Draft EPC Contract

TURNKEY SOLAR POWER PROJECT AT HUTTI GOLD MINES

VOLUME II
Draft EPC Contract

September 2015

HUTTI GOLD MINES COMPANY LIMITED

(A Government of Karnataka Enterprises)

IIIrd floor, KHB Complex, National Games Village, Koramangala, Bengaluru – 47 Tel: 080 – 25710501, 25705723, 24, 25 Fax: 080 – 25718365

EPC Contract

This EPC Contract ("Contract") is made at Bengaluru, the ----------day of ----------in the year Two thousand Fifteen

-------- between ----------(herein after referred to as "The Contractor" which expression shall unless excluded by or repugnant to the contract include its successors or permitted assigns) of the one part and the HGML having their Registered Office at Hutti Gold Mines Company Limited, 3rd Floor, KHB Complex, National Games Village, Koramangala, Bengaluru - 560047 only. (hereinafter called "HGML" which expression shall unless excluded by or repugnant to the context include its successors or assigns) of the other part.

WHEREAS the aforesaid HGML has accepted the tender of the aforesaid Contractor for ----------

---------- as per HGML's LOA No.----------

----------hereinafter called "**the Works**" and more particularly described enumerated or referred to in the specification, terms and conditions prescribed in the LOA which for the purpose of identification have been signed by ---------- on behalf of the Contractor and by ----------on behalf of HGML a list whereof is made out in the Schedule hereunder written and all of which said documents are deemed to form part of this contract and included in the expression " **the Works"** wherever herein used, upon the terms and subject to the conditions hereinafter mentioned.

AND WHEREAS HGML has accepted the tender of the Contractor for the said works for the sum of Rs.----------(Rupees:----------) upon the terms and subject to the conditions herein mentioned.

NOW THIS AGREEMENT WITNESSES AND IT IS HEREBY AGREED AND DECLARED THAT:–

(a) The Contractor shall do and perform all works and things in this contract mentioned and described or which are implied therein or therefrom respectively or are reasonably necessary for the completion of the works as mentioned and at the times, in the manner and subject to the terms, conditions and stipulations contained in this contract, and in consideration of the due provision, executions, construction and completion of the works agreed to by the contractor as aforesaid, HGML doth hereby covenant with the Contractor to pay all the sums of money as and when they become due and payable to the Contractor under the provisions of the contract. Such payments to be made at such times and in such manner as is provided by the contract

(b) The conditions and covenants stipulated herein before in this contract are subject to and without prejudice to the rights of the HGML to enforce penalty for delays and / or any other rights whatsoever including the right to reject and cancel on default or breach by the Contractor of the conditions and the covenants as stipulated in the general conditions, specifications, forms, or tender schedule, drawing, etc., attached with HGML's LOA No.----------.

The Contract Value, extent of supply delivery dates, specifications, and other relevant matters may be altered by mutual agreement and if so altered shall not be deemed or construed to mean or apply to affect or alter other terms and conditions of the contract and the general conditions and the contract so altered or revised shall be and shall always be deemed to have been subject to and without prejudice to said stipulation.

SCHEDULE

List of documents forming part of the contract:

1. General Conditions of Contract
2. Special Conditions of Contract
3. Schedule 1: Format for Performance Bank Guarantee
4. Schedule 2: Format of Bank Guarantee for Mobilization Advance
5. Schedule 3: Indemnity Bond
6. Schedule 4: List of Banks
7. Schedule 5: Technical Specifications

In witness whereof the parties hereto have set their hands and seals this day and month year first above written.

Signed, Sealed and delivered by:	Signed, Sealed and delivered by:
(Signature with Name, Designation & official seal)	(Signature with Name, Designation & official seal)

Witnesses:

1. 2.

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A. CONTRACT AND INTERPRETATION

1. DEFINITIONS AND ABBREVIATIONS

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

"**Acceptance**" means acceptance of Facilities by the Employer after third party certification and Commissioning of the Project and demonstration of functioning of the Project.

"**Affected Party**" means HGML or the Contractor whose performance has been affected by an event of Force Majeure.

"**Applicable Law**" means any statute, law, regulation, ordinance, notification, rule, regulation, judgment, order, decree, bye-law, approval, directive, guideline, policy, requirement or other governmental restriction or any similar form of decision of, or determination by, or any interpretation or administration having the force of law in the Republic of India and the State Government, by any Government Authority or instrumentality thereof, whether in effect as of the date of this Contract or thereafter.

"**Bid**" shall mean the proposal submitted by the Contractor along with all documents/credentials/attachments annexure etc., in response to the RFP document, in accordance with the terms and conditions hereof.

"**Commissioning**" means the Project shall be considered commissioned if all equipment as per rated capacity has been installed and energy has transmitted into grid.

"**Completion**" means that the Facilities (or a specific part thereof where specific parts are specified in the SCC) have been completed operationally and structurally, and that all work in respect of Pre-Commissioning of the Facilities or such specific part thereof has been completed; and Commissioning has been attained as per Technical Specifications.

"Completion Schedule" means the Commissioning of Project within six months from the date of signing of this Contract and subsequent O&M for 5 (five) years including one year of successful demonstration of the Project.

"**Contract**" means the Contract Agreement entered into between the Employer and the Contractor, together with the Contract Documents referred to therein; they shall constitute the Contract, and the term "the Contract" shall in all such documents be construed accordingly.

"**Contract Documents**" means the documents listed in the Form of Contract.

"Contract Value" means the firm sum specified in the Contract, subject to such additions and adjustments thereto or deductions therefrom, as may be made pursuant to the Contract i.e. the base value including taxes and duties.

"**Contractor**" means the company whose Bid to perform the Contract has been accepted by the Employer and is named as such in the Contract Agreement, and includes the legal successors or permitted assigns of the Contractor.

"Contractor's Equipment" means all plant, facilities, equipment, machinery, tools, apparatus, appliances or things of every kind required in or for installation, Completion and maintenance of Facilities that are to be provided by the Contractor, but does not include Plant and Equipment, or other things intended to form or forming part of the Facilities.

"Contractor's Representative & Construction Manager" means the representative named in the Contract/appointed by the Contractor as per the provision of Clause 17.2.

"**Day**" means calendar day of the Gregorian calendar.

"Defect Liability Period" means the period of validity of the warranties including O&M of the Facilities for 5 years from Commissioning date, during which the Contractor is responsible for defects with respect to the Facilities (or the relevant part thereof).

"**Employer**" means Hutti Gold Mines Company Limited (HGML), Bengaluru and includes the legal successors or permitted assigns of the Employer.

"**Engineer-in-Charge**" means a graduate electrical engineer to work and over view the implementation of the Project along with Third Party Inspector (graduate electrical engineer) appointed by the Employer to perform the duties delegated by the Employer as per the provision of Clause 17.1.

"Facilities" means the Plant and Equipment to be supplied, installed and commissioned, as well as all the Installation Services including all infrastructure as mentioned in scope of works mentioned at GCC Clause 7 to be carried out by the Contractor under the Contract.

"Functional Guarantee" means during the Guarantee Test, the Facilities and all parts thereof shall attain the guarantees specified under the Technical Specifications.

"**GCC**" means the General Conditions of Contract hereof.

"Guarantee Test(s)" means the test(s) specified in the Technical Specifications to be carried out to ascertain whether the Facilities or a specified part thereof is able to attain the Functional Guarantees specified in the Technical Specifications.

"HGML" shall mean Hutti Gold Mines Company Limited.

"IEC" means International Electro-technical Commission.

"Installation Services" means all those services ancillary to the supply of the Plant and Equipment for the Facilities, to be provided by the Contractor under the Contract; e.g., transportation and provision of marine or other similar insurance, inspection, Site preparation works (including the provision and use of Contractor's Equipment and the supply of all use structural and construction materials required), installation including civil and allied works etc., testing, Pre-Commissioning, Commissioning, operations, maintenance, the provision of operations and maintenance manuals, training of Employer's Personnel etc.

"LoA" means Letter of Award issued to the Selected Bidder in accordance with the provision of RFP document.

"**Month**" means calendar month of the Gregorian calendar.

"O&M" means Operation and Maintenance of the Facilities.

"Operational Acceptance" means the acceptance by the Employer of the Facilities (or any part of the Facilities where the Contract provides for acceptance of the Facilities in parts), which certifies the Contractor's fulfillment of the Contract in respect of Functional and Plant Performance Guarantees of the Facilities.

"Performance Demonstration Period" means the period during which the Contractor is required to demonstrate the performance of the plant as per the requirements specified in Schedule 5 – Technical Specifications of this Contract.

"Plant and Equipment" means permanent plant, equipment, machinery, apparatus, articles and things of all kinds to be provided and incorporated in to the Facilities by the Contractor under the Contract (including the spare parts), but does not include Contractor's Equipment.

"Plant Performance Guarantee Test" means the Tests conducted by the Contractor after Commissioning of the Facilities.
"**PR**" means Performance Ratio.

"Pre-Commissioning" means the testing, checking and other requirements specified in the Technical Specifications that are to be carried out before Commissioning by the Contractor in co-ordination with Engineer-in-Charge and Third Party Inspector.

"SCC" means the Special Conditions of Contract.

"**Site**" means the land and other places upon which the Facilities are to be installed, and such other land or places as may be specified in the Contract as forming part of the Site.

"Solar Power Plant" or "Solar PV Plant" means Gird Connected 14MW Solar Photovoltaic Power Plant engineered, procured, supplied and commissioned by the Contractor in accordance with the provisions of this Agreement and Schedule 5 – Technical Specifications of this Contract.

"**Sub-contractor,**" including vendors, means any person to whom execution of any part of the Facilities, including preparation of any design or supply of any Plant and Equipment, is sub-contracted directly or indirectly by the Contractor, and includes its legal successors or permitted assigns.

"Third Party Inspector" means the third party appointed by the Employer for monitoring and supervision of the Project.

"Time for Completion" means the time within which Completion of the Facilities as a whole (or of a part of the Facilities where a separate Time for Completion of such part has been prescribed) is to be attained in accordance with the stipulations in the SCC and the relevant provisions of the Contract.

2. USE OF CONTRACT DOCUMENTS & INFORMATION

2.1 All documents forming part of the Contract (and all parts thereof) are intended to be correlative, complementary and mutually explanatory. The Contract shall be read as a whole.

2.2 The Contract will be signed in three originals and the Contractor shall be provided with one signed original and the rest will be retained by the Employer.

2.3 The Contractor shall provide/ submit, free of cost to the Employer all the engineering data, drawings and descriptive materials with the Bid, in at least three (3) copies to form a part of the Contract immediately after issuance of LoA by HGML.

2.4 The Contractor shall not, without the Employer's prior written consent, disclose the Contract or any provision thereof or any specification, plan, drawing, pattern therewith to any person other than person employed by the Contractor in performance of the Contract. Disclosure to any such employed person shall be made in confidence and shall extend strictly for purpose of performance of the Contract only.

2.5 The Contractor shall not, without Employer's prior written consent, make use of any document or information except for purpose of performing the Contract.

2.6 Any document other than the Contract itself, shall remain the property of the Owner/Employer.

3. INTERPRETATION

3.1 Language

All correspondence and documents related to the EPC Contract exchanged between the Contractor and the Employer shall be written in English language, provided that any printed literature furnished by the Contractor may be written in another language, as long as such literature is accompanied by a translation of its pertinent passages in English language in which case, for purposes of interpretation of the EPC Contract, the translation shall govern.

3.2 Singular and Plural

The singular shall include the plural and the plural the singular, except where the context otherwise requires.

3.3 Headings

The headings and marginal notes in the General Conditions of Contract are included for ease of reference, and shall neither constitute a part of the Contract nor affect its interpretation.

3.4 Persons

Words importing persons or parties shall include firms, corporations and government entities.

3.5 Entire Agreement

The Contract constitutes the entire agreement between the Employer and Contractor with respect to the subject matter of Contract and supersedes all communications, negotiations and agreements (whether written or oral) of parties with respect thereto made prior to the date of Contract. The various documents forming the Contract are to be taken as mutually explanatory.

3.6 Amendment

No amendment or other variation of the Contract shall be effective unless it is in writing, is dated, expressly refers to the Contract, and is signed by a duly Authorized Representative of each party hereto.

3.7 Independent Contractor

3.7.1 The Contract does not create any agency, partnership, joint venture or other joint relationship between the parties hereto.

3.7.2 Subject to the provisions of the Contract, the Contractor shall be solely responsible for the manner in which the Contract is performed. All employees, representatives or Sub-contractors engaged by the Contractor in connection with the Performance of the Contract shall be under the complete control of the Contractor and shall not be deemed to be employees of the Employer. Nothing contained in the Contract or in any subcontract awarded by the Contractor shall be construed to create any contractual relationship between any such employees, representatives or Sub-contractors and the Employer.

3.7.3 Under no circumstances the Sub-contractor shall claim or shall put any binding to the Employer and at all times the Sub-contractor must be managed by the Contractor. The Employer shall not be responsible for any claims at any time by the Contractor in relation to the Sub-contractor.

3.8 Non-Waiver

3.8.1 Subject to GCC Clause 3.8.2 below, no relaxation, forbearance, delay or indulgence by either party in enforcing any of the terms and conditions of the Contract or the granting of time by either party to the other shall prejudice, affect or restrict the rights of that party under the Contract, nor shall any waiver by either party of any breach of Contract operate as waiver of any subsequent or continuing breach of Contract.

3.8.2 Any waiver of a party's rights, powers or remedies under the Contract must be in writing, must be dated and signed by an Authorized Representative of the party granting such waiver, and must specify the right and the extent to which it is being waived.

3.9 Severability

a. If any provision or condition of the Contract is prohibited or rendered invalid or unenforceable, such prohibition, invalidity or unenforceability shall not affect the validity or enforceability of any other provisions and conditions of the Contract.

b. It is stated that each paragraph, clause, sub-clause, schedule or annexure of this Contract shall be deemed severable & in the event of the unenforceability of any paragraph, clause sub-clause, schedule or the remaining part of the paragraph, clause, sub-clause, schedule annexure & rest of the Contract shall continue to be in full force & effect.

3.10 Country of Origin

"Origin" means the place where the materials, equipment and other supplies for the Facilities are mined, grown, produced or manufactured and from which the services are provided.

4. NOTICES

4.1 Unless otherwise stated in the Contract, all notices to be given under the Contract shall be in writing, and shall be sent by personal delivery, registered post, special courier, or e-mail to the address of the relevant party by the Authorized Representative of the party set out in Contract coordination procedure to be finalized and mutually agreed for the execution of the Contract and all the communication pertaining to Project shall be in accordance with the procedure with the following provisions.

4.1.1 Any notice sent shall be confirmed within two (2) days after receipt.

4.1.2 Either party may change its postal, cable, telex, or e-mail address or addresses for receipt of such notices by ten (10) days' notice to the other party in writing.

4.2 Notices shall be deemed to include any approvals, consents, instructions, orders and certificates to be given under the Contract.

5. GOVERNING LAWS

5.1 The Contract shall be governed by and interpreted in accordance with laws in force in India. The Courts of Bengaluru shall have exclusive jurisdiction in all matters arising under the Contract.

5.2 The Contract must be interpreted and read under the influence of Indian Contracts Act, 1872 and all amendments as on date.

6. SETTLEMENT OF DISPUTES

6.1 Dispute Resolution

6.1.1 Either Party is entitled to raise any claim, dispute or difference of whatever nature arising under, out of or in connection with this Contract ("Dispute") by giving a written notice (Dispute Notice) to the other party, which shall contain:

a) a description of the Dispute;
b) the grounds for such Dispute; and
c) all written material in support of its claim.

6.1.2 The other party shall, within thirty (30) days of issue of Dispute Notice issued under Clause 6.1.1, furnish:
a) counter-claim and defences, if any, regarding the Dispute; and
b) all written material in support of its defences and counter-claim.

6.1.3 Within thirty (30) days of issue of Dispute Notice by any Party pursuant to Clause 6.1.1 if the other party does not furnish any counter claim or defense under Clause 6.1.2 or thirty (30) days from the date of furnishing counter claims or defense by the other Party, both the Parties to the Dispute shall meet to settle such Dispute amicably. If the Parties fail to resolve the Dispute amicably within thirty (30) days from the later of the dates mentioned in this Clause 6.1.3, the Dispute shall be referred for dispute resolution in accordance with Clause 6.2.

6.2 Arbitration

6.2.1 It is agreed by the Parties that, any disputes or claims arising out of this Agreement shall be settled by the sole or several arbitrators appointed in accordance with The Arbitration Centre-Karnataka (Domestic and International), Rules 2012.

6.2.2 The place of arbitration shall ordinarily be Bengaluru but by agreement of the Parties, the arbitration hearings, if required, may be held elsewhere.

6.2.3 The request for arbitration, the answer to the request, the terms of reference, any written submissions, any orders and awards shall be in English and, if oral hearings take place, English shall be the language to be used in the hearings.

6.2.4 The provisions of this Clause shall survive the termination of this Agreement for any reason whatsoever.

6.2.5 The award shall be of majority decision. If there is no majority, the award will be given by the presiding Arbitrator.

6.2.6 The Parties agree that the decision or award resulting from arbitration shall be final and binding upon the Parties and shall be enforceable in accordance with the provisions of the Arbitration Centre – Karnataka (Domestic and International), Rules 2012 subject to the rights of the aggrieved parties to secure relief from any higher forum.

6.3 Reference to Arbitration

Notwithstanding any reference to the Arbitration herein,

6.3.1 The parties shall continue to perform their respective obligations under the Contract unless they otherwise agree.

6.3.2 The Employer shall pay the Contractor any payment due to the Contractor.

B. Subject Matter of Contract:

7. SCOPE OF FACILITY

7.1 The scope of Facility includes, but not limited to, the following:

7.1.1 Design, engineering, manufacturing, procurement & supply, packing and forwarding, transportation, unloading, storage, erection & installation, testing, Commissioning of Solar PV Power Plant and comprehensive O&M for 5 (Five) years of Solar PV Power Plant for the capacity mentioned in SCC. The Contractor shall register the Project for Clean Development Mechanism (CDM) benefit.

7.1.2 All associated civil engineering works including design for:

a) Soil testing, earthwork for Site grading, cutting, filling, levelling & compacting of land

b) Construction of foundation & mounting structures for SPV panels

c) Fencing of SPV plant with security gate (s)

d) Installation of fire safety equipment.

e) Construction of equipment room and office cum control room.

f) Arrangement of permanent water supply for module washing and daily usage.

g) Construction of Storm water drainage & sewage network

h) Construction of Approach Road to plant from main Road and road network within plant for easy access to main locations for O&M.

i) Street lighting and area lighting within plant

7.1.3 All power conditioning system including junction boxes, Inverters/ PCU, DC and AC circuit breaker(s).

7.1.4 Integrated microprocessor based SCADA with required software and hardware for control and monitoring of SPV plant.

7.1.5 All associated electrical works required for interfacing at grid network voltage prescribed (i.e. transformer(s), breakers, isolators, lightning arrestor(s), panels, protection system, cables, metering, earthing of transformer etc.) as per Technical Specifications.

7.1.6 Design, supply, erection, testing & commissioning of transmission line / cabling and associated switchgear equipment, transformer and metering equipment for connecting into existing nearby switchyard as per Technical Specification and State Regulations.

7.1.7 Design and implementation of plant monitoring scheme with compatible software and hardware for accessing the SCADA data remotely at a location in Hutti.

7.1.8 Comprehensive O&M of the SPV plant as detailed in Technical Specification including supply and storage of all spare parts, consumables, repairs/ replacement of any defective equipment etc.

7.1.9 Obtaining all associated Statutory and Regulatory compliances and approvals for successful construction and operation of Plant.

7.1.10 Provision and inventory management of all mandatory and recommended spares as per the OEM recommendation and plant requirement.

7.1.11 Scrap disposal and waste management including removal of debris and other non-usable material.

7.2 The Contractor is free to use materials or equipment's having standards exceeding, the specification mentioned under the Technical Specification.

7.3 Unless otherwise expressly limited in the Technical Specifications, the Contractor's obligations

cover the provision of all Plant and Equipment including spares and the Performance of all services required for the design, the manufacture (including procurement, quality assurance, construction, installation, associated civil, structural and other construction works, Pre-Commissioning and delivery) of the Plant and Equipment and the installation, Commissioning, Completion of Facilities and carrying out Guarantee Tests for the Facilities in accordance with the plans, procedures, specifications, drawings, codes and any other documents as specified in the Technical Specifications. Such specifications include, but are not limited to, the provision of supervision and engineering services; the supply of labor, materials, equipment, spare parts (as specified in GCC Sub-Clause 7.5 below) and accessories; Contractor's Equipment; construction utilities and supplies; temporary materials, structures and facilities; transportation (including, without limitation, loading, unloading and hauling to, from and at the Site); insurance and storage, except for those supplies, works and services that will be provided or performed by the Employer, as set forth in GCC Clause 9.

