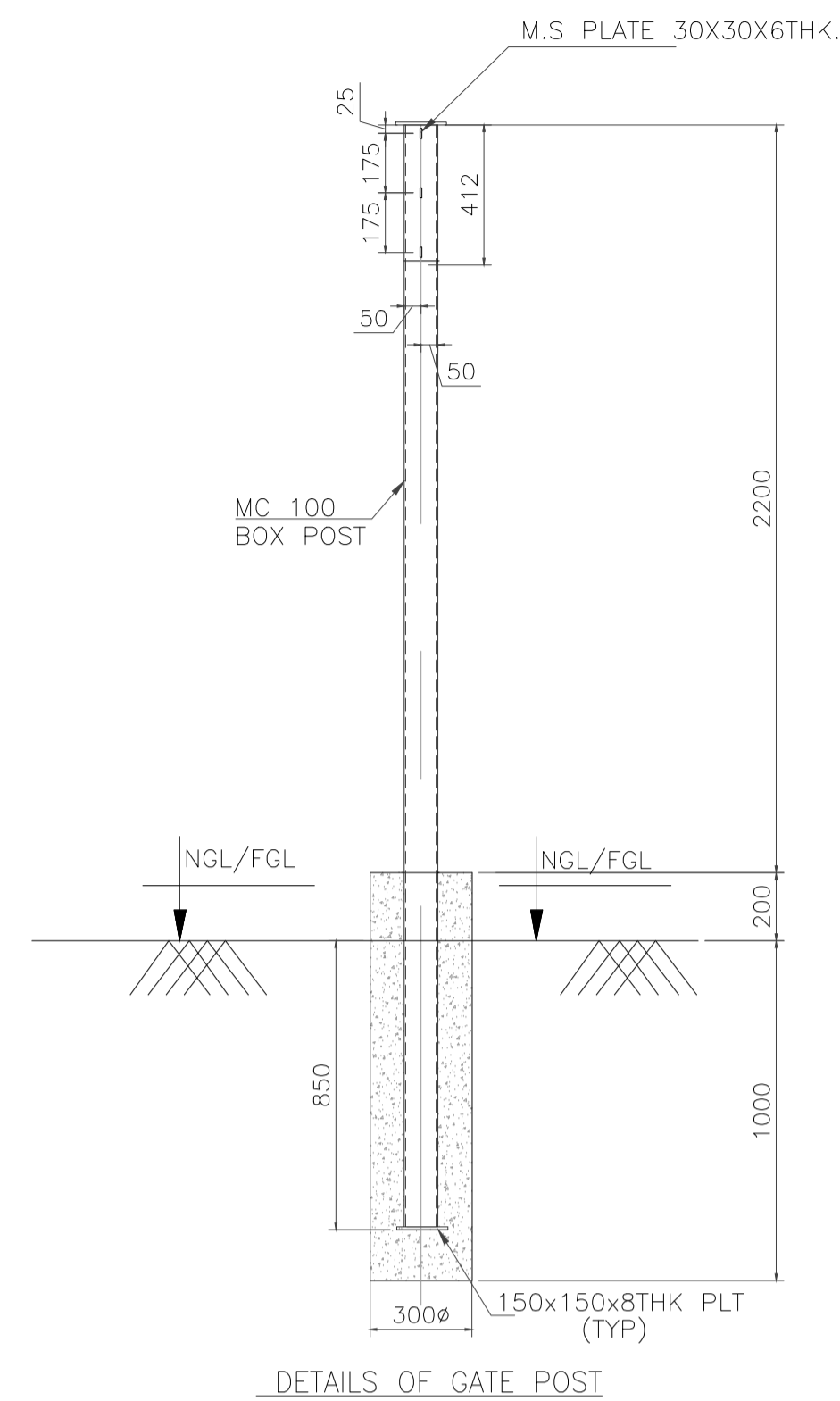
CL	CENTER LINE	T&B	TOP & BOTTOM
TOC	TOP OF CONCRETE	C/C	CENTER TO CENTER
SECT	SECTION	REIN.	REINFORCEMENT
EL	ELEVATION	TYP	TYPICAL
LVL	LEVEL	THK	THICK
BOB	BOTTOM OF BEAM	MIN	MINIMUM

NOTES:

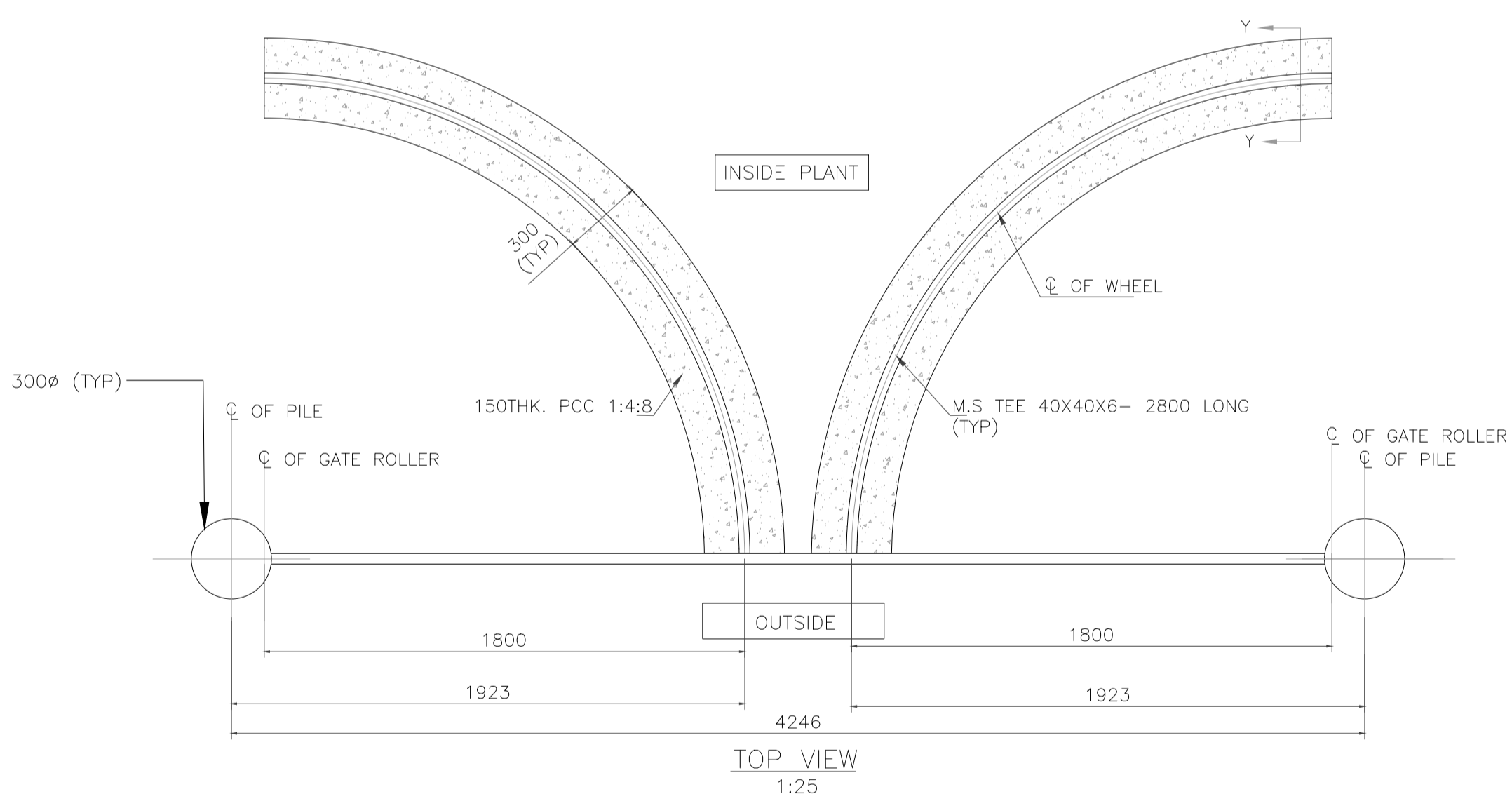
- FOR LEGEND, NOTES, ENGINEERING AND CONSTRUCTION REFERENCE REFER SH 01 OF 03.



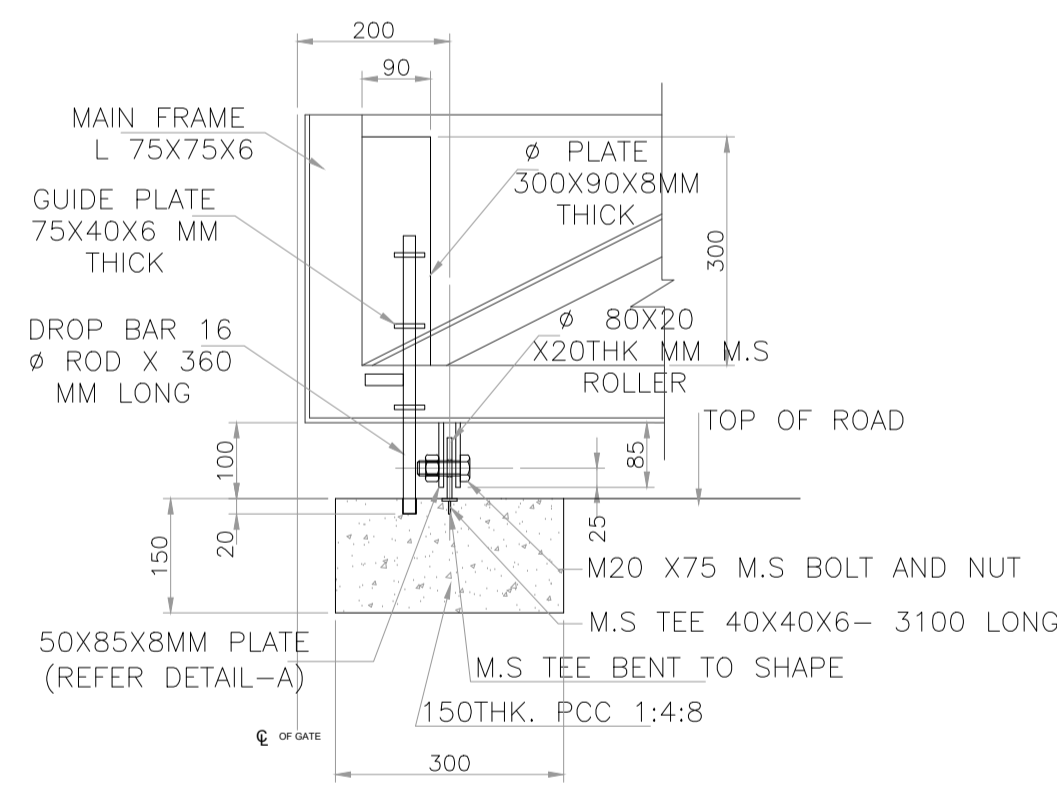
ELEVATION OF SECONDARY GATE & WICKET GATE