7.4 The Contractor shall, unless specifically excluded in the Contract, perform all such work and/or supply all such items and materials not specifically mentioned in the Contract but that can be reasonably inferred from the Contract as being required for attaining Completion of the Facilities as if such work and/or items and materials were expressly mentioned in the Contract.

7.5 In addition to the supply of mandatory spare parts included in the Contract, the Contractor agrees to supply spare parts, recommended or otherwise required for the O&M of the Facilities. However, the identity, specifications and quantities of such spare parts and the terms and conditions relating to the supply thereof are to be agreed between the Employer and the Contractor based on the recommendation of OEM, and the price of such spare parts shall be that given as part of Appendix V: Proforma for Financial Proposal of the RFP document, which shall be added to the Contract Value. The price of such spare parts shall include the purchase price therefor and other costs and expenses (including the Contractor's fees) relating to the supply of spare parts. The prices of spares covered under the Appendix V of the RFP document shall be kept valid for a period as specified in SCC. Contractor shall maintain the minimum required spares mandatory or recommended or otherwise at any time during the O&M period.

8. CONTRACTOR'S RESPONSIBILITY

8.1 The Contractor shall design, procure, manufacture (including associated purchases and/or subcontracting), install, commission and complete the Facilities, carry out the Guarantee Tests with due care and diligence in accordance with the Contract including the O&M for the prescribed period.

8.2 The Contractor confirms that it has entered into this Contract on the basis of a proper examination of the data relating to the Project provided by the Employer and assessed by himself at the Site location, and on the basis of information that the Contractor could have obtained from a visual inspection of the Site (if access thereto was available) and of other data readily available to it only after proper due diligence relating to the requirement for executing the Project and facilities available prior to Bid submission. The Contractor acknowledges that any failure to acquaint itself with all such data and information shall not relieve its responsibility

for properly estimating the difficulty or cost of successfully performing the Scope of Work.

8.3 The Contractor shall acquire at its own cost, on behalf of the Employer, in the Employer's name, all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in the country where the Site is located that are necessary for the setting up of the Solar Power Plant mentioned under the Contract. The Contractor shall be responsible for, but not limited to, entry permits for all imported Employer's Equipment (if any). In this regard, any document required from Employer shall be intimated at least 10 days prior to submission. Contractor has to ensure safe keeping of the documents and diligent use. It is the responsibility of the Contractor to safe keep and return all the approvals, permits, licenses, certificates and other relevant document generated as a result of the setting up of Project and O&M process to the Employer.

8.4 The Contractor shall also seek for any exemption applicable for the Project as per the orders released from GOI time to time. In this regard, the Contractor shall be responsible to take all necessary certificates as a proof of exemptions on behalf of Employer. The Contractor shall register the Project for Clean Development Mechanism (CDM) benefit. However, all the documents required from Employer, as needed for the process, will be provided by Employer. The demand of such documents shall be made to the Employer in at least 10 days advance.

8.5 The Contractor shall comply with all laws in force at the place, where the Facilities are installed and where the Installation Services are carried out. The laws will include all national, provincial, municipal or other laws that affect the Performance of the Contract and binding upon the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any and all liabilities, damages, claims, fines, penalties and expenses of whatever nature arising or resulting from the violation of such laws by the Contractor or its personnel, including the Sub-contractors and their personnel, but without prejudice to GCC Sub-Clause 9.1 hereof.

8.6 Any plant, material, spares & spares inventory and services that will be incorporated in or be required for the Facilities and other supplies shall have their origin as defined under GCC Clause 3.10 (Country of Origin).

8.7 Unless otherwise specified in the Contract or agreed upon by the Employer and the Contractor, the Contractor shall provide/ deploy sufficient, properly qualified operating and maintenance personnel; shall supply and make available all raw materials, spares, other materials and facilities; and shall perform all work and services of whatsoever nature, to properly carry out Pre-Commissioning, Commissioning and Guarantee Tests, all in accordance with the provisions of "Technical Specifications" to the Contract at or before the time specified in the program furnished by the Contractor under GCC Clause 18 hereof and in the manner thereupon specified or as otherwise agreed upon by the Employer and the Contractor.

9. EMPLOYERS' RESPONSIBILITY

9.1 The Employer shall ensure the accuracy of all information and/or data to be supplied by the Employer as described in Scope of Works and Supply by the Employer to the Contract, except

when otherwise expressly stated in the Contract.

9.2 The Employer shall be responsible for acquiring and providing legal and physical possession of the Site thereto required for the proper execution of the Contract. The Employer shall give full possession of Site and accord all rights of access thereto on or before the date(s) specified in SCC.

9.3 If requested by the Contractor and up on Employer's sole discretion, the Employer shall use its best endeavors to assist the Contractor in obtaining in a timely and expeditious manner all permits, approvals and/or licenses necessary for the execution of the Contract from all local, state or national government authorities or public service undertakings that such authorities or undertakings required for the Contractor or Sub-contractors or the personnel of the Contractor or Sub-contractors, as the case may be, to obtain.

9.4 The Employer shall be responsible for the O&M of the Facilities after Completion and proper hand over of the Site by Contractor, in accordance with GCC Clause 26 and 27. However, the Contractor, undertake O&M and, shall be responsible for the care and custody of the facility as per GCC Clause 26.9.

C. Payments

10. CONTRACT VALUE

10.1 The Contract Value mentioned under Appendix V: Proforma for Financial Proposal shall be firm and shall not change after the Award of Contract.

10.2 Subject to GCC Sub-Clauses 8.2 and 9.1 hereof, the Contractor shall be deemed to have satisfied itself as to the correctness and sufficiency of the Contract Value, which shall, except as otherwise provided for in the Contract, cover all its obligations under the Contract.

10.3 Contract Value shall be adjusted in accordance with the provisions of GCC Clause 29.

11. TERMS OF PAYMENT

11.1 The terms of Payment shall be as specified in SCC. The procedures to be followed in making application for and processing payments shall be those outlined in the same SCC Clause.

11.2 No payment made by the Employer herein shall be deemed to constitute acceptance by the Employer of the Facilities, O&M of the Facility or any part(s) thereof.

12. BANK GUARANTEES

12.1 Issuance of Bank Guarantees

The Contractor shall provide the Bank Guarantees specified below in favor of the Employer at the times, and in the amount, manner and form specified below.

12.2 Mobilization Advance Bank Guarantee

12.2.1 The Contractor shall provide a Bank Guarantee equal to advance mobilization payment, if availed, with an initial validity period of 180 days from the date of signing of this Contract. The advance mobilization payment shall be 10% of the Contract Value. However, in case of delay in Completion of Facilities under the Project, the validity of the security shall be extended by the period of such delay.

12.2.2 The security shall be in the form of an unconditional and irrevocable bank guarantee as per the Performa provided in "Schedule 2: Mobilization Advance against Bank Guarantee". The Mobilization Advance shall be interest bearing, @ 14% per annum. The mobilization advance, including the interest levied, shall be recovered in 4 equal instalments from the payment milestone 1-4 as specified in Clause 12 of the SCC. It should be clearly understood that adjustment in the value of Bank Guarantee for Mobilization Advance shall not in any way dilute the Contractor's responsibility and liabilities under the Contract including in respect of the Facilities for which the adjustment in the value of Bank Guarantee is allowed. Bank Guarantee in lieu of mobilization advance shall be returned to the Contractor on Commissioning of the Project.

12.3 Performance Bank Guarantee

12.3.1 The Contractor shall, simultaneously with signing of this Contract, provide Bank Guarantees for the due Performance of the Contract for ten percent (10%) of the Contract Value as per Clause 3.6.1 of RFP in the following manner:

a) The first set of bank guarantee for 20% of the Performance Security shall be valid for a period of 15 (fifteen months) months from date of Commissioning, which shall be returned after satisfactory O&M of the Facilities for the first anniversary from date of Commissioning.
b) The second set of bank guarantee for 20% of the Performance Security shall be valid for a period of 27 (twenty seven months) from date of Commissioning, which shall be returned after satisfactory O&M of the Facilities for second anniversary from date of Commissioning.
c) The third set of bank guarantee for 20% of the Performance Security shall be valid for a period of 39 (thirty nine months) from date of Commissioning, which shall be returned after satisfactory O&M of the Facilities for third anniversary from date of Commissioning.
d) The fourth set of bank guarantee for 20% of the Performance Security shall be valid for a period of 51 (fifty one months) from date of Commissioning, which shall be returned after satisfactory O&M of the Facilities for fourth anniversary from date of Commissioning.
e) The fifth set of bank guarantee for 20% of the Performance Security shall be valid for a period of 63 (sixty three months) from date of Commissioning, which shall be returned after satisfactory O&M of the Facilities for fifth anniversary from date of Commissioning.

However, in case of delay in demonstration of the Performance Test (PR test) and Acceptance, the validity of all the Contract Performance Bank Guarantees shall be extended by the period of such delay plus ninety days.

12.3.2 The Performance Bank Guarantee shall be denominated in the Indian Rupees and shall be in the form of unconditional and irrevocable bank guarantee in the prescribed Proforma provided in Schedule 1.

12.3.3 The Bank Guarantee submitted against Mobilization Advance and the Performance Bank Guarantee shall be essentially from any of the Banks listed at Schedule – 4: Special Conditions of Contract of the Bidding Documents.

13. TAXES AND DUTIES

13.1 Except as otherwise specifically provided in the Contract, the Contractor shall bear and pay all taxes, duties, royalties, levies and charges in connection with the Project.

13.2 All taxes, duties, royalties, and levies with respect to the Contract, if any, shall be to the Contractor's account and no separate claim in this regard will be entertained by the Employer.

D. Intellectual Property

14. COPYRIGHT & PATENT

14.1 The copyright in all drawings, documents and other materials containing data and information furnished to the Employer by the Contractor herein shall remain vested in the Employer. The Employer shall be free to reproduce all drawings, documents, specification and other material furnished to the Employer for the purpose of the Contract including, if required, for O&M of the Facilities.

14.2 The Contractor shall indemnify the Employer against third party claims of infringement of patent, trademark or industrial design rights arising from use of goods or any part thereof in India.

15. CONFIDENTIAL INFORMATION

15.1 The Employer and the Contractor shall keep confidential and shall not, without the written consent of the other party hereto, divulge to any third party any documents, data or other information furnished directly or indirectly by the other party hereto in connection with the Contract, whether such information has been furnished prior to, during or following termination of the Contract. Notwithstanding the above, the Contractor may furnish to its Sub-contractor(s)such documents, data and other information it receives from the Employer to the extent required for the Sub-contractor(s) to perform its work under the Contract, in which event the Contractor shall obtain from such Sub-contractor(s) an undertaking of confidentiality similar to that imposed on the Contractor under this GCC Clause 15.

15.2 The obligation of a party under GCC Sub-Clauses 15.1 above, however, shall not apply to that information which:

15.2.1 Now or hereafter enters the public domain through no fault of that party.

15.2.2 Can be proven to have been possessed by that party at the time of disclosure and which was not previously obtained, directly or indirectly, from the other party hereto.

15.2.3 Otherwise lawfully becomes available to that party from a third party that has no obligation of confidentiality.

15.3 The above provisions of this GCC Clause 15 shall not in any way modify any undertaking of confidentiality given by either of the parties hereto prior to the date of the Contract in respect of the Facilities or any part thereof.

15.4 The provisions of this GCC Clause 15 shall survive termination, for whatever reason, of the Contract.

16. GEOLOGICAL DISCOVERIES

All fossils, coins, articles of value or antiquity and structures and other remains or things of geological or archaeological interest discovered on the Site where the services are performed, be deem to be the absolute property of the Employer. The Contractor shall take reasonable precautions to prevent the personnel or any other persons from removing or damaging any such article or thing and shall immediately upon the discovery thereof and, before removal, acquaint the Employer of such discovery any carry out, at the expense of the Employer, the Employer's orders as to the disposal of the same.

17. REPRESENTATIVES

17.1 Engineer-In-Charge:

If the Engineer-In-Charge is not named in the Contract, then within seven (07) days of the Effective Date, the Employer shall appoint and notify the Contractor in writing of the name of the Engineer-In-Charge. The Employer may from time to time appoint some other person as the Engineer-In-Charge in place of the person previously so appointed, and shall give a notice of the name of such other person to the Contractor without delay. The Employer shall take reasonable care, unless unavoidable to see that no such appointment is made at such a time or in such a manner as to impede the progress of work on the Facilities. The Engineer-In-Charge shall represent and act for the Employer at all times during the currency of the Contract. All notices, instructions, orders, certificates, approvals and all other communications under the Contract shall be given by the Engineer-In-Charge, except as herein otherwise provided.

All notices, instructions, information and other communications given by the Contractor to the Employer under the Contract shall be given to the Engineer-In-Charge, except as herein otherwise provided.

17.2 Contractor's Representative & Construction Manager

17.2.1 If the Contractor's Representative is not named in the Contract, then within seven (07) days of the Effective Date, the Contractor shall appoint the Contractor's Representative and shall request the Employer in writing to approve the person so appointed. If the Employer makes no objection to the appointment within seven (07) days of submission, the Contractor's Representative shall be deemed to have been approved. If the Employer objects to the appointment within seven (07) days giving the reason therefor, then the Contractor shall appoint a replacement within seven (07) days of such objection, and the foregoing provisions of this GCC Sub- Clause 17.2.1 shall apply thereto.

17.2.2 The Contractor's Representative shall represent and act for the Contractor at all times during the tenure of the Contract and shall give to the Engineer-In-Charge all the Contractor's notices, instructions, information and all other communications under the Contract.

17.2.3 All notices, instructions, information and all other communications given by the Employer or the Engineer-In-Charge to the Contractor under the Contract shall be given to the Contractor's Representative or, in its absence, its deputy, except as herein otherwise provided.

17.2.4 The Contractor shall not revoke the appointment of the Contractor's Representative without the Employer's prior written consent, which shall not be unreasonably withheld. If the Employer consents thereto, the Contractor shall appoint some other person as the Contractor's Representative, pursuant to the procedure set out in GCC Sub-Clause 17.2.1.

17.2.5 The Contractor's Representative may, subject to the approval of the Employer (which shall not be unreasonably withheld), at any time delegate to any person any of the powers, functions and authorities vested in him or her. Any such delegation may be revoked at any time. Any such delegation or revocation shall be subject to a prior notice signed by the Contractor's Representative, and shall specify the powers, functions and authorities thereby delegated or revoked. No such delegation or revocation shall take effect unless and until a copy thereof has been delivered to the Employer and the Engineer-In-Charge.

17.2.6 Any act or exercise by any person of powers, functions and authorities so delegated to him or her in accordance with GCC Sub-Clause 17.2.5 shall be deemed to be an act or exercise by the Contractor's Representative.

17.2.7 Notwithstanding anything stated in GCC Sub-clause 17.1 and 17.2.1 above, for the purpose of execution of Contract, the Employer and the Contractor shall finalize and agree to a Contract Co-ordination Procedure and all the communication under the Contract shall be in accordance with such Contract Co-ordination Procedure.

17.2.8 From the commencement of installation of the Facilities at the Site until Operational Acceptance, the Contractor's Representative shall appoint a suitable person as the construction manager (hereinafter referred to as "the Construction Manager"). The Construction Manager shall supervise all work done at the Site by the Contractor and shall be present at the Site throughout normal working hours except when on leave, sick or absent for reasons connected with the proper Performance of the Contract. Whenever the Construction Manager is absent from the Site, a suitable person shall be appointed to act as his or her deputy.

17.2.9 The Employer may by notice to the Contractor object to any representative or person employed by the Contractor in the execution of the Contract who, in the reasonable opinion of the Employer, may behave inappropriately, may be in- competent or negligent, or may commit a serious breach of the Site regulations and safety. The Employer shall provide evidence of the same, whereupon the Contractor shall remove such person from the works.

17.2.10 If any representative or person employed by the Contractor is removed in accordance with GCC Sub-Clause 17.2.4, the Contractor shall, where required, promptly appoint a replacement.

18. PROJECT IMPLEMENTATION

18.1 Work Schedule

Within fourteen (14) days after the date of Issue of LOA, the Contractor shall prepare and submit to the Engineer-In-Charge a detailed program of Performance of the Contract, made in the form of PERT Chart and showing the sequence in which it proposes to preparation of Site, soil testing, establishment of Site of office, transport, procurement of materials, storing arrangements, dispatch of personnel, fabrication, design, assemble, install, establishment of step-up sub-stations, evacuation infrastructure and Pre-Commission the Facilities. The program so submitted by the Contractor shall agree with the Time Schedule indicated in SCC and any other dates and periods specified in the Contract. The Contractor shall update and revise the program as and when appropriate or when required by the Engineer-In-Charge, but without modification in the Time for Completion given in the SCC and any extension granted in accordance with clause for extension of time, and shall submit all such revisions to the Engineer-In-Charge.

18.2 Progress Report

18.2.1 The Contractor shall monitor progress of all the activities specified in the work schedule referred in GCC Sub-Clause 18.1 above, and submit the progress report to the Engineer-In-Charge as per the Contract Co-ordination procedure.

18.2.2 The progress report shall be in a form acceptable to the Engineer-In-Charge and shall also indicate: (a) percentage completion achieved compared with the planned percentage completion for each activity; and (b) where any activity is behind the program, giving

comments and likely consequences and stating the corrective action being taken.

18.3 Maintenance of Records of Weekly Progress Review Meeting at Site

The Contractor shall be required to attend all weekly Site progress review meetings organized by the 'Engineer-In-Charge' or his Authorized Representative. The deliberations in the meetings shall inter-alia include the weekly program, progress of work (including details of manpower, tools and plants deployed by the Contractor vis-à-vis agreed schedule), inputs to be provided by Employer, delays, if any and recovery program, specific hindrances to work and work instructions by Employer. The minutes of the weekly meetings shall be recorded in triplicate in a numbered register available with the 'Engineer-In-Charge' or his Authorized Representative. These recordings shall be jointly signed by the 'Engineer-In-Charge' or his Authorized Representative and the Contractor and one copy of the signed records shall be handed over to the Contractor.

19. SUBCONTRACTING

19.1 The Contractor shall not, without the prior consent in writing of the Employer, assign or sublet or transfer its Contract in whole or in part, its obligations to perform under the Contract or a substantial part thereof, other than raw materials, or for any part of the work of which makers are named in the Contract, provided that any such consent shall not relieve the Contractor from any obligation, duty or responsibility under the Contract.

19.2 The Contractor shall notify the Employer in writing of all sub contracts awarded under the Contract if not already specified in its Bid. Such notification in its Bid or later shall not relieve the Contractor from any liability or obligation under the Contract.

19.3 In case, the Contractor engages any Sub-Contractor to carry out a part of the work, the Sub-Contractor should have requisite Government License for carrying out such part of the work.

20. DESIGN AND ENGINEERING

20.1 Specifications and Drawings

20.1.1 The Contractor shall execute the basic and detailed design and engineering work in compliance with the provisions of the Contract, or where not so specified, in accordance with good and sound engineering practice not lesser than established current standard industry practice.

20.1.2 The Contractor shall be responsible for any discrepancies, errors or omissions in the specifications, drawings and other technical documents that it has prepared, whether such specifications, drawings and other documents have been approved by the Engineer-In-Charge or not, provided that such discrepancies, errors or omissions are not because of inaccurate information furnished in writing to the Contractor by or on behalf of the Employer.

20.2 Codes and Standards

Technical Specifications set out in the RFP document shall form part of this Contract. The Contract shall be executed in compliance of the codes and standards set out in Technical Specifications, the new edition or the revised version of such codes and standards current at the date of Bid submission shall apply unless otherwise specified. However, the Contractor may use equipment's/materials exceeding the standard mentioned.

20.3 Approval / Review of Technical Documents by Engineer-In-Charge

The Contractor shall prepare list of documents as per Technical Specifications and furnish to the Engineer-In-Charge for approval of the same and Review of work schedule.

Any part of the Facilities covered by or related to the documents to be approved by the Engineer-In-Charge shall be executed only after the Engineer-In-Charge's approval thereof.

20.3.1 Within ten (10) days after receipt of any document requiring the Engineer-In-Charge's approval, the Engineer-In-Charge shall either return one copy thereof to the Contractor with its approval endorsed thereon or shall notify the Contractor in writing of its disapproval thereof and the reasons therefor and the modifications that the Engineer-In-Charge proposes.

20.3.2 The Engineer-In-Charge shall not disapprove any document, except on the grounds that the document does not comply with some specified provision of the Contract or that it is contrary to good engineering practice.

20.3.3 If the Engineer-In-Charge disapproves the document, the Contractor shall modify the document and resubmit it for the Engineer-In-Charge's approval. If the Engineer-In-Charge approves the document subject to modification(s), the Contractor shall make the required modification(s), and upon resubmission with the required modifications the document shall be deemed to have been approved.

20.3.4 The procedure for submission of the documents by the Contractor and their approval by the Engineer-In-Charge shall be as per the Contract Co-ordination procedure.