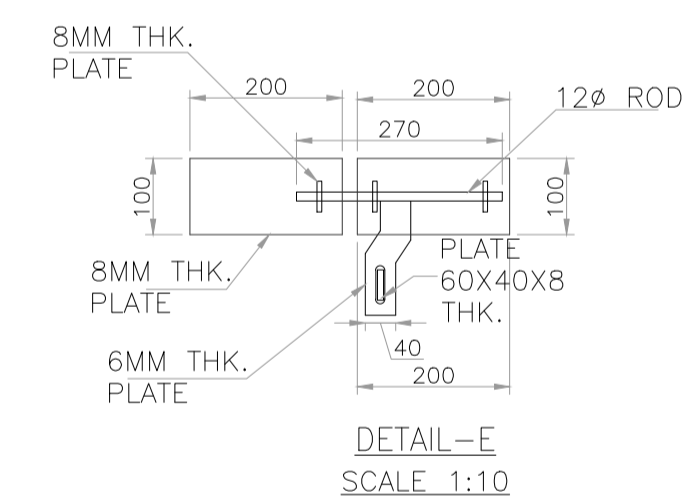
DETAILS OF GATE POST



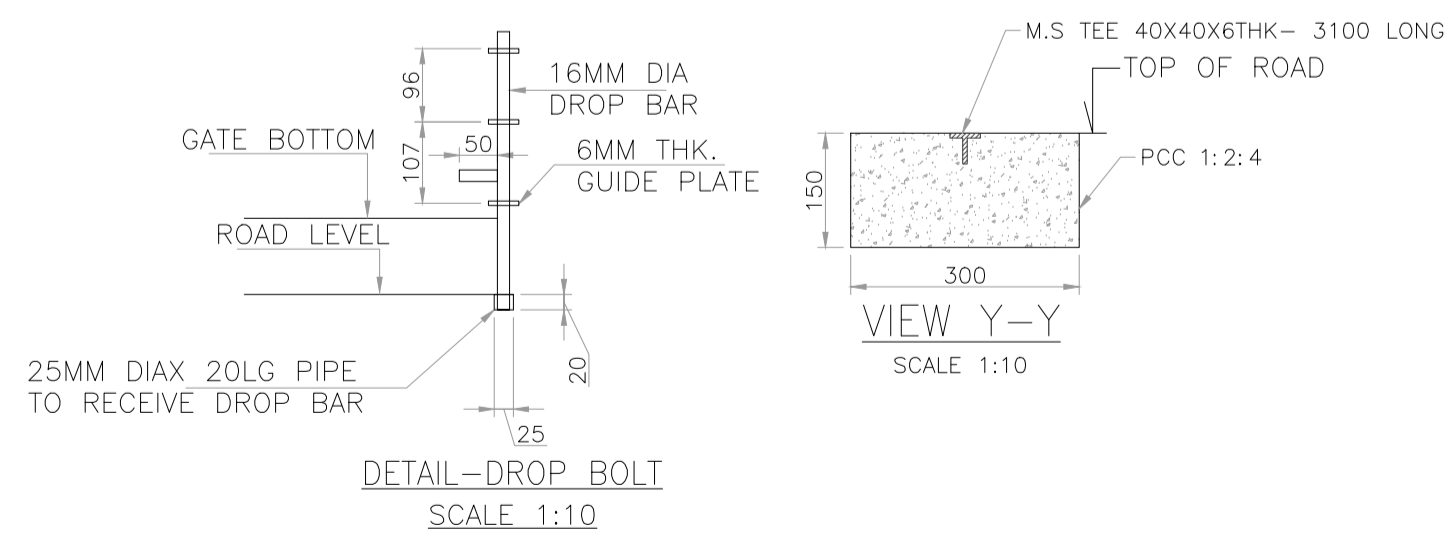
TOP VIEW
SCALE 1:25



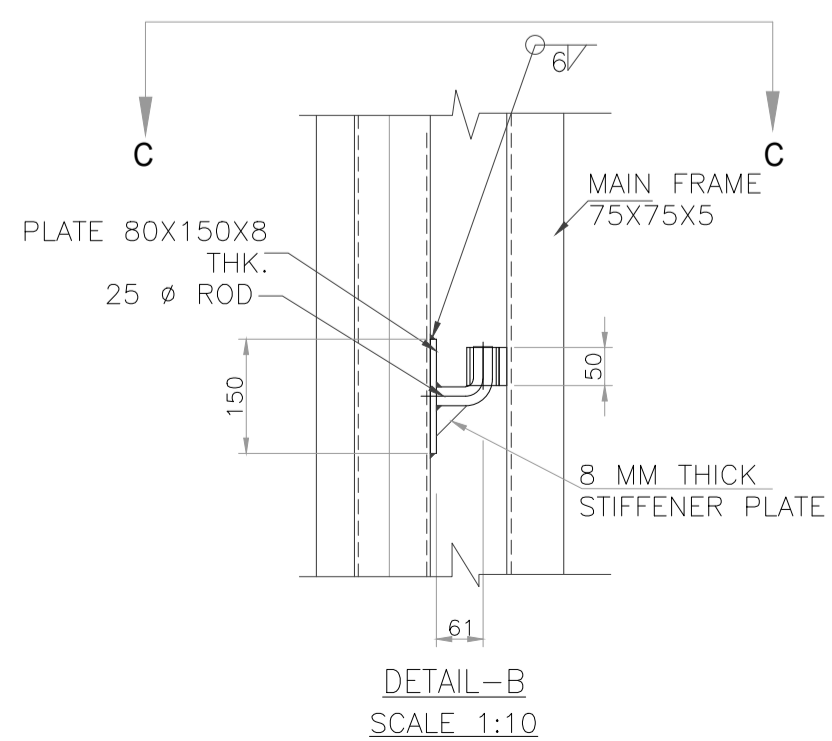
DETAIL-D
SCALE 1:10



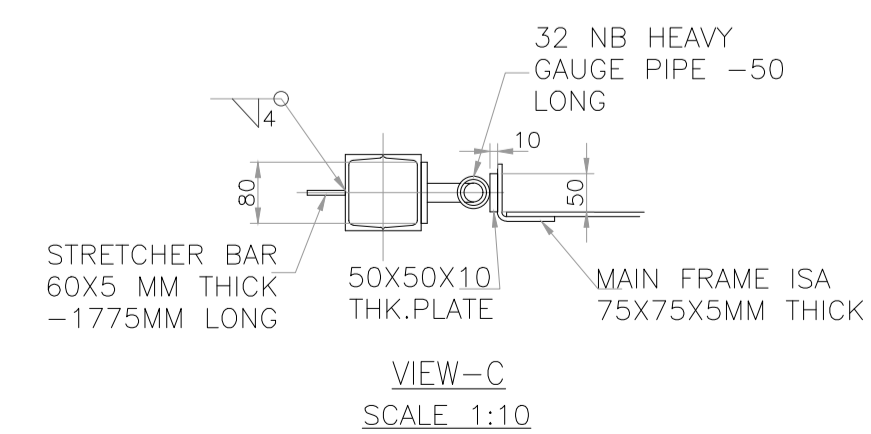
DETAIL-E
SCALE 1:10



DETAIL-DROP BOLT
SCALE 1:10



DETAIL-B
SCALE 1:10



VIEW-C
SCALE 1:10

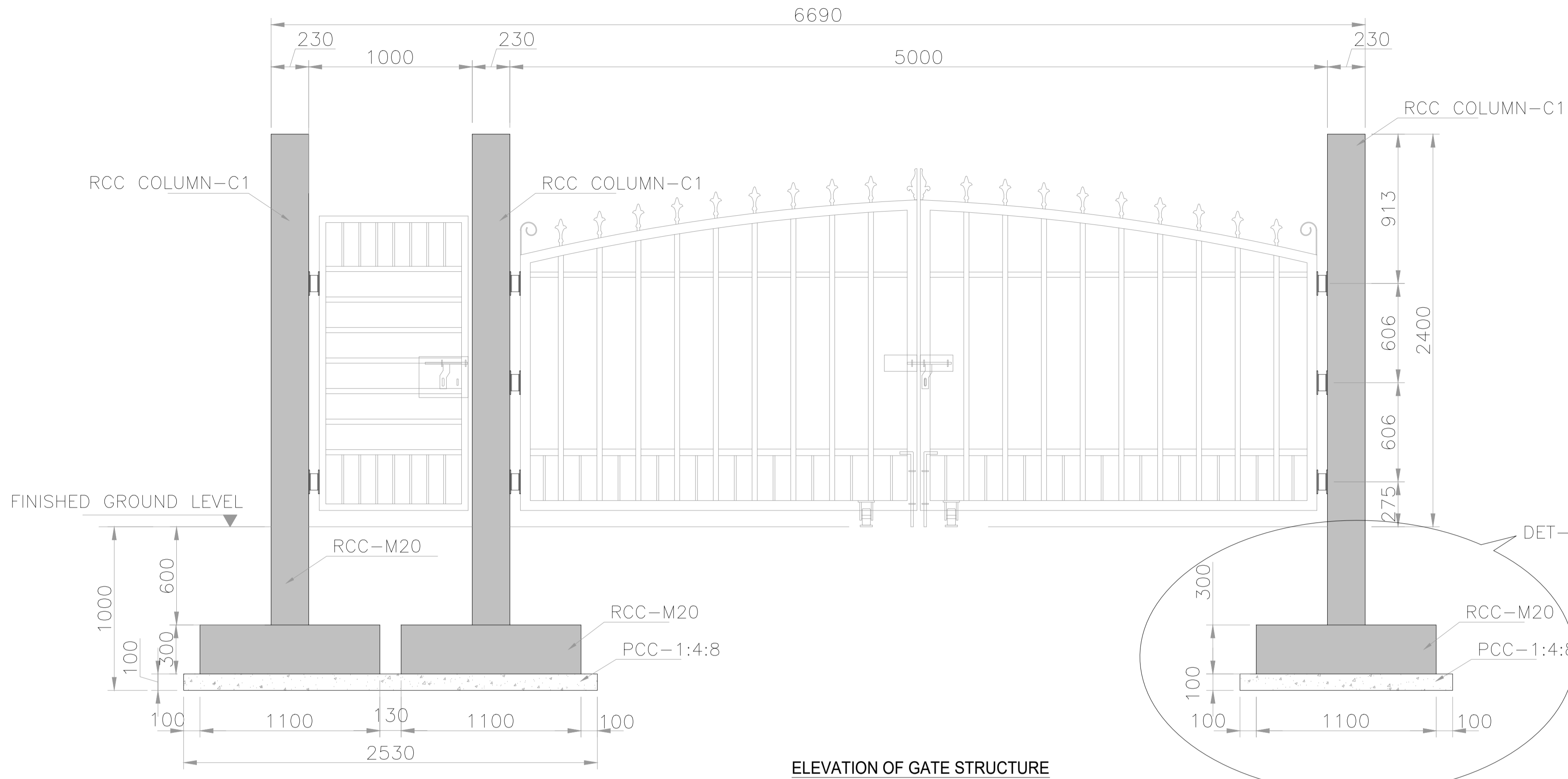
FOR TENDER PURPOSE ONLY

LEGEND

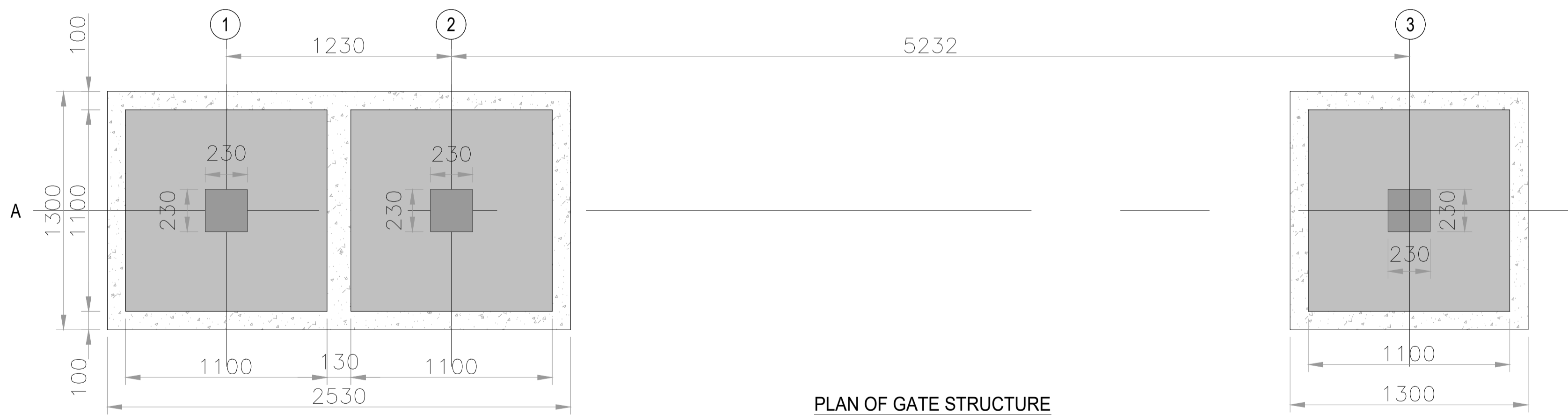
CL	CENTER LINE	T&B	TOP & BOTTOM
TOC	TOP OF CONCRETE	C/C	CENTER TO CENTER
SECT	SECTION	REIN.	REINFORCEMENT
EL	ELEVATION	TYP	TYPICAL
LVL	LEVEL	THK	THICK
BOB	BOTTOM OF BEAM	MIN	MINIMUM