20.3.5 If any dispute or difference occurs between the Employer and the Contractor in connection with or arising out of the disapproval by the Engineer-In-Charge of any document and/or any modification(s) thereto that cannot be settled between the parties within a reasonable period, then such dispute or difference may be settled in accordance with GCC Clause 6.0 (Settlement of Dispute) hereof. If such dispute or difference is referred as per GCC clause 6.0, the Engineer-In-Charge shall give instructions as to whether and if so, how, Performance of the Contract is to proceed. The Contractor shall proceed with the Contract in accordance with the Engineer-In-Charge's instructions, provided that if the Arbitration upholds the Contractor's view on the dispute, then the Contractor shall be reimbursed by the Employer for any

additional costs incurred by reason of such instructions and shall be relieved of such responsibility or liability in connection with the dispute and the execution of the instructions as the Arbitration shall decide, and the Time for Completion shall be extended accordingly.

20.3.6 The Engineer-In-Charge's approval, with or without modification of the document furnished by the Contractor, shall not relieve the Contractor of any responsibility or liability imposed upon it by any provisions of the Contract except to the extent that any subsequent failure results from modifications required by the Engineer-In-Charge.

20.3.7 The Contractor shall not depart from any approved document unless the Contractor has first submitted to the Engineer-In-Charge an amended document and obtained the Engineer-In-Charge's approval thereof, pursuant to the provisions of this GCC Sub-Clause 20.3.

20.3.8 If the Engineer-In-Charge requests any change in any already approved document and/or in any document based thereon, generally shall be taken care by the Contractor if the change is not causing any major financial impact.

21. PROCUREMENT

21.1 Plant and Equipment

The Contractor shall procure and transport all the Plant and Equipment in an expeditious and orderly manner to the Site.

21.2 Transportation

The Contractor shall at its own risk and expense transport all the Plant and Equipment and the Contractor's Equipment to the Site by the mode of transport that the Contractor judges most suitable under all the circumstances.

21.3 Packing and Marking

21.3.1 The Contractor shall be responsible for securely protecting and packing the Plant & Equipment as per prescribed standards in force to withstand the journey and ensuring safety of materials and also arrival of materials at destination in original condition and good for contemplated use. Packing case size & weight shall take into consideration the remoteness of the goods final destination and absence of heavy material handling facilities at all points in transit.

21.3.2 Packing lists of materials shall be provided in each package to facilitate checking up of the contents at the destination.

21.3.3 In order to import any items, associated with the Solar PV Power Project, from abroad or from any other state in India, Contractor shall have to arrange any clearance, permission, if required at his own risk, from any Government (Government of State & Government of India) or any

Government (Government of State & Government of India) controlled organization for transportation of materials from manufacturing shop to delivery at Site. Necessary certificates if so required shall be issued by the Employer within reasonable time after getting written request from the Contractor along with the necessary documents substantiating necessity of such approvals. All packing material is the property of the Employer and shall be immediately deposited by the Contractor to the Employer's Store at Project Site.

22. MATERIALS AND WORKMANSHIP

22.1 All materials shall be of the best quality and workmanship capable of satisfactory operation under the operating and climatic conditions as may be specified. Unless otherwise specified, they shall conform in all respect to the latest edition of the relevant IS codes specification wherever Indian specifications apply or IEC codes or equivalent internationally accepted standard.

22.2 The Contractor shall supply & deliver all equipment and materials for installation at Site. The Contractor shall arrange for transportation, loading & unloading and safe storage of materials at Project Site at his own cost & risk.

22.3 If the Contractor offers equipment manufactured in accordance with other international well recognized standards (mentioned above), he shall, in that case, supply a copy in English of the Standard Specification adopted and shall clearly mention in what respect such standard specification differs from Indian Standard Specifications. The Plant, equipment, and materials offered by the Contractor should comply with one consistent set of Standards only to make the system compatible and work in harmony as far as possible.

23. INSTALLATION

23.1 Tools & Tackles

The Contractor shall provide technically suitable tools and tackles for installation & erection of Plant & Machineries conforming to relevant BIS safety and technical standards for proper execution of work. The Employer, in no way, shall be responsible for supply of any tools and tackles for implementation of the work and also to carry out O&M activities.

23.2 Setting up/Supervision/Labor

23.2.1 Bench Mark

The Contractor shall be responsible for the true and proper setting-up of the Facilities in relation to bench marks, reference marks which are mutually agreed upon by the Contractor and Employer.

If, at any time during the progress of installation of the Facilities, any error shall appear in the position, level or alignment of the Facilities, the Contractor shall forthwith notify the

Engineer-In-Charge of such error and, at its own expense, immediately rectify such error to the satisfaction of the Engineer-In-Charge.

23.2.2 Contractor's Supervision:

The Contractor shall give or provide all necessary superintendence during the installation of the Facilities, and the Construction Manager or its deputy shall be constantly on the Site to provide full-time superintendence of the installation. The Contractor shall provide and employ only technical personnel who are skilled and experienced in their respective disciplines and supervisory staff who are competent to adequately supervise the work at hand.

23.2.3 Labor:

The Contractor shall provide and employ on the Site in the installation of the Facilities such skilled, semi- skilled and unskilled labor as is necessary for proper and timely execution of the Contract. The Contractor is encouraged to use local labor that has the necessary skills.

Unless otherwise provided in the Contract, the Contractor shall be responsible for the recruitment, transportation, accommodation and catering of all labor, local or expatriate, required for the execution of the Contract and for all payments in connection therewith.

The Contractor shall be responsible for obtaining all necessary permit(s) and/or visa(s) from the appropriate authorities for the entry of all labor and personnel to be employed by Contractor on the Site.

The Contractor shall at all times during the progress of the Contract use its best endeavors to prevent any unlawful, riotous or disorderly conduct or behavior by or amongst its employees and the labor of its Sub-contractors.

The Contractor shall, in all dealings with its labor and the labor of its Sub-contractors currently employed on or connected with the Contract, pay due regard to all recognized festivals, official holidays, religious or other customs and all local laws and regulations pertaining to the employment of labor.

23.3 Contractor's Equipment

23.3.1 All equipment brought by the Contractor onto the Site shall be deemed to be intended to be used exclusively for the execution of the Contract. The Contractor shall not remove the same from the Site without the Engineer-In-Charge's consent that such Contractor's Equipment is no longer required for the execution of the Contract.

23.3.2 Unless otherwise specified in the Contract, upon Completion of the Facilities, the Contractor shall remove from the Site all Equipment brought by the Contractor to the Site.

23.4 Site Regulations and Safety

The Contractor shall have to provide necessary and adequate safety measures including personal protective equipment and precautions to avoid any accident, which may cause damage to any equipment / material or injury to workmen. The Employer shall not be responsible for any such accidents. Also, Contractor shall engage sufficient security guards to protect Facility from any theft and unauthorized access to Site.

23.5 Site Clearance

23.5.1 Site Clearance in Course of Performance

In the course of carrying out the Contract, the Contractor shall keep the Site reasonably free from all unnecessary obstruction, store or remove any surplus materials, clear away any wreckage, rubbish or temporary works from the Site, and remove any Contractor's Equipment no longer required for execution of the Contract.

23.5.2 Site Clearance after Completion

After Completion of all parts of the Facilities, the Contractor shall clear away and remove all wreckage, rubbish and debris of any kind from the Site, and shall leave the Site and Facilities clean and safe.

23.5.3 Disposal of Scrap

The Contractor shall with the agreement of the Employer promptly remove from the Site any 'Scrap' generated during Performance of any activities at Site in pursuance of the Contract. The term 'Scrap' shall refer to scrap/waste/remnants arising out of the unpacking of equipment, construction debris, fabrication of structural steel work and piping work at the Project Site in the course of execution of the Contract and shall also include any wastage of cables during the termination process while installing the cables.

The ownership of such Scrap shall vest with the Contractor except in cases where the items have been issued by the Employer from its stores for their installation only without any adjustment to the Contract Value. The removal of scrap shall be subject to the Contractor producing the necessary clearance from the relevant authorities (Custom, Excise etc.), if required by the law, in respect of disposal of the scrap. The liability for the payment of the applicable taxes/duties shall be that of the Contractor.

The Contractor shall also indemnify to keep the Employer harmless from any act of omission or negligence on the part of the Contractor in following the statutory requirements with regard to removal/disposal of scrap. The Indemnity Bond shall be furnished by the Contractor as per Proforma enclosed as Schedule 3. Further, in case the laws require the Employer to take prior permission of the relevant Authorities before handing over the scrap to the Contractor, the same shall be obtained by the Contractor on behalf of the Employer.

23.5.4 Watching and Lighting

The Contractor shall provide and maintain at its own expense all lighting, fencing, watch and ward wherever necessary for the proper execution and the protection of the Facilities, or for the safety of the owners and occupiers of adjacent property and for the safety of the public.

24. INSPECTION & TESTING

24.1 The Employer or its Authorized Representative shall have, at all time, access to the Project Site/Contractor's premises and also shall have the power, at all times, to inspect and examine the materials and workmanship of project work during its manufacture, shop assembly and testing. If part of the plant is required to be manufactured in the premises other than the Contractor's, the necessary permission for inspection shall be obtained by the Contractor for the Employer or his duly Authorized Representative.

24.2 The Employer shall have the right to serve notice in writing to the Contractor on any grounds of objections, which he may have in respect of the work. The Contractor has to satisfy the objection, otherwise, the Employer at its liberty may reject all or any component of Plant or workmanship connected with such work.

24.3 The Contractor shall issue request letter to the Employer or its Authorized Representative for testing of any component of the Plant, which is ready for testing at least 07 days in advance from the date of actual date of testing at the premises of the Contractor or elsewhere. However, the Employer at its own discretion may waive the inspection and testing in writing under very special circumstances. In such case, the Contractor may proceed with the tests which shall be deemed to have been made in the Employer presence, and it shall forthwith forward two sets of duly certified copies of test results and certificates to the Employer for approval. The Contractor, on receipt of written acceptance from the Employer, may dispatch the equipment for erection & installation.

24.4 For all tests to be carried out, whether in the premises of the Contractor or any Sub-Contractor, the Contractor, shall provide labor, materials, electricity, fuel, water, stores, apparatus and instruments etc. free of charge as may reasonably be demanded to carry out such tests of the plant in accordance with the Contract. The Contractor shall provide all facilities to the Employer or its Authorized Representative to accomplish such testing.

24.5 The Employer or his Authorized Representative shall have the right to carry out inward inspection of the items on delivery at Site and if the items have been found to be not in line with the approved Specifications, shall have the liberty to reject the same.

24.6 If Employer desires, testing of any component(s) of the plant be carried out by an independent agency. The inspection fee, if any, shall be paid by the Employer. However, the Contractor shall render all necessary help to Employer whenever required free of charge.

24.7 The Contractor has to provide the necessary testing reports to the Employer as and when required.

24.8 Neither the waiving of inspection nor acceptance after inspection by the Employer shall, in anyway, absolve the Contractor of the responsibility of supplying the plant and equipment strictly in accordance with specification and drawings etc.

25. AUTHORIZED TEST CENTERS FOR TEST CERTIFICATES

The PV modules/ inverters/ cables and other Balance of system equipment deployed in the solar PV power plant shall have valid test certificates for their qualification as per specified IEC/ IS Standards by one of the NABL Accredited Test Centers in India. In case of module types/ equipment for which such Test facilities may not exist in India, test certificates from reputed ILAC Member body accredited Labs abroad (with proper proof of accreditation) will be acceptable.

26. COMMISSIONING AND COMPLETION OF THE FACILITIES

26.1 As soon as installation of the Facilities has, in the opinion of the Contractor, been completed as specified in the Technical Specifications, excluding minor items not materially affecting the operation or safety of the Facilities, the Contractor shall so notify the Employer (Engineer-In-Charge) in writing for conducting Pre- Commissioning Test of the Facility in co-ordination with Employers representative.

26.2 As soon as all works in respect of Pre-Commissioning are completed and, in the opinion of the Contractor, the Facilities is ready for Commissioning, the Contractor shall so notify the Engineer-In-Charge in writing. The Contractor shall commence Commissioning of the Facilities as per the GCC Clause 26.3.

26.3 Commissioning of the Facilities shall be completed by the Contractor as per procedures detailed in the Technical Specifications and in the presence of the Engineer-In-Charge or the representatives of the Employer.

26.4 If the Engineer-In-Charge notifies the Contractor of any defects and/or deficiencies, the Contractor shall then correct such defects and/or deficiencies, and shall repeat the procedure described in GCC Sub- Clause 26.2.

26.5 If the Engineer-In-Charge is satisfied that the Facilities have reached Completion, the Engineer-In-Charge shall, within seven (7) days after receipt of the Contractor's notice, issue a Completion Certificate stating that the Facilities have reached Completion as at the date of the Contractor's notice.

26.6 If the Engineer-In-Charge is not so satisfied, then it shall notify the Contractor in writing of any defects and/or deficiencies within seven (7) days after receipt of the Contractor's repeated notice, and the above procedure shall be repeated.

26.7 If the Engineer-In-Charge fails to issue the Completion Certificate and fails to inform the Contractor of any defects and/or deficiencies within fourteen (14) days after receipt of the Contractor's notice under GCC Sub-Clause 26.2, or if the Employer makes use of the Facilities, then the Facilities shall be deemed to have reached Completion as of the date of the Contractor's notice or repeated notice, or as of the Employer's use of the Facilities, as the case may be.

26.8 As soon as possible after Completion, the Contractor shall complete all outstanding minor items so that the Facilities are fully in accordance with the requirements of the Contract, failing which the Employer will undertake such completion and deduct the costs thereof from any monies owing to the Contractor.

26.9 Upon Completion and successful demonstration of the PR test, the Contractor shall be responsible for the care and custody of the Facilities, together with the risk of loss or damage thereto, and shall thereafter take over the Facilities or the relevant part thereof for the agreed duration of O&M as stipulated and mutually agreed terms and conditions.

27. GUARANTEE TEST AND OPERATIONAL ACCEPTANCE

27.1 Functional Guarantees

27.1.1 The Contractor guarantees that during the Guarantee Test, the Facilities and all parts thereof shall attain the Functional Guarantees specified under Technical Specifications, subject to and upon the conditions therein specified.

27.1.2 If, for reasons attributable to the Contractor, the guaranteed level of the Functional Guarantees specified under Technical Specifications are not met either in whole or in part, the Contractor shall, within a mutually agreed time, at its cost and expense make such changes, modifications and/ or additions to the Plant or any part thereof as may be necessary to meet such Guarantees. The Contractor shall notify the Employer upon completion of the necessary changes, modifications and/or additions, and shall seek the Employer's consent to repeat the Guarantee Test. If the level of the specified Functional Guarantee parameters, as demonstrated even during repeat of the Guarantee Test(s), are outside the acceptable shortfall limit, the Employer may at its option, either

a) Reject the Equipment and Advise immediate replacement with equipment to suit the provisions of Technical Specification without any additional cost

b) Reject the Equipment and recover the payments already made, or

c) Terminate the Contract and recover the payments already made, or

d) Accept the equipment after levy of liquidated damages in accordance with the provisions specified.

27.2 Plant Performance Guarantee Test

The Plant Performance Guarantee (as mentioned in SCC) Test shall be conducted by the Contractor after Commissioning of the Facilities to ascertain whether the Facilities or the relevant part(s) can attain the Functional Guarantees specified in the Contract Documents. The Contractor's and Engineer-In-Charge's advisory personnel shall attend the Guarantee Test. The Contractor shall promptly provide the Employer with such information as the Employer may reasonably require in relation to ascertain the performance guarantee based on the test results. The detailed procedure for Plant Performance Guarantee Test shall be carried out as per procedure laid down in Schedule 5 – Technical Specifications of this Contract.

27.3 Operational Acceptance and Acceptance

27.3.1 Operational Acceptance shall occur in respect of the Facilities when the Plant Performance Guarantee Test in accordance with the procedure specified in Schedule 5 – Technical Specifications of this Contract has been successfully completed and the Functional Guarantees are met

27.3.2 At any time after any of the events set out in GCC Sub- Clause 27.3.1 have occurred, the Contractor may give a notice to the Engineer-In-Charge requesting the issue of an Operational Acceptance Certificate in the form provided in the Bidding Documents or in another form acceptable to the Employer in respect of the Facilities or the part thereof specified in such notice as at the date of such notice.

27.3.3 The Engineer-In-Charge shall, after consultation with the Employer, and within thirty (30) days after receipt of the Contractor's notice, issue an Operational Acceptance Certificate.

27.3.4 If within thirty (30) days after receipt of the Contractor's notice, the Engineer-In-Charge fails to issue the Operational Acceptance Certificate or fails to inform the Contractor in writing of the justifiable reasons why the Engineer-In-Charge has not issued the Operational Acceptance Certificate, the Facilities shall be deemed to have been accepted as at the date of the Contractor's said notice.

28. INTER-CHANGEABILITY

All the parts shall be made accurately to applicable Standards and specification so as to facilitate replacement and repairs. All corresponding parts of similar apparatus shall be inter-changeable.

29. POWER TO VARY OR OMIT WORK

29.1 No alterations, amendments, omissions, additions, subtractions, or variations of the work (hereinafter referred to as "variation") under the Contract shall be made by the Contractor except as directed by the Employer.

29.2 If any suggested variations would, in the opinion of the Contractor, if carried out prevent

it from fulfilling any of its obligations or guarantees under the Contract, it shall notify the Employer thereof in writing and the Employer shall decide forthwith whether or not the same shall be carried out and if Employer confirms its instruction, the Contractor shall carryout the work as per the instructions.

29.3 The differences in cost, if any, occasioned by such variations, shall be added to or deducted from the Contract Value, as the case may be.

29.4 In the event of the Employer requiring any variations, reasonable and proper notice shall be given to the Contractor as well, to enable it to make arrangements accordingly, and in cases where goods or materials are already prepared/procured, or any designs, drawings or patterns made or work done that require to be altered, a reasonable sum in respect thereof shall be allowed by the Employer.

29.5 In every case in which the Contractor shall receive instructions from the Employer for carrying out any work, which either then or later, will in the opinion of the Contractor involve a claim for additional payment, the Contractor shall as soon as reasonably possible after the receipt of such instructions, inform in writing the Employer of such claim for additional payment.

29.6 In any case, if the Contractor deviates from the design or specification as defined in the Bid Document, the Contractor has to submit the deviation sheet to the Engineer-in-Charge and seek approval from the Employer.

30. NEGLIGENCE

30.1 If the Contractor neglects to supply Equipment or construct the Plant with necessary infrastructure, with due diligence and expeditiousness or refuses or neglects to comply with any reasonable order given to it in writing by the Employer or contravenes any provisions of the Contract, the Employer may give (7) seven days' notice in writing to the Contractor, to make good the failure, neglect or contravention complained of. If the Contractor fails to comply with the notice within reasonable time depending on the nature of affected work, which is evaluated by the Engineer-In-Charge from the date of serving thereof, in the event of failure, neglect or contravention capable of being made good within that time, then in such case, if the Employer thinks fit, it shall be lawful for it to take the Plant and Equipments wholly or in part, out of the Contractor's hand and give it to another person on Contract at current market price and the Employer shall be entitled to retain any balance which may be otherwise due on the Contract by it to the Contractor or such part thereof as may be necessary, to the payment of the cost with respect to such acquisition as aforesaid.

30.2 If the cost of executing the work as aforesaid shall exceed the balance due to the Contractor and the Contractor fails to make good such deficiency, the Employer shall have the right to appropriate the Performance Security in addition to take action in the manner it may consider deem fit in terms of the Contract including black-listing the Contractor.

31. STATUTORY RESPONSIBILITY

The Contractor shall comply with all Applicable Laws or ordinances, codes, approved standards, rules, and regulations and shall procure and maintain their validity all necessary Municipal, Panchayat and Government permits & licenses etc. at its own cost.

32. INSOLVENCY AND BREACH OF CONTRACT

The Employer may at any time, by notice in writing, summarily terminate the Contract without compensation to the Contractor in any of the following events:

If the Contractor shall at any time, be adjudged insolvent or shall have a receiving order or order from administration of its state made against it or shall take any proceeding for compensation under any Insolvency Act for the time being in force or make any conveyance or assignment with its creditors or suspend payment or a Receiver, Liquidator or manager on behalf of the Debenture holder is appointed or circumstances have arisen which entitle the Court or debenture holder to appoint a Receiver, Liquidator or Manager.

33. DELAY IN EXECUTION OR FAILURE TO SUPPLY

31.1 Any delay in Completion of the work, shall attract liquidated damage, for late Completion as per Liquidated Damage Clause 34 (GCC).

31.2 If the Contractor fails to deliver the plant or fails to start the work within specified time frame after signing of Contract Agreement or leave the work Site after partial execution of the work, Employer shall have the right to get the work done through any other agency at the risk and cost of the Contractor. Further to this, Employer may, without prejudice to the right of the Employer to recover damages for breach of trust of the Contract, may impose liquidity damages on the contractor as per GCC Clause 34.