NOTES:

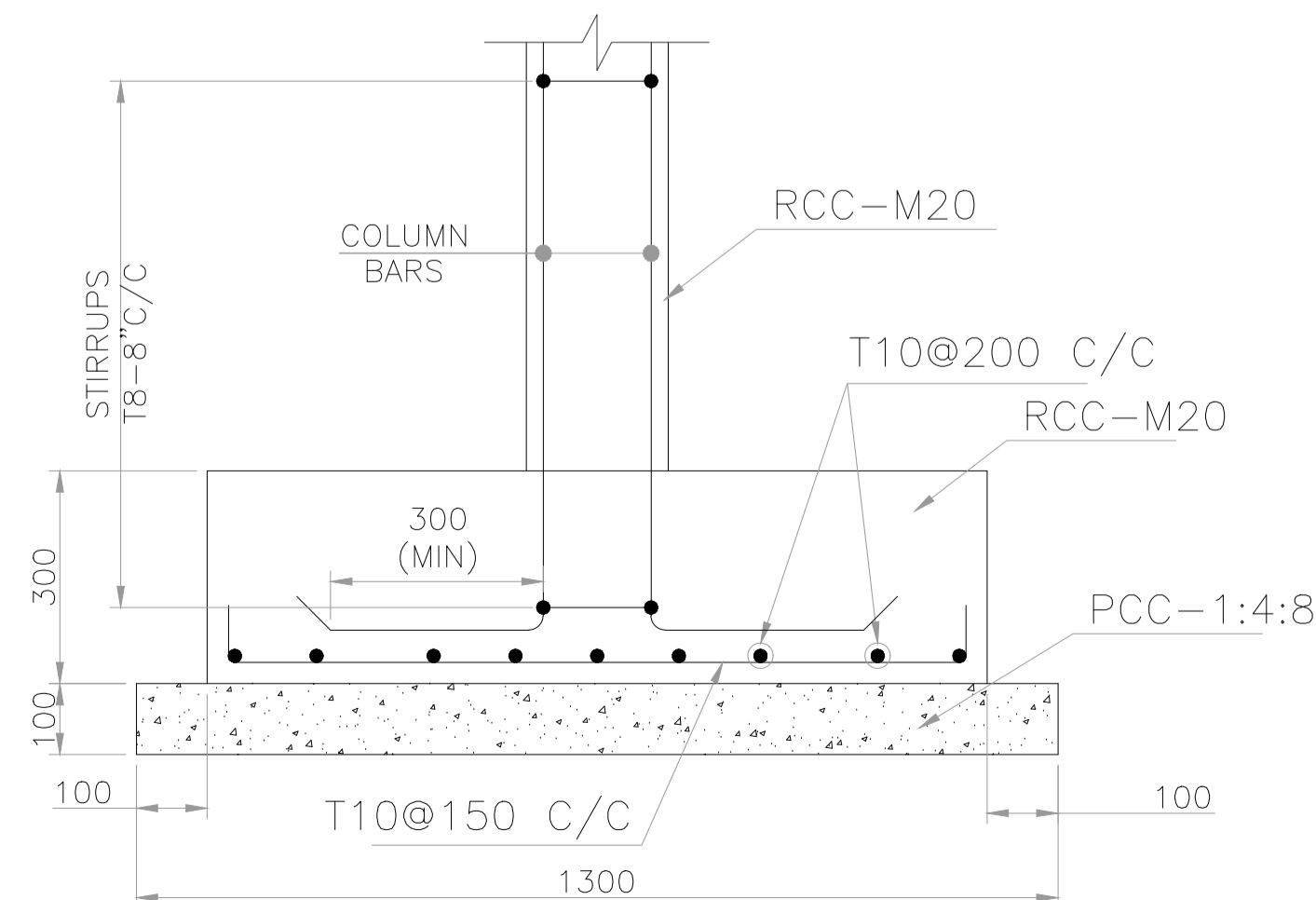
- ALL DIMENSIONS ARE IN MM AND LEVELS ARE IN METERS.
- THE DRAWING SHALL BE READ IN CONJUNCTION WITH FENCE DETAIL DRAWING.
- GRADE OF ALL THE CONCRETE SHALL BE M20 WITH 20MM NOMINAL SIZE GRADED AGGREGATES AS PER IS:456.
- THE MAXIMUM WATER-CEMENT RATIO SHOULD BE 0.45
- ALL REINFORCEMENT SHALL BE HIGH YIELD STRENGTH TMT BARS OF GRADE FE500D CONFORMING TO IS:1786.
- LAP LENGTH/DEVELOPMENT LENGTH SHALL BE 50D WHERE D IS THE DIA OF THE SMALLEST BAR.
- LAPPING OF BARS SHALL BE SUITABLY STAGGERED AND IN NO CASE MORE THAN 50% BARS SHALL BE LAPPED AT ANY SECTION.
- ALL HOOKS, BENDS, LAPS AND SPLICES SHALL BE AS PER RELEVANT IS CODE.
- CLEAR COVER TO REINFORCEMENT SHALL BE AS FOLLOWS:
FOUNDATION-50MM
PEDESTAL-40MM
- EL(±)0.000 CORRESPONDS TO NGL.



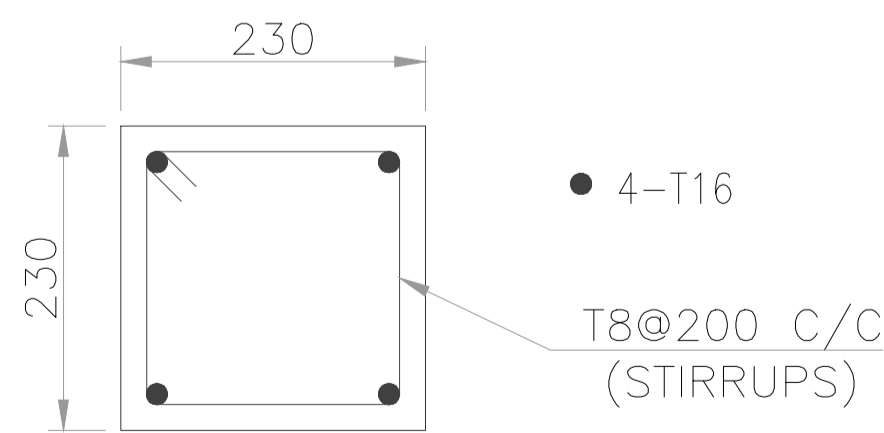
ELEVATION OF GATE STRUCTURE



PLAN OF GATE STRUCTURE



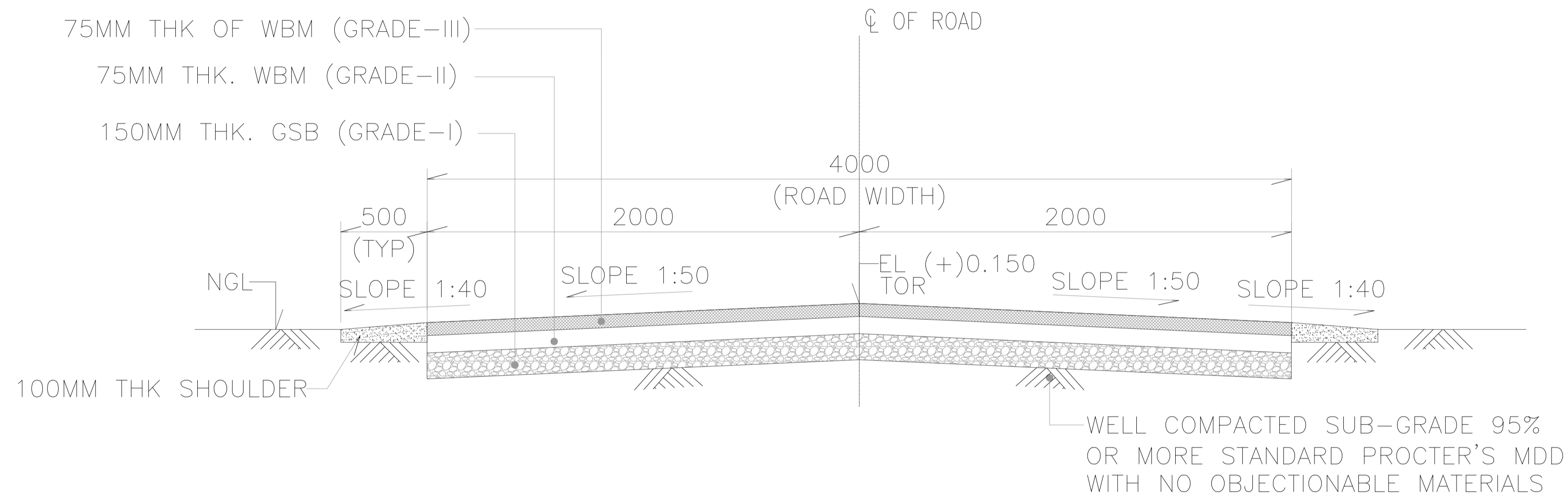
DETAIL-2 (TYP)



(COLUMN-C1)
SCALE 1:10

FOR TENDER PURPOSE ONLY

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. THE DRAWING SHALL BE REFERRED FOR ROAD MARKING ONLY.
3. THE LOCATION OF MAIN GATE, SECONDARY GATE AND SECURITY CABINS ARE SHOWN TENTATIVE ONLY. FOR EXACT LOCATION REFER PLOT PLAN.
4. MAXIMUM LONGITUDINAL GRADIENT SHALL BE 1 IN 15 AND MINIMUM LONGITUDINAL GRADIENT SHALL BE 1 IN 200.
5. SUITABLE VERTICAL CURVES SHALL BE PROVIDED AT THE CHANGE OF ROAD ELEVATION.
6. ROAD TO FOLLOW NATURAL GRADIENT. WHEREVER REQUIRED TO MAINTAIN MINIMUM AND MAXIMUM LONGITUDINAL GRADIENT CUTTING OR FILLING NEEDS TO BE DONE.
7. GENERALLY TOP OF ROAD SHALL BE 0.15M ABOVE THE NATURAL GROUND LEVEL, UNLESS OTHERWISE NOTED.
8. AT BENDS OF ROADS SMOOTH CURVES TO BE PROVIDED.
10. SUB-GRADE SHALL BE OF 300MM THK BELOW SUB-BASE COURSE CONFIRMING TO CLAUSE 303 OF MORD SPECIFICATION, COMPACTED UPTO 98% OF STANDARD PROCTOR DENSITY IN THE LAYER OF 150MM THICKNESS.
11. GRANULAR/GRAVEL SUB-BASE COURSE CONFIRMING TO CLAUSE 303 OF MORD SPECIFICATION SHALL BE 150MM COMPACTED THICKNESS, COMPACTED TO 100% OF MAXIMUM DRY DENSITY.
12. WBM 75 MM THICK GRADING-II TO BE PROVIDED AS PER CLAUSE 405 OF MORD SPECIFICATIONS.
13. WBM 75 MM THICK GRADING-III TO BE PROVIDED AS PER CLAUSE 405 OF MORD SPECIFICATIONS.
14. TOPPING: SURFACE DRESSING WITH GRAVEL OR GRAVEL-SOIL MIXTURE CONFORMING TO CL. 402 OF MORD SPECIFICATIONS FOR RURAL ROADS PUBLISHED BY IRC (MORD SPECS).
15. GRAVEL SHOULDERS CONFIRMING TO CLAUSE 407 OF MORD SPECIFICATION: 150MM (AT END) COMPACTED THICK, COMPACTED TO 100% OF MAXIMUM DRY DENSITY.

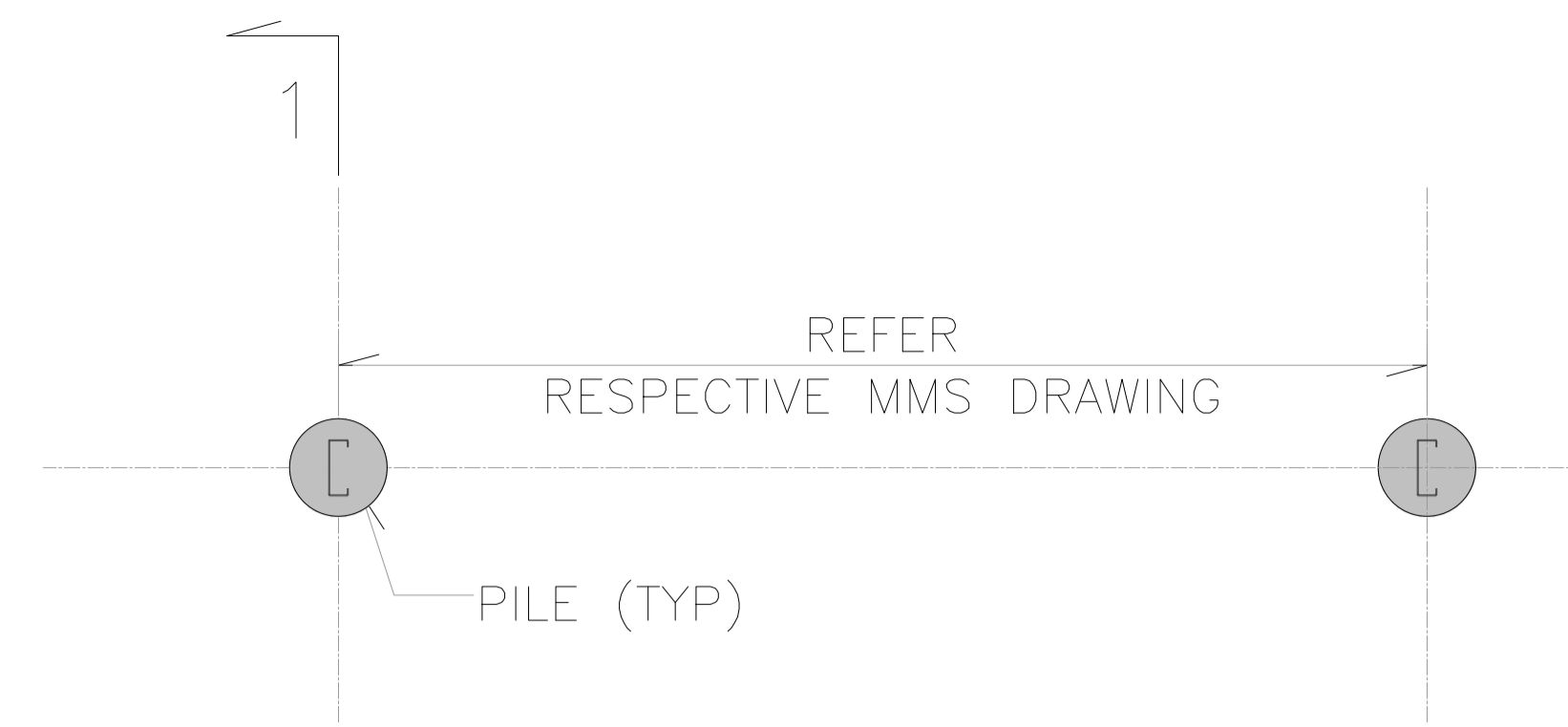


TYP CROSS SECTION OF 4.0 M WIDE INTERNAL ROAD (WBM ROAD)

SCALE: 1:40

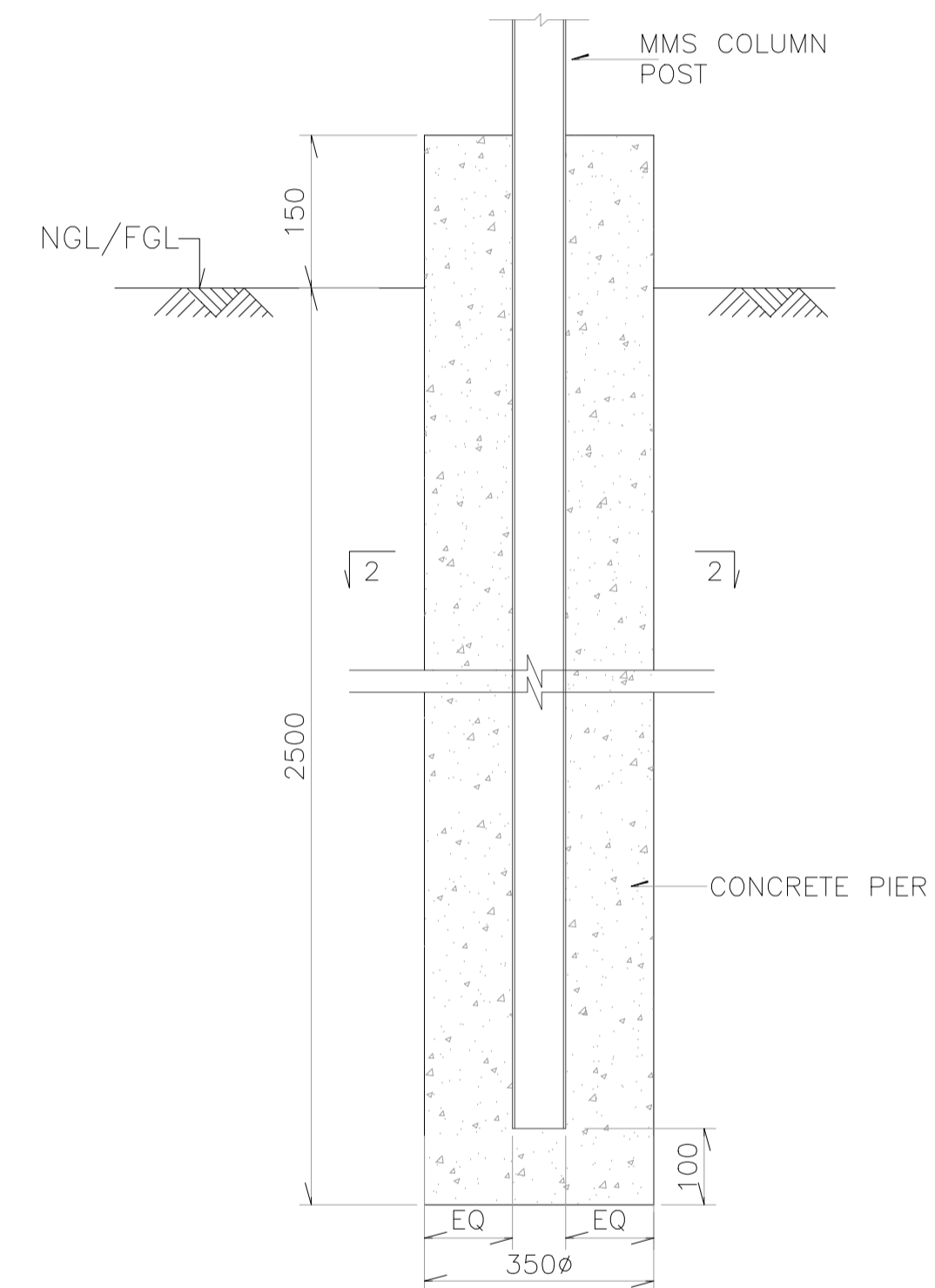
FOR TENDER PURPOSE ONLY

TITLE	INTERNAL ROAD CROSS SECTIONAL DRAWING	
SCALE:	DWG NO.	ISSUE
DC & DISC:	(SHEET 01 OF 01)	P



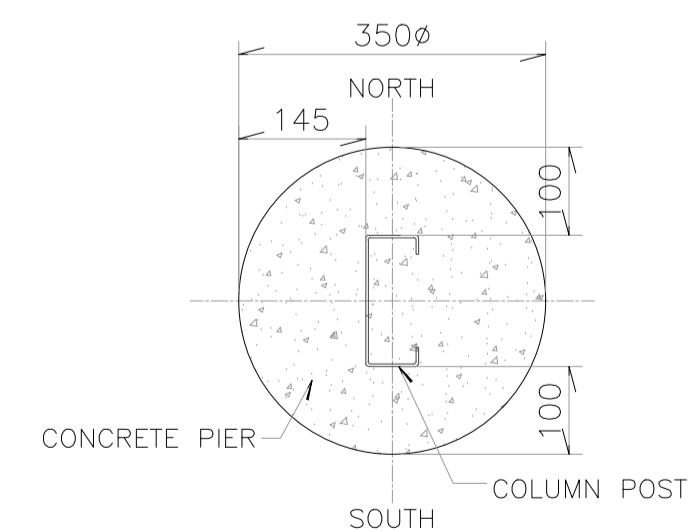
TYPICAL MMS FOUNDATION LAYOUT

NTS



SECT 1-1

(MMS STRUCTURE DETAILS SHOWN TENTATIVELY. FOR ACTUAL DIMENSIONS REFER MMS STRUCTURE GA)
1:10



SECT 2-2

1:10

BILL OF MATERIAL:

DIA(MM)	PILE LENGTH(M)	PILE CAP HEIGHT (M)	CONCRETE(M ³)	BORING(M ³)
350	2.50	0.150	0.2548	0.2404

LEGEND:

- NGL --- NATURAL GROUND LEVEL
- C/C --- CENTER TO CENTER
- TYP --- TYPICAL
- FGL --- FINISHED GROUND LEVEL
- NOS --- NUMBERS

NOTES:

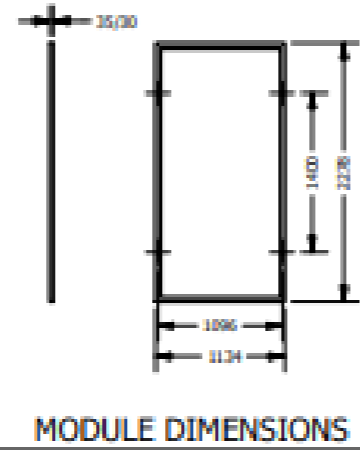
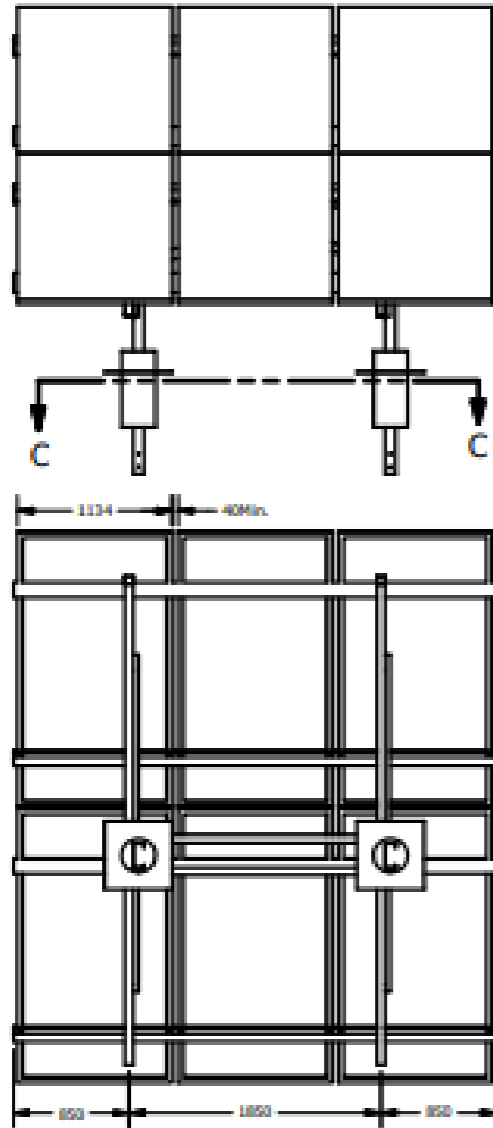
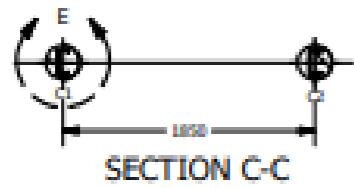
1. ALL DIMENSIONS ARE IN MILLIMETER AND ELEVATIONS IN METER.
2. GRADE OF CONCRETE IS M25, UNLESS OTHERWISE SPECIFIED.
3. DESIGN MIX PROPERTIES SHALL CONFORM TO IS 456-2000.
4. THE MINIMUM CEMENT CONTENT SHOULD BE 300 KG/M³.
5. THE MAXIMUM WATER CEMENT RATIO SHOULD BE 0.45.
6. FOR CONSTRUCTION OF ALL CONCRETE WORKS THE CEMENT USED SHALL BE OF OPC 43 GRADE.
7. CONCRETING BELOW GROUND SHALL BE DONE IN ONE POUR.
8. MINIMUM CLEAR COVER TO STEEL COLUMN SHALL BE 50MM FOR BOTTOM.
9. ORIENTATION OF COLUMN POST SHALL BE AS PER PLOT PLAN AND MMS TABLE ORIENTATION.