34. LIQUIDATED DAMAGES

34.1 The Project is scheduled to be commissioned within 180 days from the date of singing of this Contract.

34.2 In case the Contractor fails to achieve successful Commissioning of Plant by the due date indicated in Timeline, the Employer shall levy liquidated damages ("**Liquidated Damages**") on the Contractor at the following rate: (partial/ part Commissioning shall not be accepted)

34.2.1 Delay up to 1 Month: - HGML will encash 20% of the total Performance bank guarantee on day-to-day pro-rata basis.

34.2.2 Delay of more than one month and up to two months: - HGML will encash another 40% of the total Performance bank guarantee on day-to-day pro-rata basis.

34.2.3 Delay of more than two month and up to three months: – HGML will encash the balance 40% of the total Performance bank guarantee on day-to-day pro-rata basis.

34.2.4 The maximum time period allowed (with LD) for Commissioning of the Project shall be 09 months from the date of signing of the Contract. In case of delay for more than 09 months, the Employer shall get the project complete by other suitable agency at risk and cost of Contractor. For calculation of Liquidated Damages, the month shall be considered consisting of 30 days and date of signing of the Contract as reference date.

35. DEFECT LIABILITY

35.1 The Contractor must warrant that the Facilities shall be free from defects in the design, engineering, materials and workmanship of the Plant and Equipment supplied and of the work executed.

35.2 If it shall appear to the Employer that any supplies have been executed with unsound, imperfect or unskilled workmanship, or with materials of any inferior description, or that any materials or articles provided by the Contractor for the execution of Contractor are unsound or otherwise not in accordance with the Contract, the Employer/Engineer-In-Charge shall on demand in writing inform the Contractor's Representative specifying the item, materials or articles complained of, notwithstanding that the same may have been inadvertently passed, certified and paid for. The Contractor shall forthwith rectify or remove and replace that item so specified and provide other proper and suitable materials or articles at its own charge and cost, and in the event of failure to do so within a period to be specified by the Engineer-in-Charge in its demand aforesaid, the Engineer-in-Charge may on expiry of notice period rectify or remove and re-execute the time or remove and replace with others, the materials or articles complained of as the case may be at the risk and expense in all respects of the Contractor. The decisions of the Employer in this regard shall be final and binding.

35.3 The Contractor shall also be undertaking the O&M of the Facility and consequently shall be required to rectify any defects that emerge during the O&M of the Facilities for the entire term of this Contract.

35.4 The Defect Liability Period shall be 60 (sixty) months from the date of Successful Commissioning of the Project ("Defects Liability Period").

35.5 If during the Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant and Equipment supplied or of the work executed by the Contractor, the Contractor shall promptly, in consultation and agreement with the Employer regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Contractor shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect.

35.6 Furthermore, without prejudice to the generality of the foregoing, it is clarified that the

Contractor shall also be responsible for the repair, replacement or making good of any defect, or of any damage to the Facilities arising out of or resulting from any of the following causes:

a) Improper O&M of the Facilities by the Contractor; and

b) Operation of the Facilities outside specifications of the Facilities.

35.7 The Employer shall give the Contractor a notice stating the nature of any such defect together with all available evidence thereof, promptly following the discovery thereof. The Employer shall afford all reasonable opportunity for the Contractor to inspect any such defect.

35.8 The Employer shall provide the Contractor all necessary access to the Facilities and the Site to enable the Contractor to perform its obligations under this Clause 35 (Defect Liability). The Contractor may, with the consent of the Employer, remove any Plant and Equipment or any part of the Facilities that are defective from the Site, if the nature of the defect and/or any damage to the Facilities caused by the defect is such that repairs cannot be expeditiously carried out at the Site.

35.9 If the repair, replacement or making good is of such a nature that it may affect the efficiency of the Facilities or any part thereof, the Employer may give to the Contractor a notice requiring that tests of the defective part of the Facilities shall be made by the Contractor immediately upon completion of such remedial work, whereupon the Contractor shall carry out such tests.

35.10 If such part fails the tests, the Contractor shall carry out further repair, replacement or making good (as the case may be) until that part of the Facilities passes such tests. The tests, in character, shall in any case be not inferior to what has already been agreed upon by the Employer and the Contractor for the original Equipment/part of the Facilities.

35.11 If the Contractor fails to commence the work necessary to remedy such defect or any damage to the Facilities caused by such defect within a reasonable time (which shall in no event be considered to be less than seven (7) days), the Employer may, following notice to the Contractor, proceed to do such work, and the costs incurred by the Employer in connection therewith shall be paid to the Employer by the Contractor or may be deducted by the Employer from any amount due to the Contractor or claimed under the Plant Performance Guarantee, without prejudice to other rights, which the Employer may have against the Contractor in respect of such defects.

35.12 If the Facilities or any part thereof cannot be used by reason of such defect and/or making good of such defect, the Defect Liability Period of the Facilities or such part, as the case may be, shall be extended by a period equal to the period during which the Facilities or such part cannot be used by the Employer because of any of the aforesaid reasons. Upon correction of the defects in the Facilities or any part thereof by repair/replacement, such

repair/replacement shall have the defect liability period of twelve (12) months from such replacement.

35.13 In addition, the Contractor shall also provide an extended warranty for any such component of the Facilities and for the period of time. Such obligation shall be in addition to the defect liability specified under Clause 35.2.

36. TERMINATION FOR DEFAULT

36.1 The Employer may, without prejudice to any other remedy for breach of Contract, by written notice of default sent to the Contractor, terminate the Contract in whole or in part.

36.2 If the Contractor fails to deliver or execute any or all of the goods within the time period(s) under the Contract or any extension thereof granted by the Employer pursuant to the clause for Delay in Execution or Failure to Supply or, if the Contractor fails to perform any other obligations(s) under the Contract.

36.3 In the event the Employer terminates the Contract in whole or in part, pursuant to above, the Employer may procure, upon such terms and in such manner as it deems appropriate, goods similar to those undelivered, the Contractor shall be liable to the Employer for any excess costs for such similar goods. However, the Contractor shall continue the Performance of the Contract to the extent not terminated.

36.4 In case termination of the Contract due to default, the Contractor may be debarred from participation in future tenders by HGML for a period to be specified.

37. BREACH & CANCELLATION OF THE CONTRACT

37.1 In case of non-Performance in any form or change of the covenant and conditions of the Contract by the Contractor, Employer shall have the power to annul, rescind, cancel or terminate the order and upon its notifying in writing to the Contractor that it has so done, this Contract shall absolutely determine. The decision of the Employer in this regard shall be final and binding.

37.2 The following conditions shall contribute to the breach of contract:

a) If the Contractor fails to deliver any or all of the Goods within the period(s) specified in the Contract; or

b) If the Contractor fails to perform any of their obligations(s) under the Contract, and

c) If the Contractor, in either of the above circumstances does not rectify his failure within a period of 30 (Thirty) days (or such longer period as the HGML may authorize in writing) after receipt of the default notice from the Employer

38. FORCE MAJEURE

38.1 A 'Force Majeure' means any event or circumstance or combination of events those stated below that wholly or partly prevents or unavoidably delays an Affected Party in the performance of its obligations under this Agreement, but only if and to the extent that such events or circumstances are not within the reasonable control, directly or indirectly, of the Affected Party and could not have been avoided if the Affected Party had taken reasonable care or complied with prudent utility practices:

a) Act of God, including, but not limited to lightning, drought, fire and explosion (to the extent originating from a source external to the Site), earthquake, volcanic eruption, landslide, flood, cyclone, typhoon or tornado;

b) Any act of war (whether declared or undeclared), invasion, armed conflict or act of foreign enemy, blockade, embargo, revolution, riot, insurrection, terrorist or military action;

c) Unless the delay has occurred solely as a result of the Contractors default, in obtaining necessary approvals for evacuation, approvals from government electrical inspectorate, delay in Pre-Commissioning and synchronization by competent authority;

d) Radioactive contamination or ionising radiation originating from a source in India or resulting from another Force Majeure Event mentioned above excluding circumstances where the source or cause of contamination or radiation is brought or has been brought into or near the Power Project by the Affected Party or those employed or engaged by the Affected Party.

e) An event of Force Majeure affecting evacuation of power from the Facility to the grid.

38.2 Force Majeure Exclusions

Force Majeure shall not include (i) any event or circumstance which is within the reasonable control of the Parties and (ii) the following conditions, except to the extent that they are consequences of an event of Force Majeure:

a).Unavailability, late delivery, or changes in cost of the plant, machinery, equipment, materials, spare parts or consumables for the Power Project;

b). Delay in the performance of by contractor, Sub-contractor or their agents;

c). Non-performance resulting from normal wear and tear typically experienced in power generation materials and equipment;

d). Strikes at the Facilities of the Affected Party;

e). Insufficiency of finances or funds or the agreement becoming onerous to perform; and

f). Non-performance caused by, or connected with, the Affected Party's:

i. Negligent or intentional acts, errors or omissions;

ii. Failure to comply with an Indian Law; or

iii. Breach of, or default under this Contract Agreement.

38.3 In the event of either party being rendered unable by Force Majeure to perform any obligation required to be performed by them under this Contract, relative obligation of the party affected by such Force Majeure shall be treated as suspended during which the Force Majeure clause last.

38.4 Upon occurrence of such causes, the party alleging that it has been rendered unable as aforesaid, thereby, shall notify the other party in writing by registered notice within 48 (forty eight) hours of the alleged beginning thereof giving full particulars and satisfactory evidence in support of its claim. Further, within 7 (seven) days, the Contractor will furnish a detailed Contingency Plan to overcome the effects of the incident and bring the project on its schedule after cessation of the effect of Force Majeure.

38.5 The Affected Party shall give notice to the other Party of (i) the cessation of the relevant event of Force Majeure; and (ii) the cessation of the effects of such event of Force Majeure on the performance of its rights or obligations under this Agreement, as soon as practicable after becoming aware of each of these cessations.

38.6 Time for Performance of the relative obligation suspended by the force majeure shall stand extended by the period for which such clause lasts.

38.7 If works are suspended by Force Majeure conditions lasting for more than two months, the Employer may have the option of cancelling this Contract in whole or part thereof, at its discretion.

38.8 The Contractor shall not claim any compensation for Force Majeure conditions and shall take appropriate steps to insure men and materials utilized by it under the Contract well in advance.

39. INSURANCE

39.1 During the Contract period all insurance related expenses shall be borne by the Contractor.

The goods supplied under the Contract shall be fully insured against the loss or damage incidental to manufacture or acquisition, transportation, storage and delivery in such a manner that Employer shall not incur any financial loss, as long as the plant continues to remain under the custody of the Contractor.

39.2 In case of any loss or damage or pilferage or theft or fire accident or combination of the said

incidents etc. under the coverage of insurance, the Contractor shall lodge the claim as per rules of insurance. Any FIR required to be lodged to local Police Station shall be the responsibility of the Contractor.

39.3 The Contractor shall arrange to supply/ rectify/ recover the materials even if the claim is unsettled for timely Completion of the Project. The final financial settlement with the insurer shall be rested upon the Contractor.

39.4 In case of any delay of the project attributable to the Contractor, the Contractor himself in consultation with Employer should take the extension of insurance. Any financial implications shall, however, be borne by the Contractor.

39.5 The Contractor should arrange for providing insurance coverage to its workmen under Workmen's Compensation Act or similar Rules and Acts as applicable during execution of work for covering risk against any mishap to its workmen. The Contractor shall also undertake a Third Party Insurance. The Employer will not be responsible for any such loss or mishap.

39.6 All other insurance like, Contractor All Risk, Erection All Risk, insurance against theft and acts of GOD, as required for the construction and O&M of the plant and to indemnify the employer/ equipment/ material and resources shall be borne by the contractor. Fire insurance is to be arranged by the Contractor up to the years of O&M of the Facility.

39.7 The insurance are suitably taken for the activity/ act which is required to cover all the risk associated to the activity / act. The Contractor shall be responsible to take suitable insurance till the completion of the O&M and indemnify the Employer from all associated risks.

40. STATUTORY ACTS AND RULES

The work shall be executed in conformity with Indian Electricity Act 2003, Central Electricity Authority Regulations, Explosive Act 1948, Petroleum Act 1934, National Building Code, hazardous waste management rules 2009, e – waste (Management& Handling) rules 2011 and relevant Rules/ Acts in vogue at the time of execution including O&M period.

41. HAZARDOUS MATERIAL

Any hazardous material used during construction or used as part of the plant has to be taken back by the supplier for recycling or dumping purpose after its operating / working life, so that it may not affect the environment or any living being. Contractor(s) have to comply with Karnataka State Pollution Control Board regulation.

42. STOPPAGE OF WORK

Employer shall not be responsible and not liable to pay any compensation due to stoppage of work as a reaction from local public due to any undue action on the part of the Contractor causing annoyance to local people.

43. HINDRANCE REGISTER

The Contractor may also maintain a Hindrance Register where reasons for delay may be recorded from time to time and at the time of occurrence of the hindrance and get it duly certified by the Engineer-in-Charge or his Authorized Representative.

44. MANUALS

The Contractor shall supply all necessary erection and Commissioning manuals, O&M manuals etc. as and when required. Six sets of test results, manuals etc. shall be submitted by the Contractor on Completion of the work.

45. DELIVERY OF EQUIPMENT

45.1 The Contractor shall deliver the equipment of the plant and machineries in accordance with the terms of the Contract at the time(s) to the place(s) and in the manner specified in the Contract. The Contractor shall comply with instructions that may be given by the Employer from time to time regarding the transit of the plant and material.

45.2 Notification of delivery or dispatch in regard to each and every consignment shall be made to the Employer immediately after dispatch or delivery from the manufacturing works. The Contractor shall supply to the consignee invoice in triplicate, CENVAT copy for availing CENVAT/VAT benefit and packing account of all stores delivered or dispatched by him.

45.3 In case of any occurrence of loss or damage in transit, it shall be the liability of the Contractor to initiate or pursue the claim with insurance Employer. It should take immediate steps to repair the damaged apparatus or replacement there to.

46. LIABILITIES DURING TRANSIT

The Contractor shall be responsible for loss, damages, or depreciation to goods or of plant, equipment, and machineries up to delivery at Site.

47. DEDUCTION FROM CONTRACT VALUE

47.1 All costs, claims, damages or expenses, which the Employer may have paid for which the Contractor is liable, will be deducted by the Employer from deposited Performance Bank Guarantee or from any money due or which become due to him under this Contract or any contract are being executed elsewhere with the Employer.

47.2 Any sum of money due and payable to the Contractor, as per the Contract Agreement, may be appropriated by the Employer and set off against any claim of the Employer, for the payment of a sum of money arising out of or under any other contract made by the Contractor with the Employer. It is an agreed term of the Contract that the sum of money, withheld or obtained under this clause by the Employer, will be kept withhold or retained as such by the Employer or till this claim arising out of in the same Contract is either

mutually settled or determined by the arbitrator, or by competent court, as the case may be, and that the Contractor shall have no claim for interest or damages whatsoever on this account or any other account in respect of any sum of money withheld or retained under this clause and duly notified as such to the Contractor.

48. WARRANTY / GUARANTEE

48.1 PV modules used in grid connected solar power plants must be warranted for peak output wattage, which should not perform at rated capacity of lesser than 90% at the end of 10 years and 80% at the end of 25 years.

48.2 The modules shall be warranted for at least 25 years for failures due to material defects and workmanship.

48.3 The mechanical structures, electrical works and overall workmanship of the grid connected solar power plant must be warranted for a minimum of 25 years.

48.4 The Contractor must ensure that the goods supplied under the Contract are new, unused and of most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the Contract.

48.5 The warranty / guarantee period shall be as follows:

48.5.1 Solar PV Modules: Modules shall be warranted for a minimum period of 25 years in the Contractor's detailed Warranty / Guarantee certificate. Same should be furnished with its Bid.

48.5.2 Power Conditioning Units (PCU)/ Inverters: PCUs shall be warranted for the guarantee period provided by the original equipment manufacturer. Same should be furnished with its Bid.

48.5.3 Transformers, associated switch gear and others: Contractor must furnish in detail its warranties / guarantees for these items.

48.6 During the period of Warranty / Guarantee the Contractor shall remain liable to replace any defective parts, that becomes defective in the plant, of its own manufacture or that of its Sub-contractors, under the conditions provided for by the Contract under and arising solely from faulty design, materials or workmanship, provided such defective parts are not repairable at Site. After replacement, the defective parts shall be returned to the Contractors works at the expense of the Contractor unless otherwise arranged.

48.7 At the end of guarantee period, the Contractor's liability shall cease. In respect of goods not covered by the first paragraph of this clause, the Employer shall be entitled to the benefit of such guarantee given to the Contractor by the original contractor or manufacturer of such goods.

48.8 During the O&M and guarantee period, the Contractor shall be responsible for any defects in

the work due to faulty workmanship or due to use of sub- standard materials in the work. Any defects in the work during the guarantee period shall therefore, be rectified by the Contractor without any extra cost to the Employer within a reasonable time as may be considered from the date of receipt of such intimation from the Employer failing which the Employer shall take up rectification work at the risk and cost of the Contractor.

49. FINAL BILL

49.1 The final bill relating to the EPC Contract shall be prepared only after the Guaranteed Performance of the plant has been observed. It will include the adjustments of all claims against the Contractor by the Employer and awarded in its favour by the Arbitrator, up to the date of preparation of the final bill.

49.2 The O&M shall be comprehensive. The maintenance service provided shall ensure project functioning of the Solar PV system as a whole and Power Evacuation System to the extent covered in the Contract. All preventive / routine maintenance and breakdown / corrective maintenance required for ensuring maximum uptime shall have to be provided. Accordingly, the Comprehensive O&M shall have two distinct components as described below:

49.2.1 Preventive / Routine Maintenance:

This shall be done by the Contractor regularly and shall include activities such as cleaning and checking the health of the Solar PV system, cleaning of module surface, tightening of all electrical connections, and any other activity including the associated civil works, as mentioned in GCC clause 7, wear and tear that may be required for proper functioning of the Solar PV system as a whole. Necessary maintenance activities, Preventive and Routine for Transformers and associated switch gears also shall be included.

49.2.2 Breakdown / Corrective maintenance:

Whenever a fault has occurred, the Contractor has to attend to rectify the fault & the fault must be rectified within 24 hrs time from the time of occurrence of fault, failing which the Contractor will be liable for additional liquidated damages as per terms & conditions under Plant Performance Guarantee and under Warranty mentioned in SCC.

49.3 The date of comprehensive O&M period shall begin on the date of demonstration of guaranteed PR. However, operation of the Power Plant means operation of system as per Bid and workmanship in order to keep the project trouble free covering the guarantee period. The Contractor must demonstrate the committed CUF at the end of every year in accordance with commitment made in the Techno-Commercial Enclosures of the Bid.

50. RISK PURCHASE

If the Contractor fails, on signing of the Contract, to take up the work within a reasonable period or leave the work Site after partial execution of the work, the Employer shall have the liberty to get the work done through other agency at the Contractor's own risk and additional

cost if any has to be borne by the Contractor. If the situation, so warrants, to compel the Employer to cancel the Contract, it shall be liable to compensate the loss or damage, which the Employer may sustain due to reasons of failure on Contractor's part to execute the work in time.

51. UNFORESEEN CONDITIONS

51.1 If, during the execution of the Contract, the Contractor shall encounter on the Site any physical conditions (other than climatic conditions) or artificial obstructions that could not have been reasonably foreseen prior to the date of the Contract Agreement by an experienced contractor on the basis of reasonable examination of the data relating to the Facilities, and on the basis of information that it could have obtained from a visual inspection of the Site (if access thereto was available) or other data readily available to it relating to the Facilities, and if the Contractor determines that it will in consequence of such conditions or obstructions incur additional cost and expense or require additional time to perform its obligations under the Contract that would not have been required if such physical conditions or artificial obstructions had not been encountered, the Contractor shall promptly, and before performing additional work or using additional Plant and Equipment or Contractor's Equipment, notify the Engineer-in-Charge in writing of

i) The physical conditions or artificial obstructions on the Site that could not have been reasonably foreseen

ii) The additional work and/or Plant and Equipment and/or Contractor's Equipment required, including the steps which the Contractor will or proposes to take to overcome such conditions or obstructions

iii) The extent of the anticipated delay

iv) The additional cost and expense that the Contractor is likely to incur.

On receiving any notice from the Contractor under this GCC Sub-Clause 51.1, the Engineer-in-Charge shall consult and decide upon the actions to be taken to overcome the physical conditions or artificial obstructions encountered. Following such consultations, the Engineer-in-Charge shall instruct the Contractor of the actions to be taken.

51.2 Any reasonable additional cost and expense incurred by the Contractor in following the instructions from the Engineer-in-Charge to overcome such physical conditions or artificial obstructions referred to in GCC Sub-Clause 51.1 shall be paid by the Employer to the Contractor as an addition to the Contract Value.

51.3 If the Contractor is delayed or impeded in the Performance of the Contract because of any such physical conditions or artificial obstructions referred to in GCC Sub-Clause 51.1, the Time for Completion shall be extended in accordance with GCC Clause 53 (Extension of Time for Completion).