FOR TENDER PURPOSE ONLY

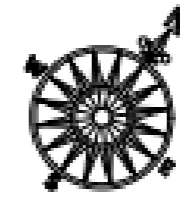
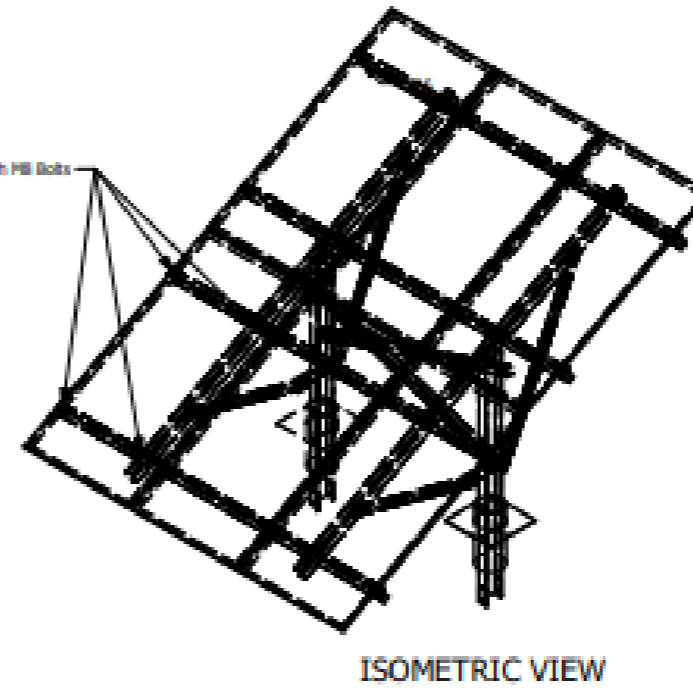
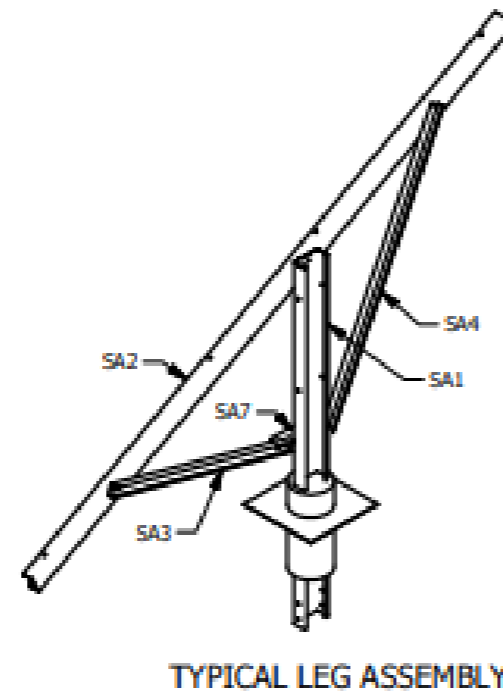
TITLE MMS FOUNDATION DETAILS.

SCALE : NTS DC & DISC: DB-CV DWG NO. (SHEET 01 OF 01) ISSUE P

2PX3 MMS GENERAL ASSEMBLY



4 Point Bolting of Module with HB Bolts



- PROJECT DETAILS:**
- No. of Modules : 06/06
 - Table Size : 2PX3 (MMS)
 - Ground Clearance : 800mm
 - Tilt Angle : +20Deg

Module Parameters in mm					
Module	X	Y	X'	Y'	Z
Solar PV Module	1134	2278	850	1400	35

NOTE: THIS MMS IS SUITABLE FOR ABOVE LISTED MODULES AT SPECIFIED PITCH AS ABOVE.

PARTS LIST

ITEM	PART NUMBER	QTY
1	SA1 - Column	2
2	SA2 - Rafter	2
3	SA3 - Front Bracing	2
4	SA4 - Back Bracing	2
5	SAS - Purlins	4
6	SA6 - Purlin-Rafter Cleat	8
7	SA7 - Brace Mounting Cleat	2
8	SA8 - Leg to Leg Bracing	2
9	SA9 - Column Extension Piece	2



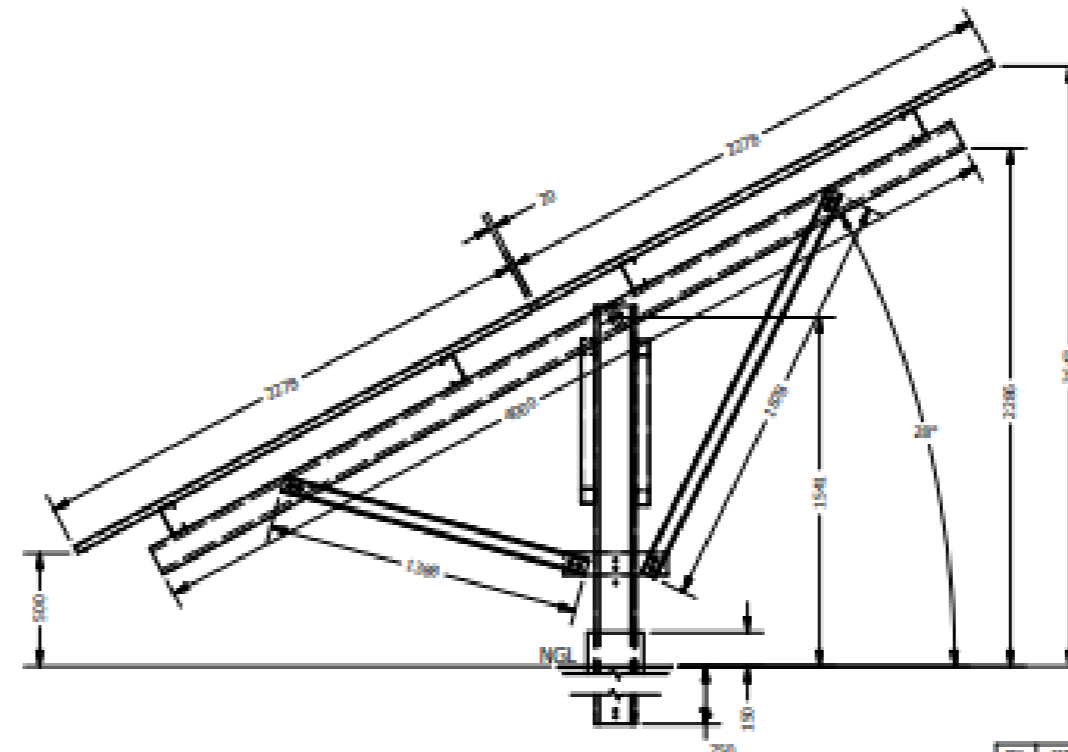
LEGEND:

- SA: Sub Assembly
- GA: General Assembly
- TYP: Typical
- NGL: Normal Ground Level
- MDS: Module Data Sheet
- C'No: Column No. (per number)

MEMBER FABRICATION TOLERANCES:

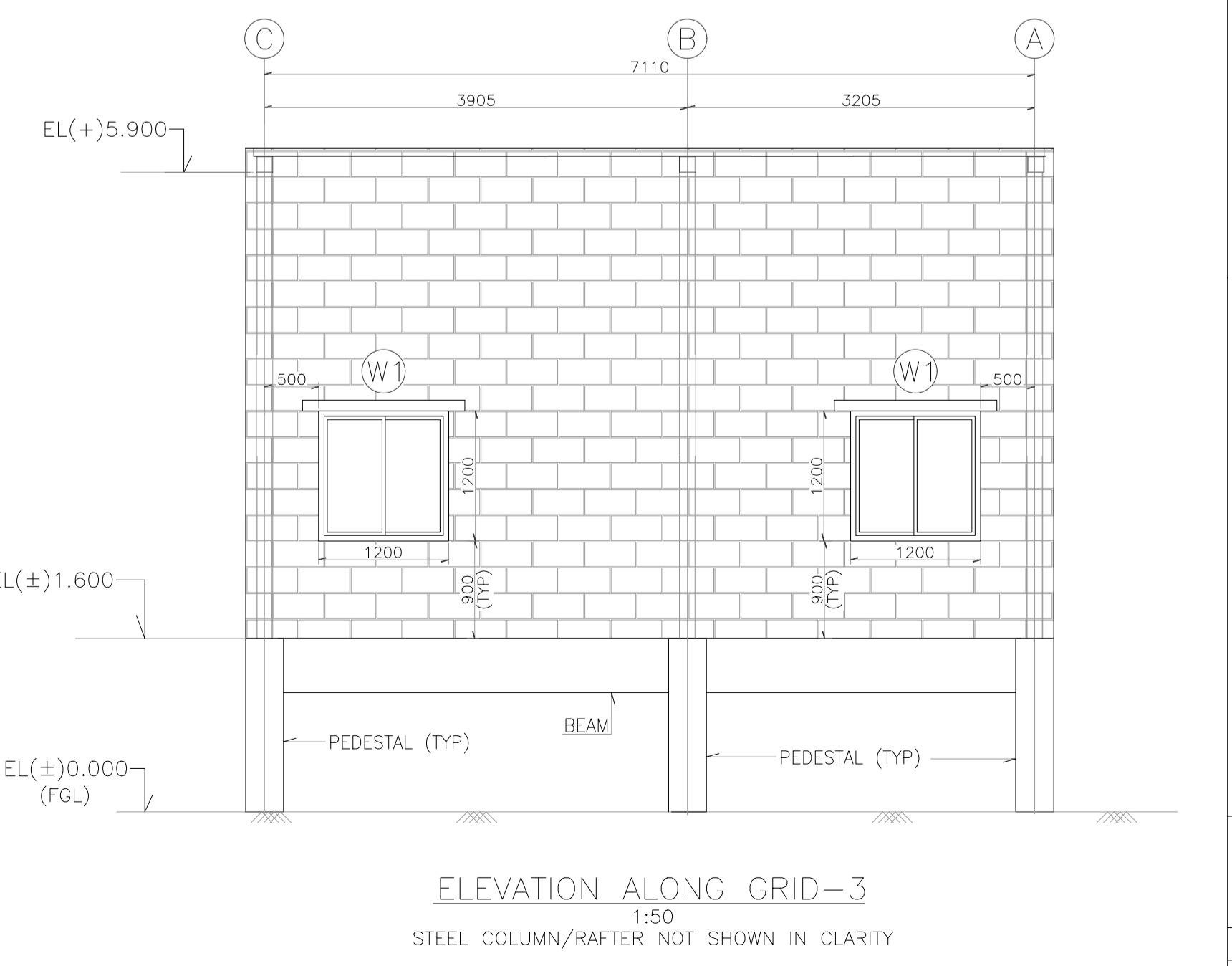
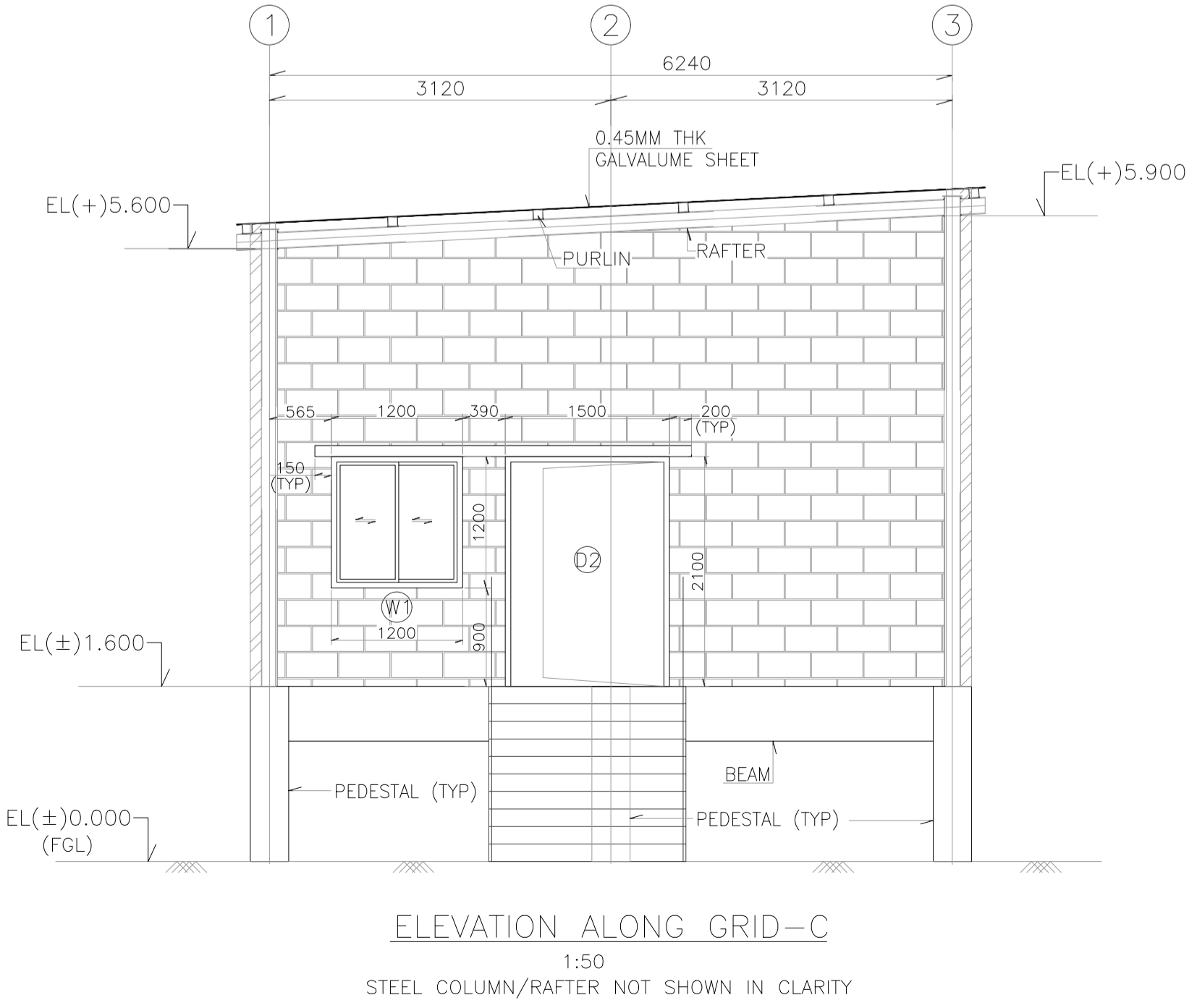
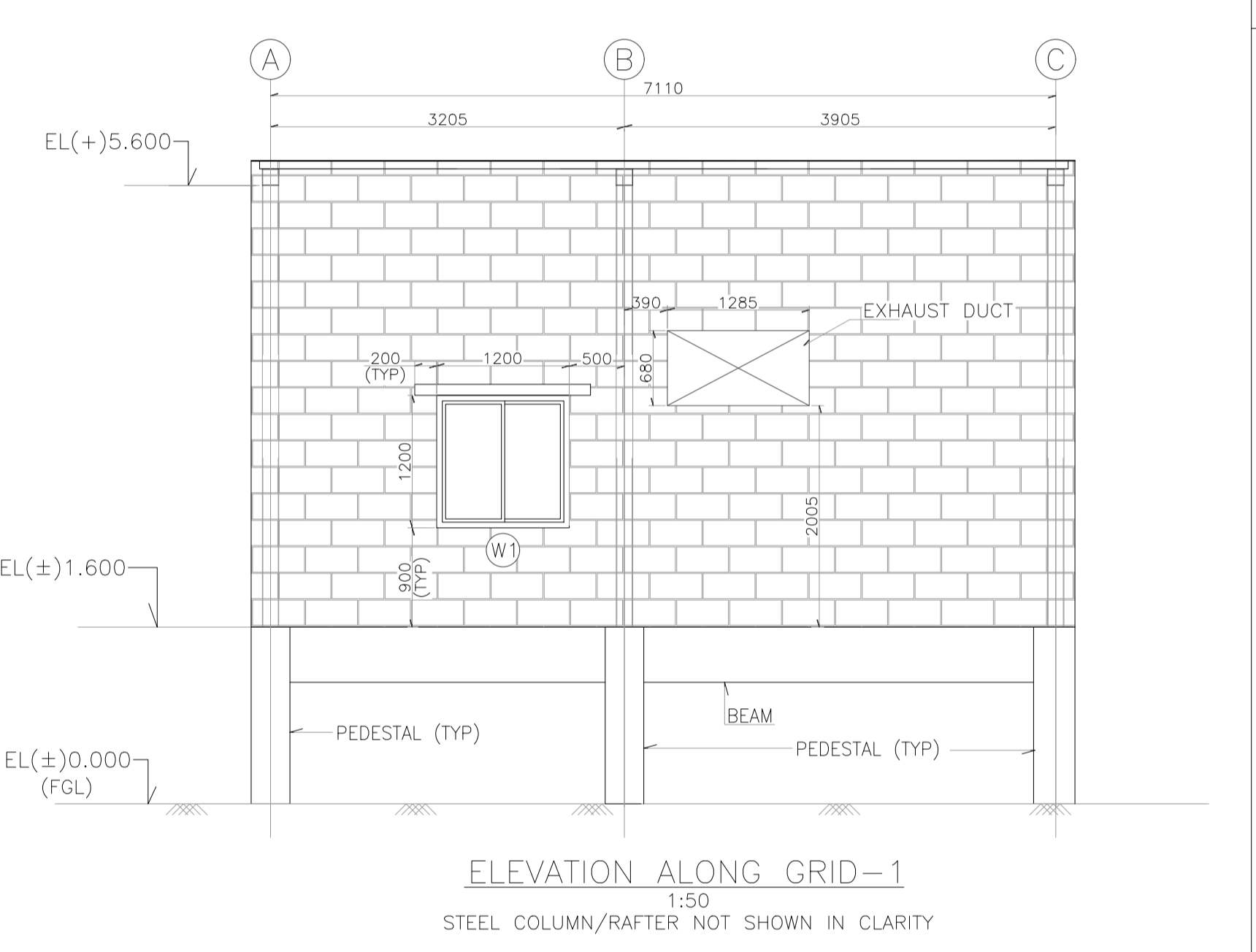
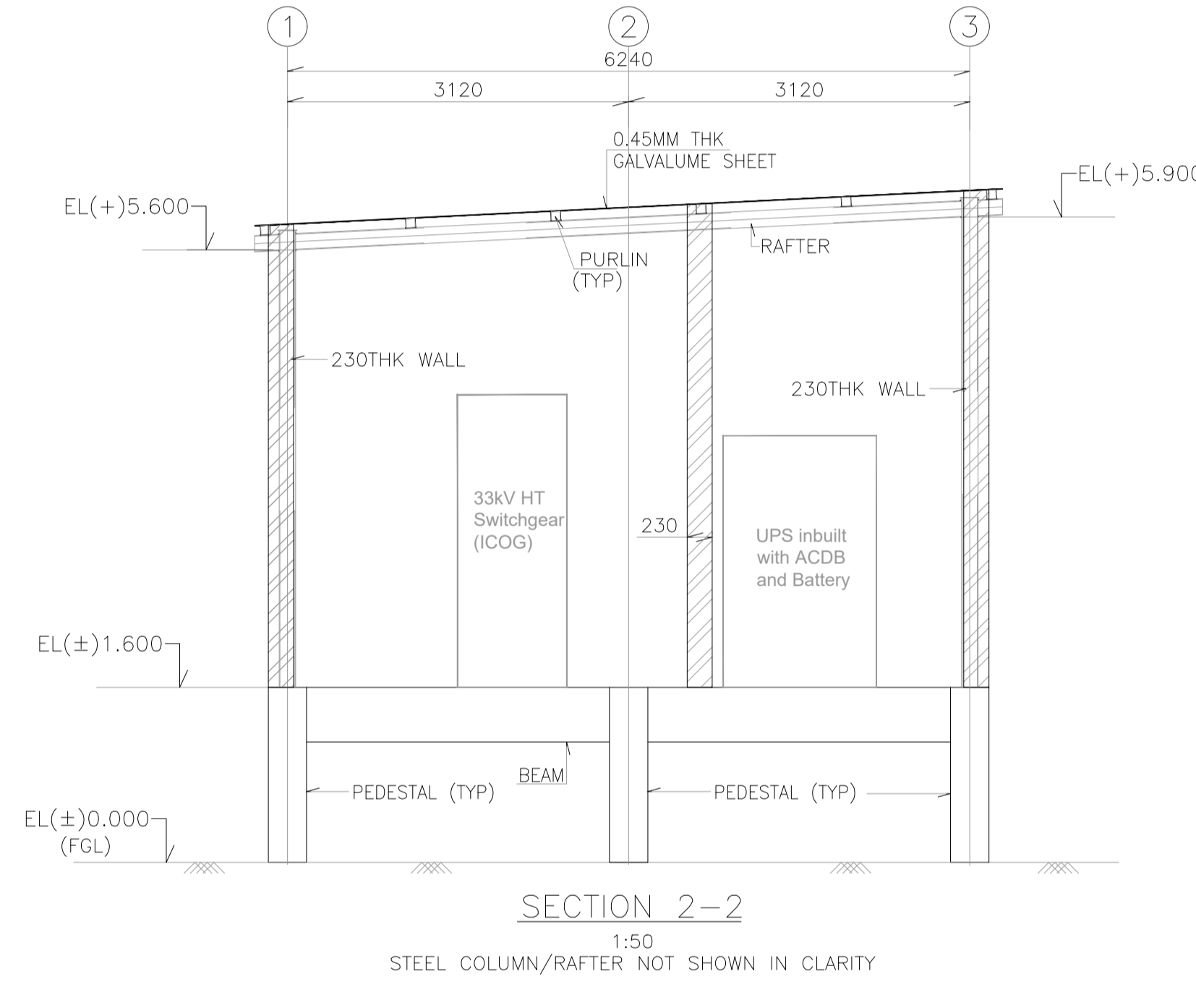
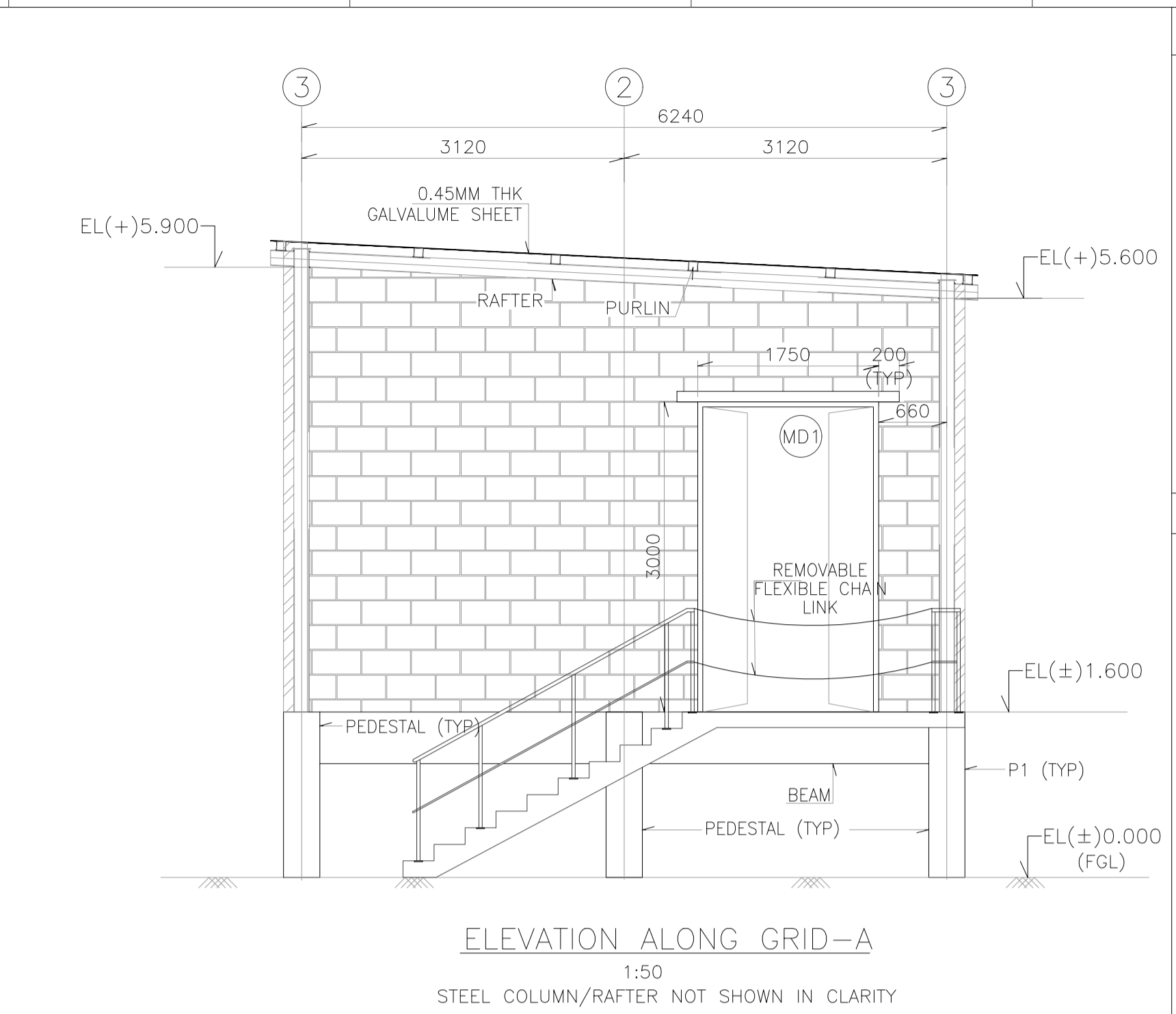
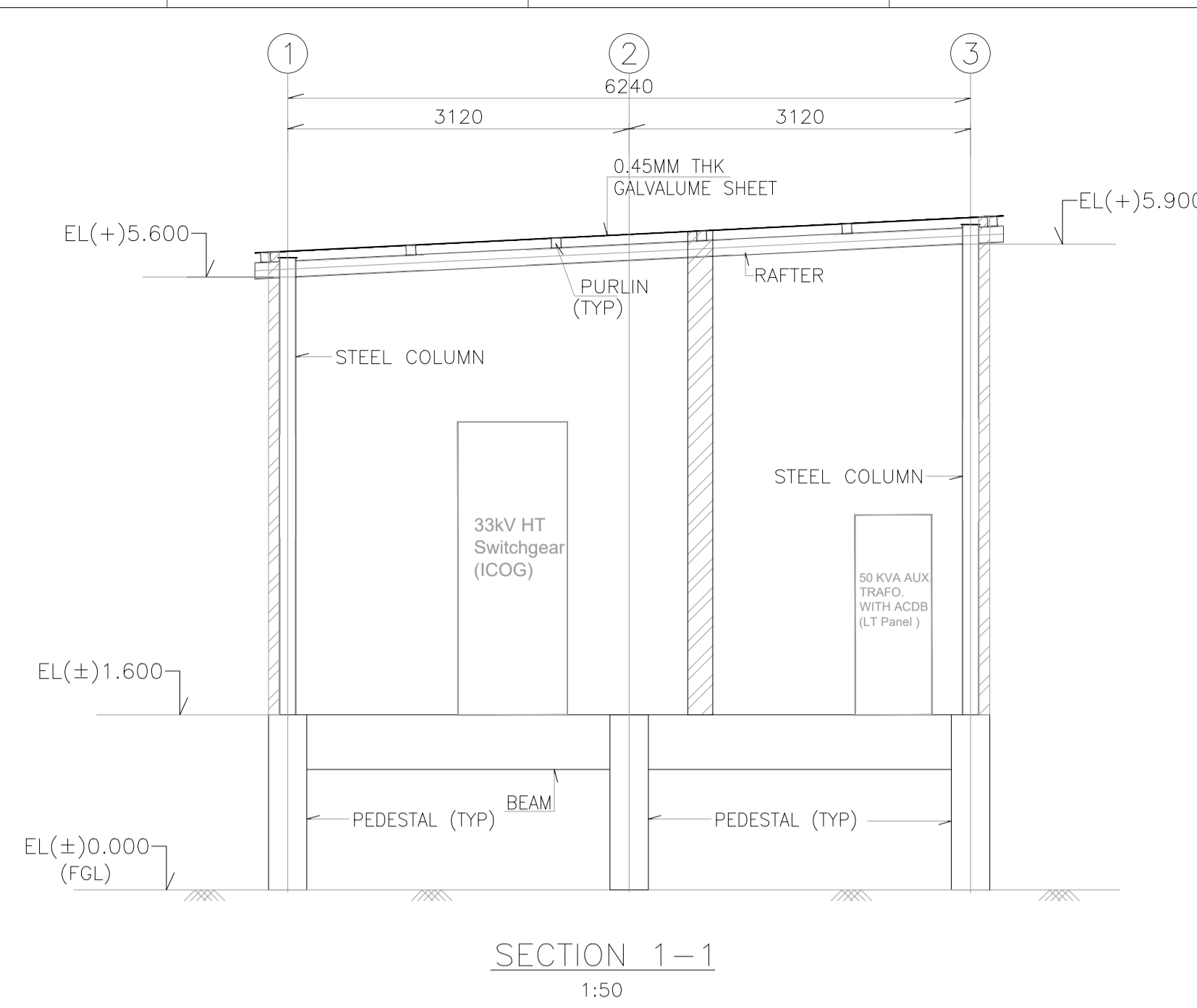
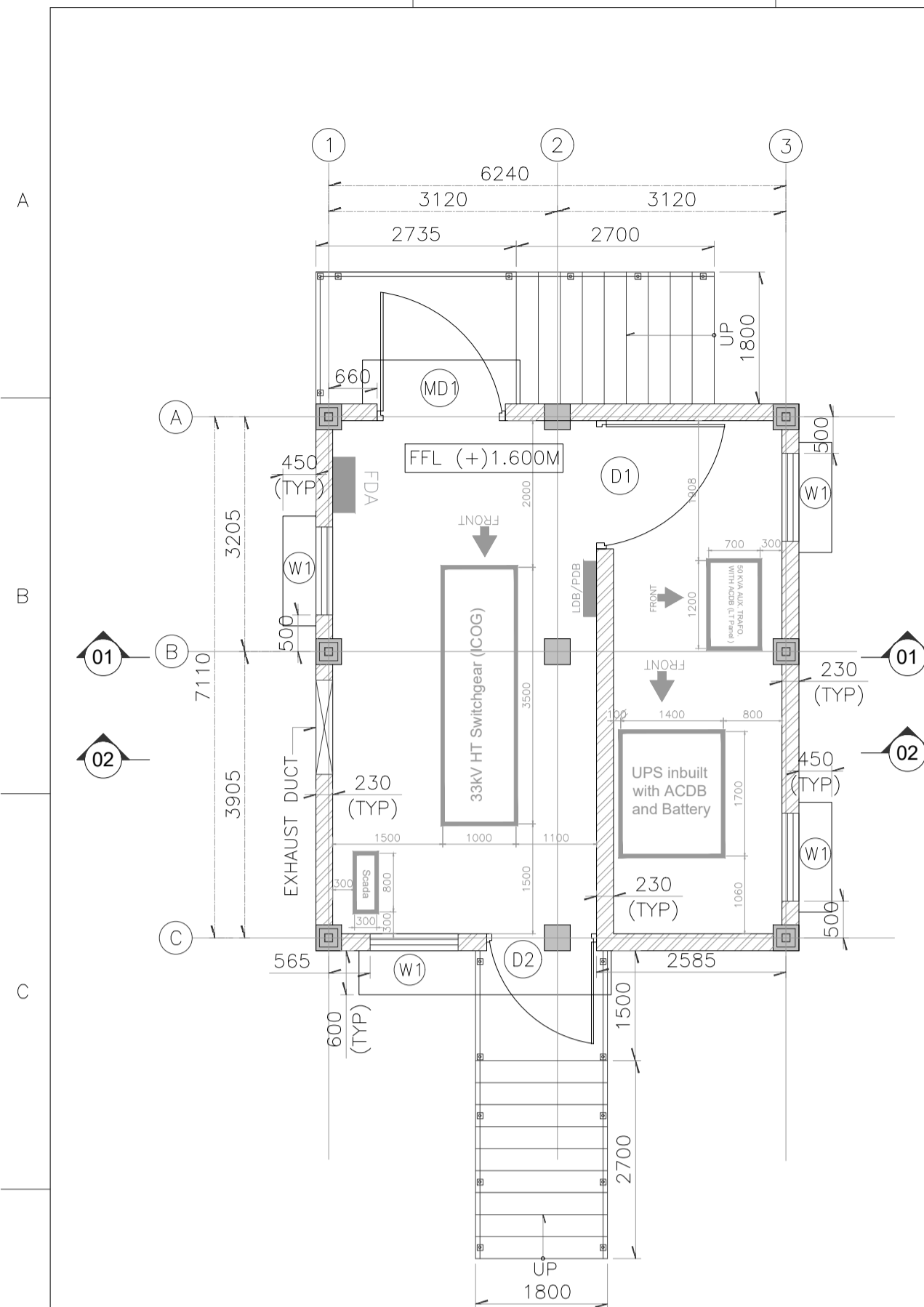
- PROFILE SIZE: ± 0.5 MM
- THICKNESS: ± 0.1 MM
- RIGHT ANGLE: $\pm 0.2^\circ$
- HOLE TO HOLE PITCH: ± 1 MM (MIN)
- EDGE TO HOLE: ± 0.5 MM
- TOTAL LENGTH: ± 0.5 MM
- CAMBER & OVERLAP: 0.2% OF MEMBER LENGTH