52. CHANGE IN LAWS AND REGULATIONS

If, after the date of Bid submission, in the country where the Site is located, any law, regulation, ordinance, order or bye-law having the force of law is enacted, promulgated, abrogated or changed (which shall be deemed to include any change in interpretation or application by the competent authorities) that subsequently affects the costs and expenses of the Contractor and/or the Time for Completion, the Contract Value may be correspondingly increased or decreased, and/or the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been affected in the Performance of any of its obligations under the Contract.

53. EXTENSION OF TIME FOR COMPLETION

53.1 The Time(s) for Completion specified in the SCC shall be extended if the Contractor has delayed or impeded in the Performance of any of its obligations under the Contract by reason of any of the following:

53.1.1 Any occurrence of Force Majeure as provided in GCC Clause 38 (Force Majeure), unforeseen conditions as provided in GCC Clause 51 (Unforeseen Conditions).

53.1.2 Any changes in laws and regulations as provided in GCC Clause 52 (Change in Laws and Regulations) or by such period as shall be fair and reasonable in all the circumstances and as shall fairly reflect the delay or impediment sustained by the Contractor.

53.2 Except where otherwise specifically provided in the Contract, the Contractor shall submit to the Engineer-in-Charge a notice of a claim for an extension of the Time for Completion, together with particulars of the event or circumstance justifying such extension as soon as reasonably practicable after the commencement of such event or circumstance. As soon as reasonably practicable after receipt of such notice and supporting particulars of the claim, the Employer and the Contractor shall agree upon the period of such extension. In the event that the Contractor does not accept the Employer's estimate of a fair and reasonable time extension, then the matter will be settled in accordance with the provisions of GCC Sub-Clause 6.1.

53.3 The Contractor shall at all times use its reasonable efforts to minimize any delay in the Performance of its obligations under the Contract.

53.4 The Contractor shall be required to attend all weekly Site progress review meetings organized by the 'Engineer-in-Charge' or his Authorized Representative. The deliberations in the meetings shall include the weekly program, progress of work (including details of manpower, tools and plants deployed by the Contractor vis-à-vis agreed schedule), inputs to be provided by Employer, delays, if any and recovery program, specific hindrances to work and work instructions by Employer. The minutes of the weekly meetings shall be recorded in triplicate in a numbered register available with the 'Engineer-in-Charge' or his Authorized Representative. These recordings shall be jointly signed by the 'Engineer-in-Charge' or his Authorized Representative and the Contractor and one copy of the signed records shall be

handed over to the Contractor.

54. CARE OF FACILITIES

The Contractor shall be responsible for the care and custody of the Facilities or any part thereof until the date of Completion of the Facilities pursuant to GCC Clause 18 or, where the Contract provides for Completion of the Facilities in parts, until the date of Completion of the relevant part, and shall make good at its own cost any loss or damage that may occur to the Facilities or the relevant part thereof from any cause whatsoever during such period. The Contractor shall also be responsible for any loss or damage to the Facilities caused by the Contractor or its Sub-contractors in the course of any work carried out, pursuant to GCC Clause 35 (Defect Liability).

55. CONTRACTOR PERFORMANCE & FEEDBACK AND EVALUATION SYSTEM

The Employer has in place an established 'Contractor Performance and Feedback System' against which the Contractor's Performance during the execution of Contract shall be evaluated on a continuous basis at regular intervals. In case the Performance of the Contractor is found unsatisfactory on any of the following four parameters, the Contractor shall be considered ineligible for participating in future tenders for a period as may be decided by the Employer:

a) Financial Status

b) Project Execution and Project Management Capability

c) Engineering & QA Capability

d) Claims & Disputes

56. FRAUD PREVENTION POLICY

56.1 The Contractor along with their Associate/ Collaborator/ Sub-contractors/ sub-vendors/ Consultants/ Service Providers shall observe the highest standard of ethics and shall not indulge or allow anybody else working in their organization to indulge in fraudulent activities during execution of the Contract. The Contractor shall immediately apprise the Employer about any fraud or suspected fraud as soon as it comes to their notice.

Special Conditions of Contract

Contents

1. PROJECT DESCRIPTION

The main objective of this Project is design, engineering, procure, manufacture, supply, erection, testing and commissioning of 14MW (AC) Grid-Connected Solar Photovoltaic Power Plant with all associated infrastructure including establishing step-up stations, pooling sub-stations of 11/110kV, 110kV transmission line with associated metering and switchgear and 5 (five) years operation & maintenance from the date of commissioning on turnkey basis.

2. PROJECT SITE

Project site shall be at Hutti, Lingsugur Taluk, Raichur District, Karnataka State. Details of the Project Site are mentioned under Schedule 5 – Technical Specifications of this Contract.

3. ENGINEER IN – CHARGE AND THIRD PARTY INSPECTOR

Engineer in - Charge will be appointed and will be intimated after issue of LoA. Third Party Inspector will be appointed and will be intimated to the Contractor.

4. SCOPE OF SERVICES

Engineering, procurement, supply and commissioning of 14 MW (AC) Grid-Connected Solar Photovoltaic Power Plant along with all equipment and infrastructure related to the Project along with accessories and recommended & mandatory spares including, but not limited to that of mentioned in the Schedule 5 – Technical Specifications, transportation, unloading, receiving and storage at Site.

a. Arranging to repair and/or re-order and supply all damaged or short-supply items.

b. Final check-up of equipment and pre – commissioning, commissioning and putting the system into successful operation for performance demonstration while feeding power to the grid while keeping the plant up for 100%.

c. Comprehensive Operation and Maintenance of the plants for 5 (Five) years after commissioning and PR and Plant Performance Guarantee Test.

5. TRAINING OF EMPLOYER'S PERSONNEL

On successful Commissioning of the Plant, the Contractor shall provide training on Solar Power Plant operations and maintenance to a team of upto 10 personnel (Engineers and Technician/Operators) as nominated by HGML.

6. PERFORMANCE GUARANTEE

6.1 The Solar Power Plant performance will be evaluated through performance ratio test as per IEC 61724 and CUF calculation as per the formulas and procedures mentioned under Schedule 5 – Technical Specifications of this Contract.

6.2 The minimum acceptable PR of the plant is 0.78 and CUF shall be 19% against installed DC capacity at STC.

6.3 As the PR of the Plant is dependent on the quality of plant equipment and optimum design of the plant, the Contractor shall demonstrate the PR of 0.78 as per the procedure mentioned at Clause 6.1 of SCC for Operational Acceptance of the Solar Power Plant.

6.4 The initial acceptance of the Solar Power Plant will be evaluated during commissioning by measuring PR for continuous 7 days. However, Contractor must demonstrate the PR for a period of 30 days as per the PR test procedure specified in Schedule 5 – Technical Specifications of this Contract.

6.5 The Acceptance of Plant will be evaluated based on minimum CUF demonstrated at the end of one year from the date Commissioning.

6.6 During O&M period, the Solar Power Plant performance will be evaluated based on annual Capacity Utilization Factor. The CUF will be determined based on annual radiation measured at the plant and the guaranteed PR by the Contractor. Second year onwards plant deration factor also will be considered to evaluate the CUF.

6.7 During the Performance Demonstration Period after the commissioning of the plant and during the O&M period, the Contractor need to maintain 100% uptime of the plant to achieve the proposed CUF at the end of each year. Any repair, replacement, overhauling, etc., are to be performed during night times so that no generation loss will be there in day time.

6.8 Bidders are expected to make their own study of solar profile and other related parameters of the area & make sound commercial judgment about the Performance Ratio. It shall be the responsibility of the Bidder to access the corresponding solar insolation values and related factors of solar plant along with expected grid availability. The Bidder should access all related factors about the selected Site for the Project before giving commitments of PR and CUF of the proposed Project.

6.9 The Contractor shall be responsible for achieving PR and CUF. For any shortfall in achieving PR and CUF, compensation shall be recovered from the Contractor as per SCC Clause 23.

7. PROJECT TIME LINES:

The time lines for execution of the Contract is 180 days from the date of signing of the Contract and as per the indicative milestones mentioned below.

Timelines for Scope of work

Sl. No	Stage	Reference from D
1.	Signing of EPC Contract	Zero Date (D)
2.	Site Development Work	D+30
3.	Approval of Major drawings	D+60
4.	Completion of Civil work	D+75
5.	Completion of supply of major equipment like SPV Modules (including structure for the above), Power Conditioning Units, transformers etc.	D+90
6.	Installation of all major equipment	D+135
7.	Interconnection of all major equipment and completion of installation	D+155
8.	Completion, testing and commissioning of Solar PV power plant	D+180
9.	Operational Acceptance (PR test demonstration)	D+210

8. MODE OF EXECUTION

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

9. PROGRAMME OF WORK

The Contractor shall submit the programme of work within 15 days from the date of receipt of LoA. The programme shall include a Bar Chart indicating there in the starting position and completion date of each of the major items of work.

10. STARTING OF WORK

The Contractor shall be required to start the work within 15 (fifteen) days from the date of signing of Contract and shall thereof, report to the HGML accordingly.

11. COMPLETION SCHEDULE

11.1 The Time for Completion of the construction activities is 180 days from the date of singing of Contract. Thereafter, 5 years of O&M Contract from the date of Acceptance of the Solar Power Plant.

11.2 The Contractor shall inform the Employer at least 30 days in advance in written notice, and a final notice 7 days in advance to enable the Employer inform the commissioning committee of the date on which it intends to synchronize the Solar Power Plant to the grid system.

11.3 The Contractor shall prepare the completion schedule accordingly and inconformity with provisions of Technical Specifications and carry out the work as per the Technical Specifications subject to "Force Majeure" conditions. The Contractor shall mobilize resources keeping in view, the above Time for Completion.

12. TERMS OF PAYMENT

12.1 HGML shall pay the Contractor in the following manner and at the following time:

Sl. No	**Payment Milestones**	**Amount** (excluding applicable taxes and duties)*
1.	Upon the completion of all drawings and deliverables required for the construction of plant	5% of ECV
2.	Upon delivery, inspection and acceptance of modules at Site against certified invoice	25% of ECV
3.	Upon complete delivery, inspection and acceptance of balance of systems including PCUs, transformers, panel mounting structures, etc. at Site against certified invoice	25% of ECV
4.	Upon completion of erection of 400V/11kV sub-station, 11/110kV sub-station, evacuation infrastructure 11kV, 110 kV, associated civil works namely control rooms, security room, store room, inverter room and other civil structures after certification from Engineer-in-Charge	10% of ECV
5.	Upon Commissioning of the Facility	15% of ECV
6.	Operation Acceptance of the Facility pursuant to successful Guarantee Tests and demonstration of PR and submission of all As – built documentation	10% of ECV
7.	Demonstration of CUF and successful operation and maintenance for first year from the date of commissioning	Year 1: OM-1
8.	On successful Operation and Maintenance of the Solar Power Plant on yearly basis for second year from the date of commissioning	Year 2: OM-2
9.	On successful Operation and Maintenance of the Solar Power Plant on yearly basis for third year from the date of commissioning	Year 3: OM-3
10.	On successful Operation and Maintenance of the Solar Power Plant on yearly basis for fourth year from the date of commissioning	Year 4: OM-4

Sl. No	Payment Milestones	**Amount** (excluding applicable taxes and duties)*
11.	On successful Operation and Maintenance of the Solar Power Plant on yearly basis for fifth year from the date of commissioning	Year 5: OM-5
12.	On successful Operation and Maintenance of the Solar Power Plant and handing over the Solar Power Plant in good operable condition on certification by the Engineer-in-Charge, to the Employer	10% of ECV

* Taxes and duties shall be payable as per actuals on the submission of documentation.

**'OM' indicates the O&M Contract Value quoted by the Contractor for each individual year in its Financial Bid.

a) OM payment shall be made to the Contractor on four equal quarterly instalments.
b) The first set of bank guarantee for 20% of the Performance Security shall be valid for a period of 15 (fifteen months) months from date of Commissioning, which shall be returned after demonstration of CUF and satisfactory operation and maintenance of solar power plant for the first anniversary from date of Commissioning.
c) The second set of bank guarantee for 20% of the Performance Security shall be valid for a period of 27 (twenty seven months) from date of Commissioning, which shall be returned after satisfactory operation and maintenance of solar power plant for second anniversary from date of Commissioning.
d) The third set of bank guarantee for 20% of the Performance Security shall be valid for a period of 39 (thirty nine months) from date of Commissioning, which shall be returned after satisfactory operation and maintenance of solar power plant for third anniversary from date of Commissioning.
e) The fourth set of bank guarantee for 20% of the Performance Security shall be valid for a period of 51 (fifty one months) from date of Commissioning, which shall be returned after satisfactory operation and maintenance of solar power plant for fourth anniversary from date of Commissioning.
f) The fifth set of bank guarantee for 20% of the Performance Security shall be valid for a period of 63 (sixty three months) from date of Commissioning, which shall be returned after satisfactory operation and maintenance of solar power plant for fifth anniversary from date of Commissioning.

12.2 Mobilisation Payment shall be payable against submission of unconditional and irrevocable Mobilization Advance Payment Bank Guarantee of equivalent amount of mobilisation payment as per format in Schedule 2 issued by the bank as enlisted at Schedule 4. This Bank Guarantee shall be valid till 180 days from the date of issue of signing of Contract. The recovery of the mobilization advance shall be made in accordance with GCC Clause 12.2.

12.3 ECV indicates the Contract Value quoted by the Successful Bidder in its Financial Proposal excluding O&M cost.

12.4 Subject to any deduction which the Employer may be authorized to make under this Contract, and or to any additions or deductions provided for in this Contract, the Contractor shall be entitled to payment as follows:

12.4.1 All payments shall be made in Indian Rupees, unless otherwise specified in the Contract Agreement. All payment shall be made on the basis of certified invoices.

12.4.2 The Contractor shall submit the bill / invoice for the work executed showing separately VAT, Service Taxes and any other statutory levies in the bill / invoice.

12.4.3 All taxes and deductions shall be applicable as per prevailing income tax, Works Contract Tax and other statutory rules and provisions in force.

12.4.4 The Contractor, while submitting the Invoices, shall provide the breakup of supply, services & other works and applicable taxes separately.

13. PRICE ESCALATION

No Price escalation is allowed. The rate(s) quoted against the work shall remain firm during the entire Contract period. Any change in Forex rate shall not be considered for price variation.

14. TAXES AND DUTIES

14.1 The price quoted shall be inclusive of all applicable taxes, duties, royalties, levies as applicable, which shall be paid on submission of proper documentary evidences for the same.

14.2 Contractors have to quote the rates of taxes & duties based on the concessional exemption in the same that can be availed by the Contractor on its own. No change in the Contract Value will be allowed by the Employer.

15. PROCUREMENT OF MATERIALS

The Contractor shall procure all necessary material required for the Project work and arrange to store them properly. Test certificate in accordance with the specifications are to be furnished by the Contractor to the Employer for approval in respect of the materials procured by the Contractor.

16. SAMPLES

Employer reserves the right to choose samples from the supplied lot for conforming to the quality from laboratories of its choice for acceptance of the equipment's and materials.

17. NOTICE OF OPERATION

The Contractor shall not carry out important operation without the consent in writing of the Employer or his representative. For carrying out such important activity, the Contractor shall intimate to the Employer at least 72 hours before starting of the job.

18. REJECTION OF MATERIALS

The Engineer–in–Charge's decision in regard to the quality of the material and workmanship will be final. The Contractors at its own cost and risk without any compensation shall immediately remove any material rejected by the Engineer–in–Charge from the Site of work.

19. CONSTRUCTION POWER & WATER SUPPLY

19.1 The Contractor has to arrange Construction Power and water at the site for construction purpose at its own cost.

19.2 Cost of electricity required during construction shall be payable by the Contractor. For construction, temporary connection for construction power from ESCOM shall be arranged by the Contractor as per applicable tariff.

19.3 The Employer may provide space for storage of material, and accommodation for labours at Site. The Contractor shall make his own arrangement for the above.

20. LABOUR ENGAGEMENT

The Contractor shall be responsible to provide all wages and allied benefits to its labours engaged for execution of the project work and also to carry out O&M service. The Contractor shall remain liable to the authorities concerned for compliance of the respective existing rules and regulations of the government for this purpose and shall remain liable for any contravention thereof. The Contractor is required to obtain necessary EPF sub-code from Regional Provident Fund Commissioner, Raichur.

21. HANDING OVER –TAKING OVER

The work shall be taken over by the Employer upon successful completion of all tasks to be performed at Site on equipment supplied, installed, erected and commissioned by the Contractor in accordance with provision of the Contract. During handing over complete Project work, the Contractor shall submit the following for considering final payment:

21.1 All as- Built Drawings and documents as per the contract coordination procedure set out for the successful completion of the Project.

21.2 Detailed Engineering Document with detailed specification, schematic drawing, circuit drawing, cable routing plans and test results, manuals for all deliverable items, Operation,

Maintenance & Safety Instruction Manual and other information about the Project.

21.3 Bill of material.

21.4 Inventory of recommended and mandatory spares at Project Site.

21.5 Immediately after taking over of complete facilities (s), the same will be handed over to the Contractor for O&M for a period of as mentioned in the SCC Clause 4.

22. LIQUIDATED DAMAGES

Liquidity damages for the delay in construction of the plant shall be as per the GCC Clause 34.

23. LIQUIDATED DAMAGES FOR PR AND CUF DEVIATIONS

23.1 During the Operational Acceptance any shortfall in the Performance Ration (PR) as determined through the PR Test Procedure specified in Schedule 5 – Technical Specifications of this Contract will attract imposition of liquidated damages. For every 0.01 shortfall in PR below 0.78 by the Contractor, a penalty of 1% of the Contract Value shall be levied. In case 0.05 shortfall in the Plant PR below 0.78, remaining 4% of the Contract Value shall be levied.

23.2 In case of any defect in the system or after Commissioning, the Contractor shall repair it within 48 hours. Otherwise LD shall be charged and the same shall be deducted from the Performance Security submitted to the Employer.

23.3 Liquidated Damages for lesser CUF shall be charged at a rate of:

Difference in units derived from committed and achieved CUF (for a period of one year after Commissioning) x Rs. [Tariff charged to HGML by ESCOM].

Liquidated Damages shall be recovered from the O&M payment payable to the Contractor.

24. MISCELLANEOUS

24.1 Based on reviewing the Project, if the progress is below expectation as demanded by the Employer then the Employer reserves right to reduce the scope of the Contractor in part or full and assign the same to other contractor(s) and get the work done at the risk and cost of the existing Contractor.

24.2 The Contractor shall continue to provide all the monitoring services, licenses, software, access to all information (real-time or stored) that were been used during the O&M to the Employer and to the transmission authority.

24.3 The Contractor shall construct a temporary facility/ arrangement at site or otherwise for the stay of Employer's employee/ consultant at the time of construction of the Solar Power Plant.

24.4 Provision for installing any additional monitoring equipment to facilitate on- line transfer of data to the competent authority shall be provided by the Contractor.

24.5 In case of discrepancy between GCC Clause and SCC Clause on a particular subject, SCC conditions will prevail.

Schedule 1: Format for Performance Bank Guarantee

(**Note**: Total Performance Guarantee is to be submitted in 3 Nos. of Bank Guarantee in the ratio of 20%, 40%, 40%)

[To be on non-judicial stamp paper of Rupees One Hundred Only (INR 100/-) or appropriate value as per Stamp Act relevant to place of execution, duly signed on each page. Foreign entities submitting Bid are required to follow the applicable law in their country]

Reference No. ……. Bank Guarantee No. ……. Dated: ……. (On stamp paper of Rs.100/-)

1. In consideration of the ----- [*Insert name of the Bidder*] (hereinafter referred to as 'Contractor') submitting the response to NIT inter alia for Engineering, Procurement, Construction, Commissioning, Operation and Maintenance of 14MW AC Solar Photovoltaic Grid Connected Power Plant on turnkey basis at Village Hutti, Taluk Lingsugur, District Raichur in the State of Karnataka, in response to the RFP dated…… issued by HGML (hereinafter referred to as HGML) and HGML considering such response to the RFP of ……[*insert the name of the Contractor*] (which expression shall unless repugnant to the context or meaning thereof include its executers, administrators, successors and assignees) and selecting the Contractor and issuing Letter of Intent No ------- to (*Insert Name of Contractor*) as per terms of RFP and the same having been accepted by the Contractor. As per the terms of the RFP, the_____[*insert name & address of bank*] hereby agrees unequivocally, irrevocably and unconditionally to pay to HGML at [*Insert Name of the Place from the address of HGML*] forthwith on demand in writing from HGML or any Officer authorised by it in this behalf, any amount upto and not exceeding Rupees----------*[Insert amount*] only, on behalf of M/s _____*[Insert name of the Contractor*] This guarantee shall be valid and binding on this Bank up to and including _____[*insert date of validity*] and shall not be terminable by notice or any change in the constitution of the Bank or the term of contract or by any other reasons whatsoever and our liability hereunder shall not be impaired or discharged by any extension of time or variations or alternations made, given, or agreed with or without our knowledge or consent, by or between parties to the respective agreement.

2. Our liability under this Guarantee is restricted to Rs. _____

(Rs._____ only).

3. Our Guarantee shall remain in force until ……..[*insert date of validity*]. HGML shall be entitled to invoke this Guarantee till ……. until [*Insert date which is 30 days after the date in the preceding sentence*].

4. The Guarantor Bank hereby agrees and acknowledges that HGML shall have a right to invoke this BANK GUARANTEE in part or in full, as it may deem fit.

5. The Guarantor Bank hereby expressly agrees that it shall not require any proof in addition to the written demand by HGML, made in any format, raised at the above mentioned address of the Guarantor Bank, in order to make the said payment to HGML.

6. The Guarantor Bank shall make payment hereunder on first demand without restriction or conditions and notwithstanding any objection by ---------- [*Insert name of the Contractor*] and/or any other person. The Guarantor Bank shall not require HGML to justify the invocation of this BANK GUARANTEE, nor shall the Guarantor Bank have any recourse against HGML in respect of any payment made hereunder

7. This BANK GUARANTEE shall be interpreted in accordance with the laws of India and the courts at Bengaluru shall have exclusive jurisdiction.

8. The Guarantor Bank represents that this BANK GUARANTEE has been established in such form and with such content that it is fully enforceable in accordance with its terms as against the Guarantor Bank in the manner provided herein.

9. This BANK GUARANTEE shall not be affected in any manner by reason of merger, amalgamation, restructuring or any other change in the constitution of the Guarantor Bank.

10. This BANK GUARANTEE shall be a primary obligation of the Guarantor Bank and accordingly HGML shall not be obliged before enforcing this BANK GUARANTEE to take any action in any court or arbitral proceedings against the selected Contractor , to make any claim against or any demand on the selected Contractor or to give any notice to the selected Contractor or to enforce any security held by HGML or to exercise, levy or enforce any distress, diligence or other process against the selected Contractor.

11. The Guarantor Bank acknowledges that this BANK GUARANTEE is not personal to HGML and may be assigned, in whole or in part, (whether absolutely or by way of security) by HGML to any entity to whom HGML is entitled to assign its rights and obligations.

12. Notwithstanding anything contained hereinabove, our liability under this Guarantee is restricted to Rs._____(Rs._____only) and it shall remain in force until…….. We are

liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only if HGML serves upon us a written claim or demand.

Signature

Name

Power of Attorney No.

For

[Insert Name of the Bank]
Banker's Stamp and Full
Address.

Dated this _____day of_____, 20_____

Witness:

1.
……
…….

Signature

Name and Address

2.
……
….. Signature

Name and Address

Schedule 2: Format of Bank Guarantee for Mobilization Advance

[To be on non-judicial stamp paper of Rupees One Hundred Only (INR 100/-) or appropriate value as per Stamp Act relevant to place of execution, duly signed on each page]

Reference No. ……. Bank Guarantee No. ……. Dated:

……. To:

WHEREAS HGML has issued LOI No……. for "……" (hereinafter called "the Contractor"), having its registered office at

……..

AND WHEREAS vide Clause 12.2 of Section III: General Conditions of Contract, Mobilization Advance up to 10% (10 percent) of the original contract value of Rs…….. is payable to the Contractor against Bank Guarantees, the Contractor hereby applies for Mobilization Advance of --% (--- percent) amounting to Rs……../- (Rupees……..) of the Contract Price, Now, we the undersigned, Bank of ……., being fully authorized to sign and to incur obligations for and on behalf of and in the name of Bank of ……..hereby declare that the said Bank will guarantee the Employer the full amount of Rs. ……../- (Rupees……..) as stated above. We, …….[Insert Name of Bank], do hereby unconditionally, irrevocably and without demur guarantee and undertake to pay the Employer immediately on demand any or all money payable by the Contractor to the extent of Rs. ……../- (Rupees……..) without any demur, reservation, context, 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 on 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 is valid till ……..[*180 days*] At any time during the period in which this guarantee still valid of the Contractor fails to fulfil its obligation under the Contract, it is understood that the Bank will extend this guarantee under the same condition for the required time on demand by the Employer at the cost of the Contractor. The Guarantee hereinbefore contained shall not be affected by any change in the constitution of the Bank or of the Contractor. The neglect or forbearance of the Employer in enforcement of payment of any money, the payment whereof is intended to be hereby secured or the giving of time by the Employer for the payment hereof shall in no way relieve the Bank of their liability under this Deed. The expressions "the Employer", "the Bank" and "the Contractor" hereinbefore used shall include their respective successors and assigns. Notwithstanding anything contained herein: Our liability

under this Bank Guarantee shall not exceed Rs……../- (Rupees…….) this bank Guarantee shall be valid up to……..[*insert date of validity*] We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only and only if you serve upon us a written claim or demand on or before ……(date of expiry of Guarantee). In witness whereof we of the Bank have signed and sealed this Guarantee on the……day of …….. being herewith duly authorized.

For

[Insert Name of the Bank]__ Banker's Stamp and Full Address. Dated this day of _, 20

Witness:

1. ……. Signature

Name and Address

2. …….. Signature

Name and Address

INSTRUCTIONS FOR FURNISHING PERFORMANCE BANK GUARANTEE

- The Bank Guarantee by Bidders will be given on non-judicial stamp paper as per stamp duty applicable at the place where the tender has emanated. The non-judicial stamp paper should be in name of the issuing bank.
- The Bank Guarantee by Bidder will be given from bank as per Schedule 1: List of Banks only.
- This bank guarantee/ all further communication relating to the bank guarantee should be forwarded to _____, Hutti Gold Mines Company Limited, 3rd Floor, KHB Complex, National Games Village, Koramangala, Bengaluru - 560047.
- The full address along with the Telex/Fax No. and email address of the issuing bank to be mentioned.

Schedule 3: Indemnity Bond to be executed by The Contractor for The Removal / Disposal of Scrap/Disposal of Surplus Material

(TO BE EXECUTED ON STAMP PAPER OF APPROPRIATE VALUE)

INDEMNITY BOND

This INDEMNITY BOND executed this …… day of ……. 20….. by ….....(Name of Company)……., a Company registered under the Companies Act, 1956/2013. and having its registered office(s) at……..(Office Address)……, hereinafter called the Indemnifier/Contractor (which expression shall, unless excluded by or repugnant to the context, be deemed to mean and include its successors, administrators, executors and permitted assigns).

IN FAVOUR OF

HGML, a Government of Karnataka Enterprise, having its registered office at Hutti Gold Mines Company Limited, 3rd Floor, KHB Complex, National Games Village, Koramangala, Bengaluru - 560047 (hereinafter referred to as "HGML").

1. HGML has awarded the Contractor, contract for execution of work ("Scope of Work") as mentioned in the Contract no…….. dated ....., entered into between HGML and Contractor, relating to ……..(Name & Address of Project/Station)…… (hereinafter called 'the Project').

2. The Indemnifier for the purpose of execution of its Scope of Work had from time to time procured and stored ……..(Details of Material)……. at the Project Site.

3. After completion of the Scope of Work by Indemnifier, it has been identified that scrap …… (Details of Scrap Material & its Quantity)……..and/or surplus …… (Details of Surplus Material & its Quantity)…….. belonging to Indemnifier is lying at the said Project Site.

4. Now, the scrap…….(Details of Scrap Material & its Quantity)…..and/or surplus …… (Details of Surplus Material & its Quantity)…….. belonging to the Indemnifier, requires to be removed by Indemnifier from the Project Site.

NOW THEREFORE THIS INDEMNITY BOND WITNESSETH AS UNDER:

1. That Indemnifier by way of this indemnity requests HGML to issue approval in favour of Indemnifier for removal of scrap ……(Details of Scrap Material & its Quantity)……..and/or surplus ……(Details of Surplus Material & its Quantity)…….. belonging to Indemnifier, from the project.

2. That the Indemnifier shall ensure clearing of its scrap …… (Details of Scrap Material & its Quantity)……..and/or surplus …… (Details of Surplus Material & its Quantity)…….. by itself, as aforesaid.

3. That Indemnifier in consideration of the premises above, for itself and its respective, executors, administrators and assigns, jointly and severally agree and undertake from time to time and at all times hereafter to indemnify HGML and keep HGML indemnified from and against all claims, demands, actions, liabilities and expenses which may be made or taken against or incurred by HGML by reason of the issue of necessary approval by HGML and permitting Indemnifier to remove scrap ……(Details of Scrap Material & its Quantity)……..and/or surplus ……(Details of Surplus Material & its Quantity)…….. belonging to Indemnifier, from the project.

4. That Indemnifier undertakes to indemnify and keep HGML harmless from any act of omission or negligence on the part of the Contractor in following the statutory requirements with regard to removal/disposal of scrap and surplus belonging to Indemnifier, from the Project Site aforesaid, by the Indemnifier. Further, in case the laws require HGML to take prior permission of the relevant Authorities before handing over the scrap and/or surplus to the Indemnifier, the same shall be obtained by the Indemnifier on behalf of HGML.

IN WITNESS WHEREOF, the Indemnifier, through its authorized representative, has executed these presents on the Day, Month and Year first mentioned above at

…….. (Name of the Place)

…….. Indemnifier

(Authorised Signatory)

Witensses:

1. ……

2. ……

Schedule 4: List of Banks

1. SCHEDULED COMMERCIAL	2. OTHER PUBLIC SECTOR BANKS
SBI AND ASSOCIATES	1. IDBI Bank Ltd.
1. State Bank of India	3. FOREIGN BANKS
2. State Bank of Bikaner & Jaipur	1. Bank of America NA
3. State Bank of Hyderabad	2. Bank of Tokyo Mitsubishi UFJ Ltd.
4. State Bank of Indore	3. BNP Paribas
5. State Bank of Mysore	4. Calyon Bank
6. State Bank of Patiala	5. Citi Bank N.A.
7. State Bank of Travancore	6. Deutsche Bank A.G
NATIONALISED BANKS	7. The HongKong and Shanghai Banking Corpn. Ltd.
1. Allahabad Bank	8. Standard Chartered Bank
2. Andhra Bank	9. Societe Generale
3. Bank of India	10. Barclays Bank
4. Bank of Maharashtra	11. ABN Amro Bank N.V.
5. Canara Bank	12. Bank of Nova Scotia
6. Central Bank of India	13. Development Bank of Singapore (DBS, Bank Ltd.)
7. Corporation Bank	4. SCHEDULED PRIVATE BANKS
8. Dena Bank	1. Federal Bank Ltd.
9. Indian Bank	2. ING Vysya Bank Ltd.
10. Indian Overseas Bank	3. Axis Bank Ltd.
11. Oriental Bank of Commerce	4. ICICI Bank Ltd.
12. Punjab National Bank	5. HDFC Bank Ltd.
13. Punjab & Sind Bank	6. Yes Bank Ltd.
14. Syndicate Bank	
15. Union Bank of India	
16. United Bank of India	
17. UCO Bank	
18. Vijaya Bank	

19. Bank of Baroda	

Schedule 5: Technical Specifications

DISCLAIMER:

1. Though adequate care has been taken while preparing the R F P document, the Bidders shall satisfy themselves that the document is complete in all respects. Intimation of any discrepancy shall be given to this office immediately. If no intimation is received from any Bidder within twenty (20) days from the date of notification of RFP and Issue of the Bid documents, it shall be considered that the Bid document is complete in all respects and has been received by the Bidder.

2. Hutti Gold Mines Company Limited (HGML), The Employer, reserves the right to modify, amend or supplement this Bid document including all formats and Annexures.

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

4. The specification mentioned for the equipment's viz., Solar modules, PCU, combiner boxes, DC cables, module mounting structures, transformers, CT, PT, LT/ HT cables, interfacing panels, switch gears and other associated equipment to complete the solar power project and evacuation of power from the solar power plant to the designated KPTCL substation, the present tender document is for the reference only. It may be subjected to changes/ alterations as per the design/ planning from the successful Bidder. It is advised that the Bidder must satisfy himself with the prevailing site conditions before submission of his Bid with respect to design proposed. The design must be optimized for the site conditions and directed to achieve the maximum output from the installed capacity at all times. Moreover, the components not mentioned, but are required to complete the plant for operation is also included in the scope of bidder and shall be vetted by HGML.

Place:

(Signature)
Date: Name and Designation of bidder

A. Introduction

1. SITE DESCRIPTION

1.1 The land for the proposed project is located at Vill: Hutti, Taluk: Lingsugur, Dist: Raichur, State: Karnataka and nearly 412km from Bengaluru on NH – 7 and NH -167. Raichur district is situated in the north eastern part of the Karnataka, The district is bounded on the North by the district of Kalaburgi, on the West by the districts of Bijapur and Dharwar, on the East by the district of Mababoobnagar of Telangana, and on the South are the districts of Kurnool of Andhra Pradesh. The two rivers, the Krishna and the Tungabhadra from the entire North and Southern boundaries of the district.

1.2 Proposed Land Details:

Particulars	**Description**
Details of proposed capacity of the solar power plant	14MW (AC) SPV plant Multi crystalline)
Village	Hutti
Taluk	Lingsugur
District	Raichur
State	Karnataka
Location	Hutti
Nearest Substation Details	110kV
Transmission Line	Approx 2 km
Latitude	16.2184*
Longitude	76.6524*
Altitude	1709 ft , MSL
Estimated life of PV Power plant	25 years
Land Available	70 Acres (approx.)
Plot No./ Khasara No.	As per annexure
Type of Land	Own land
Details of land in possession	Land owned by HGML, will be handed over to Contractor
Nearest Urban Area	Raichur
Nearest Highway	NH-13 (Mangaluru-Solapur)
Nearest Railway Station	Raichur
Nearest Domestic Airport	Hyderabad Airport
Minimum values of Capacity Utilization Factor of the plant	CUF : 19% (against installed AC capacity at STC)
Water and Power for Construction	To be arranged by the Contractor

B. System Design and Philosophy

2. DESIGN PHILOSOPHY

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

2.1.1 Technology: Solar PV multi-crystalline (>14.5% Multi) of high efficiency and choice of solar panels may be preferably manufactured in India.

2.1.2 Adequate capacity of SPV modules, Junction boxes with proper protection, PCUs, Cables of appropriate rating (DC and AC) etc. to ensure generation of power as per design estimates. This is to be done by applying liberal de-rating factors for the PV array and recognizing the component, system efficiency parameters of PCUs, transformers, conductor loss etc.

2.1.3 Use of equipment and systems with proven design and performance that have a high availability track record under similar service conditions.

2.1.4 Selection of the equipment and adoption of a plant layout to ensure ease of maintenance as well as to enhance the solar plant performance.

2.1.5 Strict compliance with the approved and proven quality assurance norms and procedures during the different phases of the project, and always use the manuals and specifications issued by the manufacturer

2.1.6 Proper arrangements with respect to synchronizations to ensure evacuation of power to the grid.

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

2.1.8 It should also provide for the analysis, study and evaluation of the historical data and help in the plant maintenance people to take up the plant and equipment on preventive maintenance.

2.1.9 Appropriate generation voltage of 400/415V AC at inverter level has to be stepped up to 11kV to facilitate internal pooling and further stepping up of voltage to 110 kV at pooling station to facilitate onward transmission and evacuation to the grid at the point of metering and interconnection. The Contractor is free to select appropriate DC voltage at inverter input

level based on SPV cluster leading to inverter considering least I^2R loss in DC side.

2.1.10 The power plant has to operate in parallel with the grid system which is infinite electrical system. Any faults not taken care will result in damage of only SPV power plant without affecting STUs infinite system. Thus the Solar Power Plant has to protect its equipment against any of possible fault or other disturbances from the grid.

2.1.11 Very fast responsive microprocessor based Directional and Reverse power flow protection should be provided to ensure isolation of the solar power plant from the grid at the time of any fault or/and any additional suitable protection.

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

2.2.1 Plant layout to ensure optimum availability for generation during the day time without any shading.

2.2.2 High DC system voltage and low current handling requirements.

2.2.3 Selection of PCUs with proven performance and ready availability of requisite spares.

2.2.4 Based on the SOLAR INSOLATION data from reliable sources, the solar PV system should be so designed that it shall take into account the mean energy output after allowing for various losses, temperature corrections, on an average day for each month of the year.

2.2.5 Careful logging of operational data / historical information from the Data Monitoring Systems, and periodically processing it to determine abnormal or slowly deteriorating conditions.

2.2.6 SPV power plant should be designed to operate satisfactorily in parallel with the grid within permissible limits of high voltage and frequency fluctuation conditions, so as to export the maximum possible units generated to the grid. It is also extremely important to safeguard the system during major disturbances, like tripping / pulling out of big generating stations and sudden overloading during falling of portion of the grid loads on the power plant unit in island mode, under fault / feeder tripping conditions.

2.2.7 Flat plate SPV arrays which are held fixed at an optimum tilted angle and face towards the equator, are most common. The angle of tilt should be approximately equal to the angle of latitude for the site. A steeper angle increases the output in winter; while a shallower angle more output in summer. It should be arranged in such a manner that optimum generation is achieved.

The specifications provided with this bid document are a functional ones; any specifications provided in this document is only meant for ensuring optimum standards and there is no bar to use the equipment's of standards exceeding the standards mentioned.

The Bidder must submit a proposal based upon their own design. Bidder must optimize their own design for Solar Photovoltaic (SPV) system with proven technology so that it shall best meet to guarantee the performance factors as it is a part of the acceptance criteria given in this bid document. The bidders are advised to visit the site before designing the plant. The tenderer is free to study the actual condition of the existing location, and required to design proposed step-up substation at inverter level and pooling sub-station of 110kV level, which shall include the switchgear, communication equipments and systems as required by STU. The Bidder is required to understand and Evaluate the scope of work after visiting Hutti Gold Mines Co. Ltd. And subsequently, Tenderer can prepare a suitable, appropriate technical design, necessary site specific drawings, complete bill of materials (BOM) and full technical specifications, compatible to the proposed work.

2.3 The minimum array capacity at STC (Standard Test Conditions) shall be determined to have 14MW (AC) output at the time of installation and after stabilized operation of first year this capacity will be measured and the capacity of plant shall be minimum 14MW (AC). If the bidder anticipates any degradation of the modules during the first year, it shall be taken care of to provide additional capacity to achieve minimum 14MW (AC) of array at the end of first year to meet guaranteed generation to avoid liquidated damages/compensation on account of Performance Guaranteed Generation. (Note- This is a critical point of the entire Solar PV plant, The Bidder must take the note of all the critical parameters, considerations of technical aspects, product, site, climatic conditions, etc).

2.4 This Bid document specifically cover the rest of the electrical engineering requirements including 110kV transmission infrastructure for the proposed Grid Connected 14MW (AC) Solar Power Plant along with their associated equipment. The capacity of the plant shall be determined to attain minimum of 14MW (AC) at the point of evacuation at KPTCL substation.

2.5 Selected Bidder (Contractor) shall design and prepare the detailed project report along with BOQ (Bill of Quantities) and submit a copy to HGML for evaluation within 4 weeks from the date of signing of the Contract.

2.6 **Component and equipment reliability:**

Each component offered by the bidder shall be of established reliability. The minimum target reliability of each equipment shall be established by the bidder considering its failure, mean time between failures and mean time to restore, such that the availability of complete system is assured. The guaranteed annual system availability shall not be less than 99.9%. Bidder recommendation of the mandatory spares shall be on the basis of established reliability.

2.7 Bidder shall design the plant in order to have sustained life of 25 years with minimum maintenance requirements.

2.8 The supply, erection, commissioning and all other allied works for 14MW (AC) SPV Power Plant shall be completed within 6 months from the date of signing of the Contract.

C. Scope of Supply and Work

3. DETAILED SCOPE OF WORK

3.1 Scope of Supply & Work includes detail design, engineering, manufacture, procurement & supply of equipment and materials, preparation of single line diagrams, installation drawings, electrical lay outs, erection key diagrams, electrical and physical clearance diagrams, design calculations for Earth- mat, Bus Bar & Spacers indoor and outdoor lighting/illumination etc. design memorandum, GTP and GA drawings for the major equipment, design basis & calculation sheets, and other relevant drawings and documents, testing at manufacturers works, inspection, packing and forwarding, supply, receipt and unloading, Storing with proper security at site, providing associated civil works. , installation and incidentals, insurance at all stages, erection, testing and commissioning of 14MW (AC) Grid Interactive Solar PV Power Plant and performance demonstration with associated equipment and materials on turnkey basis at Vill: Hutti, Taluk: Lingsugur, Dist: Raichur, State: Karnataka and 05 (five) years comprehensive operation and maintenance from the date of commissioning and inclusive of performance demonstration are covered under Bidders scope of work.

3.2 The equipment and materials for 14MW (AC) Grid Interactive Solar PV Power Plant with associated system (Typical) shall include but not be limited to the receipt, unloading, storage, erection, testing and commissioning of all supplied material for the following:

3.2.1 Solar PV modules of suitable rating, in array totalling minimum of 14MW (AC) including mounting frames, structures, fasteners, array foundation and module interconnection.

3.2.2 Array Junction boxes, distribution boxes and Fuse boxes. MCBs, Surge Arrestors with string monitoring capabilities.