END VIEW DIMS:



2P x 3 MODULE MOUNTING STRUCTURE					
SNo.	Main Part	Items	Section	Qty./	Material property
1	SA1	Column	C-Section with Lip	2	Ys 350, Conforms to Gr E350A or C: IS2062-2011/HRD IS1079-2009, HDG Min. 60 Micron
2	SA2	Rafter	C-Section with Lip	2	Galvalume AZ150-Yst-550Mpa
3	SA3	Bracing Front	C-Section with Lip	2	
4	SA4	Bracing Back	C-Section with Lip	2	
5	SAS	Purlins	C-Section with Lip	4	
6	SA6	Purlin-Rafter Cleat	L- Angle	8	Ys 350, Conforms to Gr E350A or C: IS2062-2011/HRD IS1079-2009, HDG Min. 60 Micron
7	SA7	Brace Mounting Cleat	C-Section without Lip	2	Galvalume AZ150-Yst-550Mpa
8	SA8	Leg to leg Bracing	C-Section with Lip	2	Ys 350, Conforms to Gr E350A or C: IS2062-2011/HRD IS1079-2009, HDG Min. 60 Micron
9	SA9	Column Extension Piece	C-Section with Lip	2	

<p>REVISIONS</p> <table border="1"> <tr> <th>NO.</th> <th>DATE</th> <th>DESCRIPTION</th> <th>DESIGN</th> <th>CHECK</th> <th>APPV.</th> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	NO.	DATE	DESCRIPTION	DESIGN	CHECK	APPV.							<p>ISSUED BY: MMS DA DRAWINGS</p>	<p>DATE: </p>	<p>SCALE: </p>	<p>PROJECT: </p>	<p>NO. OF SHEETS: </p>	<p>TOTAL SHEETS: </p>
	NO.	DATE	DESCRIPTION	DESIGN	CHECK	APPV.												
<p>APPROVED BY: </p>																		



LEGEND:

- CL — CENTER LINE
- P — PEDESTAL
- EL — ELEVATION
- TYP — TYPICAL
- THK — THICK
- FGL — FINISHED GROUND LEVEL

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETER AND ELEVATIONS ARE IN METER.
2. EXTERNAL/INTERNAL WALLS OF 230MM THICK AEROCON BLOCK MASONRY SHALL BE IN 1:5 CM.
3. SUN SHADE PROJECTION FOR WINDOWS/DOORS SHALL BE 450/650.
4. ALL INTERNAL WALLS SHALL HAVE 12MM THICK CEMENT PLASTER WITH 1:4 CEMENT MORTAR.
5. THICKNESS OF PLASTER SHALL BE 18MM FOR EXTERNAL WITH 1:4 CEMENT MORTAR.
6. HAND RAILING PIPE SHALL BE G.I PIPE.
7. ALL WINDOW GRILLS SHALL HAVE HOT DIPPED G.I COATED MS GRILLS.
8. FOR ORIENTATION OF INVERTER PEB BUILDING, REFER LATEST APPROVED PLOT PLAN.
9. ANY DISCREPANCY FOUND IN THE DRAWING SHOULD BE INFORMED TO DESIGN OFFICE BEFORE EXECUTION.
10. 2NOS OF 8MM DIA BAR OF LENGTH 300MM SHALL BE WELDED TO THE STEEL COLUMN IN INTERVAL OF EVERY 4 LAYER OF BRICKS AT STEEL COLUMN AND BRICK MASONRY JUNCTION.