3.2.3 Power Conditioning Units (PCU) with SCADA compatibility, common AC power evacuation panel with bus bars and circuit breakers LT & HT Power Interfacing Panels, Plant Monitoring Desk, AC & DC Distribution boards.

3.2.4 Design and construction of 415V / 11kV step-up substation at inverter level and 11kV/110kV step up sub-station with power transformer, associate switchgear, metering equipment, communication equipment, auxiliary transformers, etc.

3.2.5 Relay and protection system along with battery system.

3.2.6 LT Power and Control Cables including end terminations and other required accessories for both AC & DC power.

3.2.7 Internal 415V interconnection & Indoor feeder panels to cater auxiliary needs of plant

3.2.8 11kV, 110 kV indoor/ outdoor control panels for incoming and outgoing lines with VCBs(11kv), SF6 Breackers (110kv), CTs, PTs, Bus bars, cables terminals kits and Bus coupler having Main and transfer Bus. Each bay shall complete with proper protection scheme consisting of breackers, instrument transformers, Isolators with earth switch, LAs etc.

3.2.9 ABT meters (Main and Check) with all necessary rated CT's and PT's at the plant take off point as well as at the substation as per the specification and design approved by competent authority.

3.2.10 Data acquisition system (SCADA) with remote monitoring facilities including SMU level. Provision for specific data transfer to the State Load Dispatch Centre (SLDC) shall also be provided.

3.2.11 Lightning arrestors for entire plant area.

3.2.12 PVC pipes, cable trays and accessories/trenches.

3.2.13 Earthing of the entire plant as per relevant standards.

3.2.14 Control room equipment related to solar power plant system, pooling station etc.

3.2.15 Testing, maintenance and monitoring of equipment for period of comprehensive maintenance.

3.2.16 Mandatory spares & consumables for 5 years.

3.2.17 IP PTZ type CCTV cameras not less than 28X at Main Entrance, inverter control rooms, at Main Control room and at switchyard.

3.2.18 Fire protection system in buildings and fire extinguishers.

3.2.19 One Solar resource monitoring center including testing facilities. The Solar Observatory with associated systems shall include but not be limited to the following:
a. Pyranometers.

b. Ultrasonic Anemometer.

c. Temperature Sensor – Ambient and module surface

d. Power source to the all sensors

e. Data Logger

f. Desktop and Printer

3.2.20 Construction of suitable infrastructure for evacuation of power from inverter points to step-up transformers (at 11kV) and evacuation through UG cable up to pooling station to the delivery point line with suitable switchgears.

3.2.21 Design & construction of 11/110 kV pooling substation and development of transmission line for evacuation of power using appropriate towers with provision for double circuit using coyote conductor for approximately 2 km from 11/110 kV pooling sub-station.

3.2.22 In addition to above, the Bidder is required to measure the Solar Radiation and other climatic conditions relevant to measure the plant performance.. The satellite based analysis is to be combined with direct ground based measurement equipment in order to achieve the necessary accuracy and level of detail in the assessment of solar levels and climatic conditions.

3.2.23 Estimation and determination of the plant generation on daily basis in form of look ahead scheduling power output.

3.2.24 Any other equipment / material required to complete the 14MW (AC) Solar Power Plant.

3.3 During the O&M period, the Contractor shall keep the measured daily data at regular interval and provide the same to HGML in electronic form compatible in CSV format. The right to use the data shall remain with HGML.

3.4 Materials and accessories, which are necessary or required for satisfactory and trouble-free operation and maintenance of the plant.

3.5 The items of civil construction work shall include all works required for solar PV project and should be performed specifically with respect to following but not limited to:

3.5.1 Conducting contour survey of the Solar Photovoltaic Power Plant for the total area identified for 14MW (AC) Solar Photovoltaic capacity & complete soil investigation with bore hole details.

3.5.2 Earthwork for Site grading, cutting, filling, levelling & compacting of land.

3.5.3 Construction and erection of perimeter fence/boundary wall and main/ security gate(s).

3.5.4 Construction of foundation & mounting structures for SPV panels, with proper spacing between rows of module structure

3.5.5 Construction of 10m wide motorable approach road from main road for easy access to site & 3.75m wide internal roads with 0.5m wide well compacted shoulders on each side

with WBM base to carry safe and easy transportation of equipment and material at the project site during and after construction.

3.5.6 Construction of Inverter control room with necessary illumination system, fire fighting equipment and finishing as required.

3.5.7 Construction of office building with provision for stores, control room, operator room, pantry, wash room, conference room etc. along with requisite furniture, workstations, air conditioning, internal and external illumination, other equipment as per the specifications with minimum corpet area of 3000sqft.

3.5.8 Construction of Security room at strategic locations inside the plant with minimum floor area of 150sqft.

3.5.9 Water required for construction shall be in the scope of. A suitable permanent arrangement of water (Through Bore well & water harvesting) with RO facilities shall be ensured to cater the day-to-day requirement of drinking water and permanent water supply for module cleaning with 50 mt outlet arrangement with proper water pressure and other needs of SPV power Plant during entire O&M period.

3.5.10 Construction of Storm water drainage & sewage network. Rain water harvesting system should also be provided.

3.5.11 Perimeter lighting, Fabrication, supply & erection along with required GI junction boxes, support, brackets and accessories as required. And also emergency power supply to be provided, including some standalone GI pole mounted LED lighting.

3.5.12 Suitable conduits and their accessories and Hume pipes for crossings.

3.5.13 Supply of ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes with powder coating paint for internal fixtures, cable fixing clamps, nuts and bolts etc. of appropriate sizes as required in the plant.

3.5.14 Laying of Power Cables underground / over ground with proper cable trench/tray arrangements.

3.5.15 Entire GI cable tray with proper GI support and accessories inside equipment room and control room building and other locations as required.

3.6 HGML will facilitate obtaining statutory approvals / clearances from Government Departments, not limited to, the following-

3.6.1 Evacuation approvals from competent authority.

3.6.2 Airport authority clearance if required.

3.6.3 Pollution control board clearance, if required.

3.6.4 Mining Department.

3.6.5 Forest Department.

3.6.6 All other approval, as necessary for setting up of a solar power plant including CEIG, connectivity, power evacuation, PTCC etc. as per the suggested guidelines

3.6.7 All other statutory approvals and permissions not mentioned specifically but are required to carry out hassle free construction and operation of the plant

3.7 The Bidder shall arrange deployment of qualified and suitable manpower and required necessary consumables during entire construction period.

3.8 Comprehensive Operation & Maintenance of Solar Photovoltaic Power Plant for the 5 year period from date of commissioning including deployment of engineering personnel, technicians and security personnel.

3.9 All equipment's, items and works which are not specifically mentioned in this document but are required for completion of work including construction, commissioning, operation & maintenance of Solar Photovoltaic Power Plant in every respect and for safe and efficient construction & erection, operation and guaranteed performance are included in the scope of this bid.

3.10 Furnishing of project related documents, drawings, data design, and engineering information to HGML or its authorized representative for review and approval in hard copy and soft copy from time to time as per project schedule.

3.10.1 Contour plan and soil investigation data for the area

3.10.2 GA drawings of the entire project including roads, drains, storm water drainage, sewage networks, equipment rooms, office cum control room, security gate, fire protection system etc.

3.10.3 Design basis criteria along with relevant standards and site specific condition.

3.10.4 Solar insolation data and basis for generation data.

3.10.5 Design calculations and sheets.

3.10.6 Detailed technical specifications of all the equipment.

3.10.7 General arrangement and assembly drawings.

3.10.8 Schematic diagram for entire electric system.

3.10.9 GTP & G.A. drawings for all types of structures/ components, 415V/11kV substation, 11/110 kV substation, related switchgears & other interfacing panels.

3.10.10 Relay setting charts.

3.10.11 Quality assurance plans including manufacturing quality plan and field quality plans.

3.10.12 Detailed site EHS plan, fire safety & evacuation plan and disaster management plan.

3.10.13 Detailed risk assessment and mitigation plan.

3.10.14 Test reports (for type, acceptance, and routine tests).

3.10.15 O&M Instruction's manuals and its drawings. Erection & commissioning manuals, Technical Break Down drill documentation and manuals,.

3.10.16 O&M plans, schedules and operational manuals for all equipment etc.

3.11 All drawings shall be fully corrected to agree with the actual "as built" site conditions and submitted to HGML after commissioning of the project for record purpose. All as-built drawings must include the Good for Construction deviation list.

3.12 The contractor shall forward the following to HGML within two weeks from signing of agreement Schedule for various activities in the form of PERT Chart/Barr chart.

3.12.1 Weekly site work progress report with catch-up plan(s), as necessary to monitor actual timelines of the project during construction period along with the real time snap shots during the time of construction.

3.12.2 Daily/ Monthly O&M reports after commissioning of the project.

3.13 Providing a detailed training plan for all operation, maintenance procedures, which shall after approval by HGML form the basis of the training program. The contractor, shall also provide training to HGML's nominated staff.

3.14 Employ and coordinate the training of contractors' personnel who will be qualified and experienced to operate and monitor the facility and to coordinate operations of the facility with the grid system.

3.15 Establishing a system to maintain an inventory of spare parts, tools, equipment, consumables and other supplies required for the facility's hassle free operation.

3.16 Adequate insurance coverage during EPC and O&M period to cater all risks related to construction and O&M of plant to indemnify the employer.

3.17 Maintain at the facility accurate and up-to-date operating logs, records and monthly reports regarding the Operation & Maintenance of facility.

3.18 Perform or contract for and oversee the performance of periodic overhauls or maintenance required for the facility in accordance with the recommendations of the original equipment manufacturer (OEM). List of OEM is set out in this Technical Specifications.

3.19 Procurement for spares parts, overhaul parts, tools, equipment, consumables, etc. required to operate and maintain the project in accordance with the prudent utility practices and having regarded to warranty recommendations.

3.20 Handover the facility along with inventory of spare parts, tools, equipment, consumables and supplies, particularly proprietary items, if any, for the facility's operation along-with required inventory to maintain the facility for two year on the basis of average requirement at the time of conclusion of O&M period.

3.21 Maintain all administrative offices, roads, tool room, stores room, equipment's control rooms in clean and workable condition. The solar field and entire plant facility shall be free from weeds and shrubs and same should be done in regular intervals of not more than two months.

3.22 Discharge obligations not limiting to wages/salary/contribution to welfare funds/ PF/insurance/ESI/Superannuating benefits etc to employees of the Contractor during the agreement period in terms of applicable laws.

3.22.1 The Selected Bidder shall be responsible for all the required activities for the successful running, committed energy generation & maintenance of the Solar Photovoltaic Power Plant covering:

a. Deputation of qualified and experienced engineers and technicians
b. Deputation of Security personnel for the complete security of plant
c. Successful running of Solar Power Plant for committed energy generation.
d. Co-ordination with STU/SLDC/other statutory organizations as per the requirement on behalf of Employer for Joint Metering Report(JMR), furnishing generations schedules as per requirement, revising schedules as necessary and complying with grid requirements.
e. Monitoring, controlling, troubleshooting maintaining of logs & records, registers.
f. Supply of all spares, consumables and fixing / application as required.
g. Supply & use of consumables such as grease, oil etc. throughout the maintenance period as per recommendations of the equipment manufacturers.
h. Conducting periodical checking, testing, overhauling and preventive action.
i. General up keeping of all equipment, building, roads, Solar PV modules, inverter etc.

j. Submission of periodical reports to HGML on the energy generation & operating conditions of the power plant.
k. Furnishing generation data monthly to Employer by 1st week of every month for the previous month to enable Employer raise commercial bills on consumers.
l. Replacement of Modules, Invertors/PCU's and other equipment as and when required.

3.22.2 The period of Operation and Maintenance will be deemed to commence from the date of commissioning of the Project and completion of performance demonstration followed by final acceptance. The Contract shall further be extended on the mutually agreed terms and conditions after completion of agreement period.

3.22.3 All the equipment required for Testing, Commissioning, O&M and for the healthy operation of the Plant must be calibrated, time to time, from the NABL accredited labs and the certificate of calibration must be provided prior to its deployment.

3.23 Operation and Performance Monitoring

3.23.1 Operation part consists of deputing necessary manpower necessary to operate the Solar Photovoltaic Power Plant at the full capacity. Operation procedures such as preparation to starting, running, routine operations with safety precautions, monitoring etc., shall be carried out as per the manufacturer's instructions to have trouble free operation of the complete system.

3.23.2 Daily work of the operation and maintenance in the Solar Photovoltaic Power Plant involves periodic cleaning of Modules, logging the voltage, current, power factor, power and energy output of the Plant at different levels. The operator shall also note down time/failures, interruption in supply and tripping of different relays, reason for such tripping, duration of such interruption etc. The other task of the operators is to check battery voltage-specific gravity and temperature. The operator shall record monthly energy output, down time, etc.

3.24 Maintenance

3.24.1 The contractor shall carry out the periodical/plant maintenance as given in the manufacturer's service manual and perform operations to achieve committed generation. Apart from the manufacturer recommendation, bidder shall carry out the plant performance maintenance quarterly, half yearly and annual.

3.24.2 Regular periodic checks of the Modules, PCU's and other switchgears shall be carried out as a part of routine corrective & preventive maintenance. In order to meet the maintenance requirements stock of consumables are to be maintained as well as various spare as recommended by the manufacturer at least for 5 years to be kept for usage.

3.24.3 Maintenance of other major equipment involved in Solar Photovoltaic Power Plant such as step up transformers, overhead line equipment, indoor / outdoor 11kV, 110 kV VCB / SF6 kiosk, associated switchgears, other fixtures & components and metering panel. Particular care shall be taken for outdoor equipment to prevent corrosion. Cleaning of the insulators and applying Vaseline on insulators shall also be carried out at regular intervals. Earth resistivity of Plant as well as individual earth pit is to be measured and recorded every month. If the earth resistance is high suitable action is to be taken to bring down the same.

3.24.4 According to the recommendations stock of special tools and tackles shall be maintained for PV Modules, PCU's, switchgears and other major electrical equipment.

3.24.5 A maintenance record is to be maintained by the operator/engineer-in-charge to record the regular maintenance work carried out as well as any breakdown maintenance along with the date of maintenance, reasons for the breakdowns, steps taken to attend the breakdown duration of the breakdown etc.

3.24.6 The Schedules will be drawn such that some of the jobs other than breakdown, which may require comparatively long stoppage of the Power Plant, shall be carried out preferably during the non-sunny days. The information shall be provided to Engineer-in-charge for such operation prior to start.

3.24.7 The Contractor shall deploy enough manpower at Solar Photovoltaic Power Plant site to carryout work instructions and preventive maintenance schedules as specified. The contractor shall keep at least one skilled and experienced supervisor at site on permanent basis to supervise the jobs that are being carried out at site.

3.24.8 The Contractor will attend to any breakdown jobs immediately for repair/replacement /adjustments and complete at the earliest working round the clock. During breakdowns (not attributable to normal wear and tear) at O&M period, the Contractor shall immediately report the accidents, if any, to the Engineer In-charge showing the circumstances under which it happened and the extent of damage and or injury caused.

3.24.9 The Contractor shall comply with the provision of all relevant acts of Central or State Governments including payment of Wages Act 1936, Minimum Wages Act 1948, Employer's Liability Act 1938, Workmen's Compensation Act 1923, Industrial Dispute Act 1947, Maturity Benefit Act 1961, Mines Act 1952, Employees State Insurance Act 1948, Contract Labour (Regulations & Abolishment) Act 1970, Electricity Act 2003, Grid Code, Metering Code, MNRE guidelines or any modification thereof or any other law relating whereto and rules made there under from time to time.

3.24.10 The Contractor shall at his own expense provide all amenities to his workmen as per applicable laws and rules.

3.24.11 The Contractor shall ensure that all safety measures are taken at the site to avoid

accidents to his or his sub-contractor or HGML's Workmen.

3.24.12 If any jobs covered in O&M Scope as per O&M Plan are not carried out by the contractor during the O&M period, the Engineer-In-Charge can issue a notice to the Contractor. Repetition of such instances may lead to the Termination of the Contract by the Employer and forfeiture of Bank Guarantees.

3.25 Quality Spares & Consumables

In order to ensure longevity and safety of the core equipment and optimum performance of the system the contractor should use only genuine spares of high quality standards.

3.26 Testing Equipment, Tools and Tackles

The Contractor shall arrange for all the necessary testing equipment, tools and tackles for carrying out all the construction, operation and maintenance work covered under this contract. And these test equipment's shall have the periodic calibration.

3.27 Security services

The contractor has to arrange proper security system including deputation of security personnel at his own cost for the check vigil for the Solar Power Plant. The security staff may be organized to work on suitable shift system; proper checking & recording of all incoming & outgoing materials vehicles shall be maintained. Any occurrence of unlawful activities shall be informed to HGML immediately. A monthly report shall be sent to HGML on the security aspects.

Technical Standards

4. PHOTOVOLTAIC MODULES

a) IEC 61215 2nd Ed. (Design qualification and type approval for Crystalline Si modules),

b) IEC 61730 (PV module safety qualification testing @ 1000 V DC or higher)

c) For modules to be used in a highly corrosive environment throughout their lifetime they must qualify for IEC 61701.

(Test certificate from NABL approved or /ILAC member body certified labs shall be provided).

General Requirements of Solar PV Modules:

c.1 The glass used to make the crystalline silicon modules shall be toughened low iron glass

with minimum thickness not less than 4.0 mm for 72 cell module and not less than 3.2 mm for 60 cell module. The glass used shall have transmittance of above 90% and with bending less than 0.3% to meet the specifications.

c.2 The back sheet used in the crystalline silicon based modules shall be of 3 layered structure. Outer layer of fluoropolymer, middle layer of Polyester (PET) based and Inner layer of fluoropolymer or UV resistant polymer. Back sheet with additional layer of Aluminium also will be considered. The thickness of back sheet should be of minimum 300 microns with water vapour transmission rate less than 3g/m2/day. The Back sheet shall have voltage tolerance of more than 1000 V.

c.3 The EVA used for the modules should be of UV resistant in nature. No yellowing of the back sheet with prolonged exposure shall occur.

c.4 The sealant used for edge sealing of PV modules shall have excellent moisture ingress protection with good electrical insulation (Break down voltage >15 kV/mm) and with good adhesion strength.

c.5 The junction box used in the modules shall have protective bypass diodes to prevent hot spots in case of cell mismatch or shading. The material used for junction box shall be made with UV resistant material to avoid degradation during module life and the Junction sealing shall comply IP65 degree of protection.

c.6 The crystalline silicon based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided.

c.7 The rated output of the modules shall have positive tolerance of 3-5 % and no negative tolerance is allowed.

c.8 Modules should have rugged design to withstand tough environmental conditions and high wind speeds (minimum up to 180 km/h).

c.9 Modules shall perform satisfactorily in relative humidity up to 95% and temperature between -10°C and 85°C (module temperature).

c.10 PV modules must be warranted for their output peak watt capacity, which should not be less than 90% of the initial value at the end of 10 years and 80% of the initial value at the end of 25 years.

c.11 The modules shall be warranted for minimum of 25 years against all material/manufacturing defects and workmanship.

c.12 The developer shall arrange for the details of the materials along with specifications

sheets of from the manufacturers of the various components used in solar modules along with those used in the modules sent for certification. The Bill of materials (BOM) used for modules shall not differ in any case from the ones submitted for certification of modules.

c.13 The I-V characteristics of all modules as per specifications to be used in the systems are required to be submitted at the time of supply.

Each module used in the Project shall use a RFID tag bearing the following details: **The RFID must be placed inside the lamination of the PV module.**

c.14

a) Name of manufacturer, name of manufacturer of solar cells symbol of bidder;
b) Country of Origin (separately for cells and modules)
   i. Unique model number;
   ii. Unique Serial number;
c) Month and Year of manufacture (separately for cells and module).
d) Date and Year of obtaining IEC PV module qualification certificate.
e) Name of Test Lab issuing IEC certificate.
f) Other relevant information on traceability of solar cells and module as per ISO 9000.
   i. Polarity of terminals or leads (colour coding is permissible).
   ii. Maximum system voltage for which the module is suitable.
   iii. Date & place of manufacture.
   iv. I-V Curve for the module at standard test condition (1000 W/sq m, AM 1.5, 25 °C).
   v. Wattage, Wp, Pmax, Imp, Vmp, Isc. Pld, & FF for the module.

c.15 The Contractor would be required to maintain accessibility to the list of module IDs along with the above parametric data for each module.

c.16 The temperature co-efficient of power for the modules shall not be more than 0.50%/ °C.

c.17 The module mismatch of the modules connected to an inverter should be less than 2%.

c.18 SPV module shall have module safety class-II and should be highly reliable, light weight and must have a service life of more than 25 years.

c.19 The module frame shall be made of corrosion resistant material, which shall be electrically compatible with the structural material used for mounting the modules. In case of metal frames for modules, it is required to have provision for earthing.

c.20 The module frame should have been made of Aluminium or corrosion resistant material, which shall be electrolytically compatible with the structural material used for mounting the modules with sufficient no. of grounding/installation.

c.21 All materials used for manufacturing solar PV module shall have a proven history of

reliability and stable operation in external applications. It shall perform satisfactorily in relative humidity up to 100% with temperature between -10°C to +85°C (cell) and shall withstand adverse climatic conditions, such as high speed wind, blow with dust, sand particles, saline climatic / soil conditions and for wind 180 km/hr on the surface of the panel.

c.22 Modules only with the same rating and manufacturer shall be connected to any singleinverter.

c.23 Bidder shall provide data sheet for Solar PV Module (Under STC) along with Bid Documents as per Guarantee Technical Particular.(Data Sheet- 1). Also, the bidder must provide the commercial data sheet indicating the exact power of the module, if the data sheet consists of a range of modules with varying output power.