ENGG REF DWGS:

SCHEDULE OF FINISHES

ROOM	FLOOR FINISH	INTERNAL WALL FINISH	EXTERNAL WALL FINISH
PLATFORM	30MM THK CEMENT CONCRETE IPS FLOOR (1:2:4)	12MM THICK CEMENT PLASTER WITH 1:4, WITH ACRYLIC EMULSION PAINT	18MM THICK CEMENT PLASTER WITH 1:4, AND WITH EXTERIOR EMULSION PAINT

SILL LEVEL- 9000MM FROM FFL

SCHEDULE OF DOORS

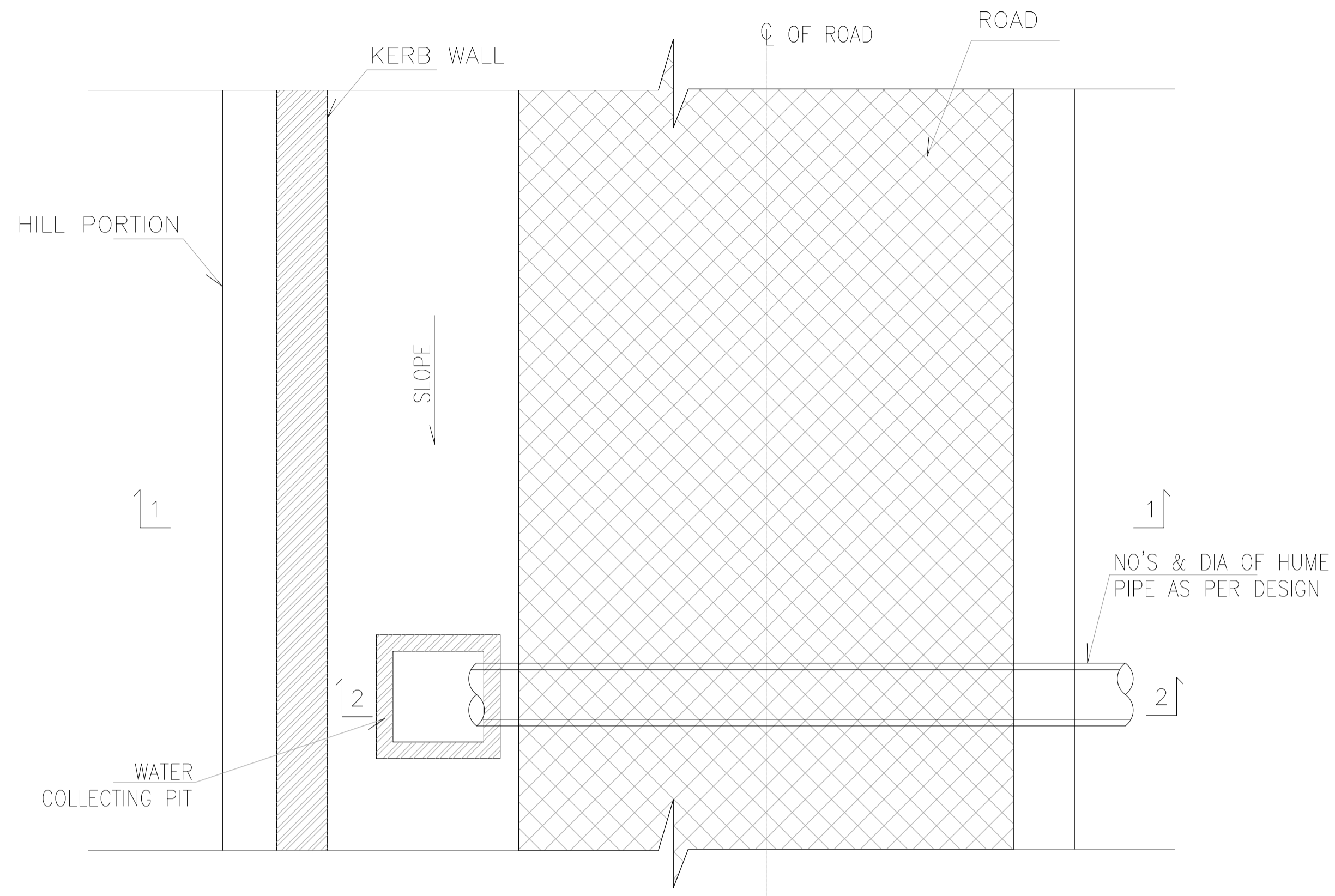
DOOR MARKING	MD1	D1	D2
FRAME SIZE	1750x3000	1750x3000	1500x2100
FRAME	ALUMINUM FRAME (ALUMINUM SECTIONS MINIMUM AVERAGE THICKNESS 2.0MM) ANODIZED GRADE AC25, MIN. THICKNESS 20 MICRONS (S1868)	ALUMINUM FRAME (ALUMINUM SECTIONS MINIMUM AVERAGE THICKNESS 2.0MM) ANODIZED GRADE AC25, MIN. THICKNESS 20 MICRONS (S1868)	ALUMINUM FRAME (ALUMINUM SECTIONS MINIMUM AVERAGE THICKNESS 2.0MM) ANODIZED GRADE AC25, MIN. THICKNESS 20 MICRONS (S1868)
GLASS	8mm THK CLEAR FLOAT GLASS	8mm THK CLEAR FLOAT GLASS	8mm THK CLEAR FLOAT GLASS
SHUTTER	6mm THK SHUTTER AS PER SPECIFICATION	6mm THK SHUTTER AS PER SPECIFICATION	6mm THK SHUTTER AS PER SPECIFICATION
FITTINGS:	HANDLE LOCK HINGE DOOR CLOSURE DOOR STOPS	HANDLE LOCK HINGE DOOR CLOSURE DOOR STOPS	HANDLE LOCK HINGE DOOR CLOSURE DOOR STOPS
QUANTITY	1	1	1
TYPE	OPENABLE LEAF 90° SWING	OPENABLE LEAF 90° SWING	OPENABLE LEAF 90° SWING

WINDOW MKD	W2
FRAME SIZE	1200x1200
MATERIALS	ALUMINUM FIXED FRAME WITH SLIDING SHUTTER.
GLASS TYPE	4MM THK CLEAR FLOAT GLASS
FITTINGS	HANDLE LOCK HINGE MS WINDOW GRILL (10mm SOLID SQUARE BAR)
QUANTITY	4

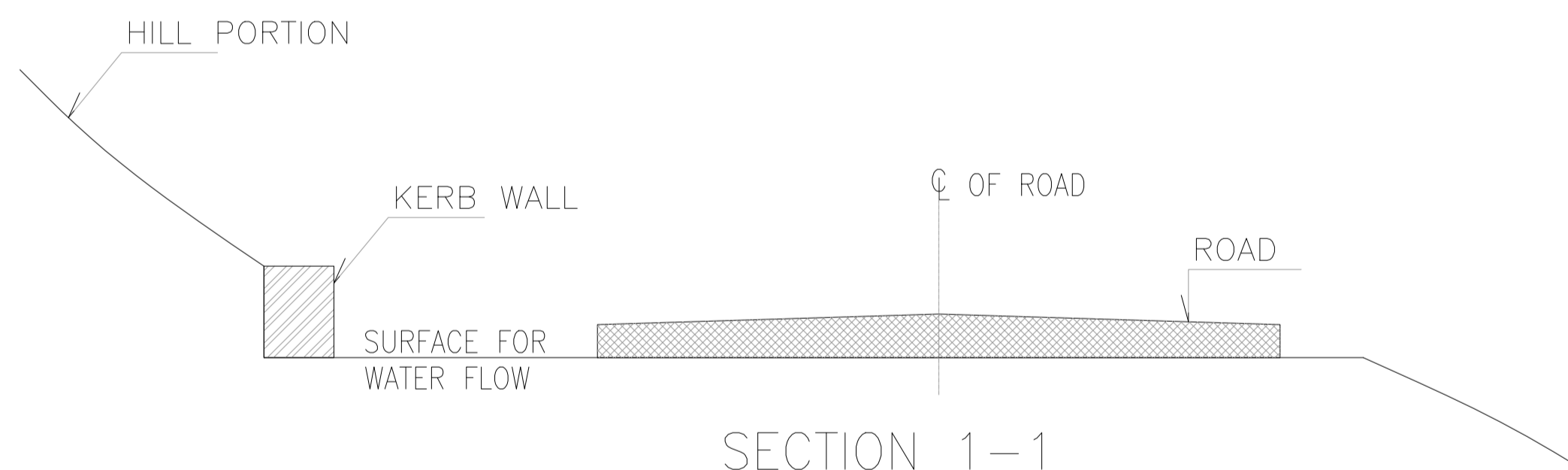
VENDOR/MANUFACTURER TO PROVIDE SHOP DRAWINGS FOR DOORS/WINDOWS BEFORE EXECUTION

FOR TENDER PURPOSE ONLY

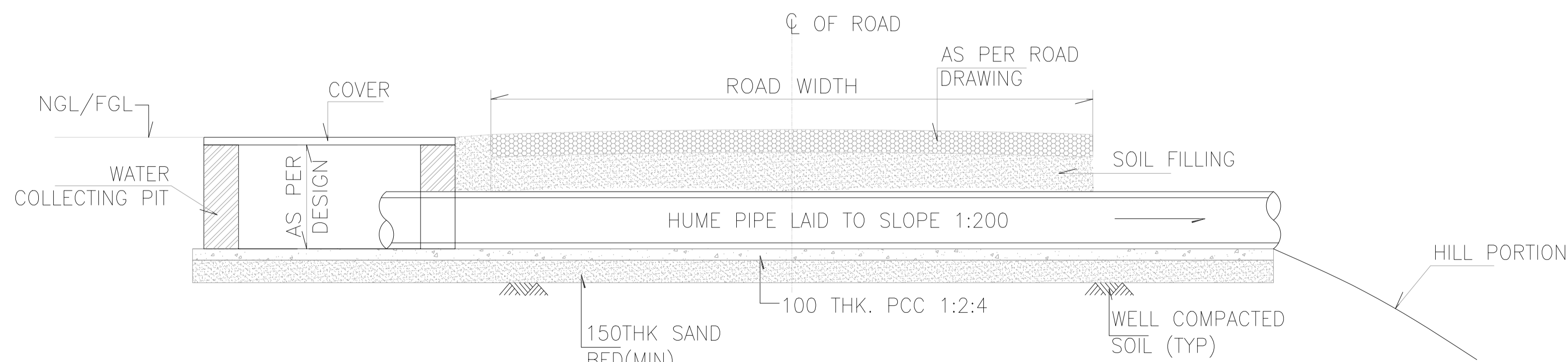
- 1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
- 2. THE DRAWING SHALL BE REFERRED FOR TYPICAL DRAIN/CULVERT DETAIL.
- 10. BOTTOM OF HUMER PIPE SHALL BE PROPERLY COMPACTED UPTO 95% OF STANDARD PROCTOR DENSITY IN THE LAYER OF 150MM THICKNESS.



PLAN OF ROAD CUM CULVERT
SCALE: 1:40



SECTION 1-1
SCALE: 1:40



SECTION 2-2
1:40

FOR TENDER PURPOSE ONLY

TITLE	TYPICAL GROUND CULVERT DETAIL	
SCALE :	DWG NO.	ISSUE
DC & DISC:	(SHEET 01 OF 01)	P