- The sampling test shall be carried out on random basis in the case of SUPPLIED PV MODULE at accreted labs by the Bidder/ supplier at his cost.

* SPV MODULES, shall have the In House Test Report issued by the manufacturer shall match with major Specs of IEC- Wp, Pmax, Vm,Im, Isc,Pld,FF,along with Product serial Number, Batch Number and date of manufacture.

c.24 The Employer or its authorized representative reserves the right to inspect the modules at the manufacturer's site prior to dispatch.

c.25 The Bidder is advised to check and ensure the availability of complete capacity of modules prior to submitting the Bid document.

c.26 Entire drawings, detailed test & flash reports and compliance certificates of the offered modules should be submitted for approval of HGML within 21 days from the date of signing of agreement and supply should start thereafter. The bidder may specify SPV panels with latest technology surpassing standards mentioned in this document with prior approval of authority.

5.1 Module Mounting Structure (Fixed):

5.1.1 The structure design shall be appropriate and innovative. It must follow the existing land profile.

5.1.2 The structure shall be designed to allow easy replacement of any module and shall be in line with the site requirements.

5.1.3 Design drawings with material selected and their standards shall be submitted for prior approval of HGML within 21 days of signing of agreement.

5.1.4 The support structure design & foundation shall be designed with reference to the existing soil conditions in order to withstand wind speed applicable for the zone (Site Location) or

180kmph, whichever is higher, using relevant Indian wind load codes. The bidder shall furnish test certificate from the competent authority for the same. The structures and foundations shall also conform to the seismic conditions pertaining to the zone using relevant Standards and codes.

5.1.5 The structure must be designed with considering appropriate factor of safety. The bidder must provide the detail design and calculation for the structure design.

5.1.6 The structure shall be designed for simple mechanical and electrical installation. 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.

5.1.7 The array structure shall be made of hot dipped galvanized steel of suitable size, which shall serve for minimum of 25years. The thickness of galvanization should be as per the relevant standards for galvanization but minimum of 80 microns. It is to 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 should ensure that inner side should also be galvanized.

5.1.8 The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels at the same time.

5.1.9 All fasteners shall be of stainless steel of grade SS 316 and must sustain the adverse climatic conditions. Two numbers of anti-theft fasteners of stainless steel on two diagonally opposite corners for each module shall be provided. If any lower grade stainless steel (SS 304/UNS20430) fasteners are used they must have protective coating to ensure the life of 25 years.

5.1.10 Modules shall be clamped / bolted with the structure properly. The material of construction shall be GI / Al / SS. Clamps / bolts shall use EPDM rubber and shall be designed in such a way so as not to cast any shadow on the active part of a module.

5.1.11 The array structure shall be grounded properly using maintenance free earthing kit.

5.1.12 The bidder/manufacturer shall specify installation details of the PV modules and the support structures with appropriate diagram and drawings.

5.1.13 The Bidder should 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) above highest flood level at the site and (ii) 600 mm.

5.1.14 For multiple module mounting structures located in a single row, the alignment of all modules shall be within an error limit of maximum 10mm.

5.1.15 Civil foundation design for Module Mounting Structures (MMS) , shall be made in accordance with the Indian Standard Codes and prevailing soil conditions with the help of Chartered Structural Designer having substantial experience in similar work. The Selected Bidder shall submit the detailed foundation & structural design analysis along with calculations and basis/ standards in the Bid duly certified by a chartered structural engineer.

5.1.16 Cables should run through from Pipes and Cable-ties shall be used to hold and guide the cables/wires from the modules to junction boxes. All the cables were aesthetically tied to module mounting structure.

5.1.17 Bidder must submit all the quality test documents and test certificates complying with the requirement of the structure.

5.1.18 Every major Component of the Plant should be suitably named/numbered for easy traceability, identification and maintenance.

5.2 SMU with Junction Box/ Combiner Box:

5.2.1 All junction/ combiner boxes including the string junction box, array junction box and main junction box/ combiner box should be equipped with appropriate functionality, safety (including fuses, grounding, contacts etc.) and protection.

5.2.2 The terminals will be connected to copper bus-bar arrangement of proper sizes to be provided. The junction boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable markings shall be provided on the bus-bars for easy identification and UV resistant cable ferrules will be fitted at the cable termination points for identification.

5.2.3 The Junction Boxes shall have suitable arrangement for the followings:

a. Strings are required to be connected to the bus bar through individual fuses.

b. Provide arrangement for disconnection for each of the groups.

c. Provide a test point for each sub-group for quick fault location and to provide group array isolation.

d. Suitable space for workability and natural cooling

5.2.4 The rating of all component of JB's shall be suitable with adequate factor of safety to inter connect the Solar PV array.

5.2.5 The junction boxes shall be dust, vermin, and waterproof and made of thermoplastic/ metallic in compliance with IEC 62208, which should be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP65 (Outdoor)/ IP21 (indoor) and Protection

Class II.

5.2.6 The Array Junction Box will also have suitable surge protection. In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Device (SPD). The maintenance free earthing shall be done as per the relevant standards.

5.2.7 Each Array Junction Box will have suitable Reverse Blocking Diodes of maximum DC blocking voltage of 1000V with suitable arrangement for its connecting. The bypass & reverse blocking diodes should work for temperature extremes and should have efficiency of 99.98%, confirmed by appropriate IEC standards.

5.2.8 Adequate capacity solar DC fuses & isolating miniature circuit breakers should be provided if required.

5.2.9 Details of junction box specifications, including all components, Data Sheet shall be provided along with Bid document. (Data Sheet 2)

5.2.10 Bidder shall provide all the test reports/ test certificates and compliance certificates before installation at site.

5.3 Power Conditioning Unit (PCU) Standards & Compliances

5.3.1 PCU shall confirm to the following standards and appropriately certified by the labs:

a)	Efficiency measurement:	IEC 61683
b)	Environmental Testing:	IEC 60068-2 or IEC 62093
c)	EMC, harmonics, etc.:	IEC 61000 series, 6-2, 6-4 and other relevant Standards.
d)	Electrical safety:	IEC 62109 (1&2), EN 50178 or equivalent

Recommended practice for PV – Utility interconnections: IEEE standard 929 – 2000 or equivalent

a) Protection against islanding of grid: IEEE1547/ UL1741/ IEC 62116 ore equivalent

b) Grid Connectivity: Relevant CEA/ CERC regulation and grid code (amended up to date)
c)Reliability test standard: IEC 62093 or equivalent

The MNRE, NISE (SEC) approved / tested inverters are preferred.

General requirements of PCU:

5.3.2 Power Conditioning Unit (PCU)/ Inverter shall consist of an electronic inverter along with associated control, protection and data logging devices.

5.3.3 The rated power/name plate capacity of the inverters shall be the AC output of the

inverter at 50°C. Any inverters with AC output at 50°C, below the name plate/rated power of the inverter shall not be allowed.

5.3.4 The inverter supplied shall have minimum of 10% additional DC input Capacity. (E.g. if Inverter is supplied with rated capacity of 500 kW (AC) shall accept at least 550 kW of DC power.)

5.3.5 All PCUs should consist of associated control, protection and data logging devices and remote monitoring hardware and compatible with software used for string level monitoring.

5.3.6 Dimension and weight of the PCU shall be indicated by the Bidder in the offer.

5.3.7 Only those PCUs/ Inverters which are commissioned for more than 100 MW capacity solar PV projects till date shall be considered for this project. Bidder has to provide sufficient information to the satisfaction of the Employer before placing the final order for PCUs/Inverters.

5.3.8 The minimum European efficiency of the inverter shall be 98% load as per IEC 61683 standard for measuring efficiency. The Bidder shall specify the conversion efficiency of different loads i.e. 25%, 50%, 75% and 100% in its offer. The Bidder should specify the overload capacity in the bid.

5.3.9 The PCU shall be tropicalized and design shall be compatible with conditions prevailing at site. Provision of exhaust fan with proper ducting for cooling of PCU's should be incorporated in the PCU's, keeping in mind the extreme climatic condition of the site as per the recommendations of OEM to achieve desired performance and life expectancy.

5.3.10 The inverters shall have minimum protection to IP 65(Outdoor)/IP 21(indoor) and Protection Class II.

5.3.11 Nuts & bolts and the PCU enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.

5.3.12 Grid Connectivity: Relevant CERC regulations and grid code as amended and revised from time to time shall be complied. The system shall incorporate a uni-directional inverter and should be designed to supply the AC power to the grid at load end. The power conditioning unit shall adjust the voltage & frequency levels to suit the Grid.

5.3.13 All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency.

5.3.14 The inverter output shall always follow the grid in terms of voltage and frequency. 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 (PWM) technology. This should be capable of synchronize maximum within 1 Minute.

5.4 Operational Requirements for Inverter/ PCU

5.4.1 The PCU must have the feature to work in tandem with other similar PCU's and be able to be successively switched "ON" and "OFF" automatically based on solar radiation variations during the day.

5.4.2 The PCU shall be capable of controlling power factor dynamically.

5.4.3 Maximum power point tracker (MPPT) shall be integrated in the power conditioner unit to maximize energy drawn from the Solar PV array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism of MPPT shall be mentioned by the Bidder in its offer. The MPPT unit shall confirm to IEC 62093 for design qualification.

5.4.4 The system shall automatically “wake up” in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.

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

5.4.6 Stand – By Mode: The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.

5.4.7 Basic System Operation (Full Auto Mode): The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.

5.4.8 PCU shall have provisions/features to allow interfacing with monitoring software and hardware devices.

5.5 Protection against faults for PCU

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

Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices. In addition, it shall have following minimum protection against various possible faults.

5.5.1 Grounding Leakage Faults: The PCU shall have the required protection arrangements against grounding leakage faults.

5.5.2 Over Voltage & Current: In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Devices (SPD).

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

5.5.4 Galvanic Isolation: The PCU inverter shall have provision for galvanic isolation.

5.5.5 Each solid state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter.

5.5.6 Anti-islanding (Protection against Islanding of grid): The PCU shall have anti islanding protection. (IEEE 1547/UL 1741/ equivalent BIS standard)

5.5.7 Unequal Phases: The system shall tend to balance unequal phase voltage (with 3- phase systems).

5.5.8 Reactive Power: The output power factor of the PCU should be of suitable range to supply or sink reactive power. The PCU shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line.

5.5.9 Isolation: The PCU shall have provision for input & output isolation. Each solid- state electronic device shall have to be protected to ensure long life as well as smooth functioning of the PCU.

5.5.10 All inverters/ PCUs shall be three phase using static solid state components. DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. Fuses & Circuit breakers used in the DC lines must be rated suitably.

5.5.11 The Bidder should select the inverter (Central) as per its own system design so as to optimize the power output.

5.5.12 Desired Technical Specifications of PCU.

a) Sinusoidal current modulation with excellent dynamic response.
b) Compact and weather proof housing (indoor/ outdoor)
c) Comprehensive network management functions (including the LVRT and capability to inject reactive power to the grid)
d) No load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%
e) Optional VAR control
f) Unit wise & integrated Data logging
g) Dedicated Prefabs / Ethernet for networking

5.5.13 Inverter/ Power Condition unit must provide protection against:

a) Over current
b) Sync loss
c) Over temperature
d) DC bus over voltage
e) Cooling Fan failure (If provided)
f) Short circuit
g) Lightning
h) Earth fault
i) Surge voltage induced at output due to external source
j) Power regulation in the event of thermal overloading
k) Set point pre-selection for VAR control
l) Bus communication via -interface for integration
m) Remote control via telephone modem or mini web server
n) Integrated protection in the DC and three phase system
o) Insulation monitoring of the PV array with sequential fault location

5.5.14 Ground fault detector which is essential for large PV generators in view of appreciable discharge current with respect to ground.

5.5.15 Over voltage protection against atmospheric lightning discharge to the PV array is required.

5.5.16 The power conditioner must be entirely self-managing and stable in operation.

5.5.17 A self-diagnostic system check should occur on start up. Functions should include a test of key parameters on start up.

5.5.18 PCU/inverter front panel shall be provided with display (LCD or equivalent) to monitor, but not limited to, the following:

a. DC power input
b. DC input voltage
c. DC Current
d. AC power output
e. AC voltage (all the 3 phases and line)
f. AC current (all the 3 phases and line)
g. Power Factor
h. Frequency
i. Display of sine wave with distortion, if any.

5.5.19 Documentary Requirements & Inspection

a) The bill of materials associated with PCU's should be clearly indicated while delivering the equipment.
b) The Contractor shall provide to the Employer, data sheet containing detailed technical specifications of all the inverters and PCUs. Operation & Maintenance manual should be furnished by the Bidder along with Bid documents .(Datasheet 3)
c) The Employer or its authorized representative reserves the right to inspect the PCUs/ Inverters at the manufacturer's site prior to dispatch.

Inverters, PCU shall have the In House Test Report issued by the manufacturer which shall be comparative with the Test Report of IEC approval within the tolerances along with Product serial Number, Batch Number and date of manufacture.

5.6 Cable and Wires

5.6.1 All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. (Note: IEC standards for DC cables for PV systems is under development, the cables of 600 – 1800 volts DC for outdoor installations should comply with the draft EN 50618/ TUV 2PfG 1169/09.07 for service life expectancy of 25 years, cables shall be run through DWC/UPVC Pipes between SMU to Inverter).

Insulation: Outer sheath of cables shall be electron beam cross-linked XLPO type and black in colour. In addition, Cable drum no. / Batch no. to be embossed/ printed at every one meter. Cable Jacket should also be electron beam cross-linked XLPO, flame retardant, UV resistant and black in colour.

5.6.2 Wires with sufficient ampere capacity and parameters shall be used so that maximum voltage-drop at full power from the PV modules to inverter should be less than 1.5% (including diode voltage drop). Selected Bidder shall provide voltage drop calculations in excel sheet.

5.6.3 Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted. All wires used on the LT side shall conform to IS and should be of appropriate voltage grade. Only copper conductor wires compliant with IEC 60228, Class 5 of reputed make shall be used.

5.6.4 All high voltage cables connecting the main junction box to the Inverter/ transformers should be PVC insulated grade conforming to IS 1554 and cables shall also conform to IEC 60189 for test and measuring the methods.

5.6.5 All 11kv cables shall be run through trenches from Inverter room to 11/110kv substation.

5.6.6 Cable terminations shall be made with suitable cable lugs & sockets etc., crimped properly

and passed through brass compression type cable glands at the entry & exit point of the cubicles.

5.6.7 All cable/wires shall be provided with UV resistant printed ferrules for DC side however, for HT cables, punched/ embossed aluminium tags are required. The marking on tags shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

The wiring for modules interconnection shall be as per industry standards.

5.7 Switchboard box / DC Distribution Box (DCDB) / AC Distribution Box (ACDB) panels

5.7.1 Selected Bidder shall provide sufficient no. of switchboards / DCDB / ACDB wherever required.

5.7.2 All boxes/ panels should be equipped with appropriate functionality, safety (including fuses, grounding, etc.) and protection.

5.7.3 The terminals of proper sizes shall be used for connecting to bus-bar arrangement of proper sizes. The panels/ boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables.

5.7.4 Adequate rating fuses & isolating miniature circuit breakers should be provided.

5.7.5 The panels/ boxes shall have suitable arrangement for the followings:

a) Provide arrangement for disconnection
b) Provide a test point for quick fault location
c) To provide isolation
d) The current carrying rating of the boxes/ panels shall be suitable with adequate safety factor
e) The rating of the boxes/ panels shall be suitable with adequate safety factor to inter connect to the local/ internal grid
f) Thermal/ heat dissipation arrangement/ Vent for safe operation.

5.7.6 The boxes/ panels shall be dust, vermin, and waterproof and made of thermoplastic/ metallic in compliance with IEC 62208, which should be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP 65(Outdoor)/ IP 20(indoor) and Protection Class II.

5.7.7 All panels/ boxes shall be provided with adequately rated bus-bar, incoming control, outgoing control etc. as a separate compartment inside the panel to meet the requirements. All live terminals and bus bars shall be shrouded. The outgoing terminals shall be suitable to receive suitable runs and size of cables required for the Inverter/Transformer rating.

5.7.8 The boxes/ panels must be grounded properly to ensure all safety related measures for safe operation.

5.7.9 All the Panels to be manufactured with sufficient space for working and must have temperature suitability up to 85° C with separate cable and bus bar alley.

5.8 Lightning Protection for PV Array

5.8.1 The source of over voltage can be lightning or other atmospheric disturbance. Main aim of over voltage protection is to reduce the over voltage to a safe level before it reaches the PV or other sub-system components as per IEC 60099-4:2014 / IS: 2309– 1989 (Reaffirmed – 2005), Edition 3.1 (2006-01).

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

5.8.3 The Bidder shall submit the drawings, calculations and detailed specifications of the PV array lightning protection equipment to Employer for approval before installation of system.

5.8.4 The lightning conductor shall be earthed through flats and connected to the grounding mats as per applicable Indian Standards with earth pits. Three earth pits shall be provided for each lightning arrestor. Each lightning conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS.

5.9 Solar Photovoltaic Power Plant Electrical System

The technical requirements of design, fabrication, supply, installation, testing at works, installation testing & commissioning of all electrical equipment required for the Solar Photovoltaic Power Plant starting from inverter control panel of Plant and up to the Grid tie up point with the State grid including all control protection, metering equipment, step up transformer 415V/11kV, 11/110 kV , indoor/ outdoor switchgears and balance of equipment complete in all respects shall be of high standard and quality meeting the requirement of respective Indian standard (following table). All the Type test Reports along with material despatch Clearance Certificate (MDCC) for all equipment and cables are to be submitted by the Contractor prior to the despatch of the same. The brief particulars and requirement of equipment is as under-

IS/IEC Reference	**Specification**
IEC-298	A.C. Metal – enclosed and control gear for rated voltages above 1KV and including 72.5KV

IS/IEC Reference	Specification
IS-3427	A.C. Metal – enclosed and control gear for rated voltages above 1KV and including 52KV.
IS-8623	Specification for Low Voltage Switchgear and Control gear assemblies.
IS-13118/ IEC-56	Specification for High Voltage AC Circuit Breakers.
IEC-529	Degrees of Protection.
IS-5578 & 11353	Marking and arrangement for switchgear bus bar main connections and auxiliary wiring.
IS-325	Specification for 3 Phase Induction motors.
IS-2629	Recommended practice for hot dip galvanizing of iron and steel.
IEC-137	Bushing for AC Voltages.
IS-3347	Porcelain Transformer Bushings.
IS-5561	Terminal Connectors
IS-3156	Voltage Transformers
IS-2705	Current Transformers
IS-3231	Electric relays for power protection.
IS-13010	Watt hour meters
IS-13779	Static Energy Meters
IS-8686	Static Protection Relays
IS-1248	Electrical measuring instruments
IS-2099	High Voltage Porcelain Bushings.
IS-10118	Minimum clearances for Outdoor Switchgear.
IEC-694	Common Clauses for High Voltage Switchgear and Control gear
IEC-60255 & IEC-61330	Numerical Relays

5.10 Step-Up Transformer

All Transformers shall have the In House Test Report issued by the manufacturer with Product serial Number, Batch Number and date of manufacture.

5.10.1 The transformer at first level 415v/11kv shall be copper wound, 3 phase, ONAN, core type construction, oil immersed and shall be suitable for outdoor applications.

5.10.2 The Bidder shall provide the complete turnkey design, supply, erection, testing and commissioning of transformers and transformer substation to step-up the output of the inverter to 11 kV at the location of the inverter. The power from different inverter rooms shall be collected at a common location from where it shall be stepped up to 110 kV level and transmitted to the STU substation through overhead transmission line. However, the

detailed scheme of design lies with the bidder and must submit the same to HGML for approval prior to construction.

5.10.3 Power Transformers utilized shall be 3 phase , copper wound, ONAF . 11/110kV 50 Hz, YDN1, should be suitable for parallel operation and shall serve under fluctuations in voltage up to plus 10% to minus 15%. The bidder is required to design 11/110kv sub station of capacity 2x10MVA transformer.

5.10.4 Associated Switchgear of approved make. RTCC panel, as per design, shall provide in control room. neutral shall be effectively earthed through earthing transformer

5.10.5 General requirement of standards shall be as per below:

Standards	**Relevance**
IS: 2026 (Part 1 to 4)	Specifications for Power Transformer
IS: 2099	Bushings for alternating voltage above 1000 V
IS: 3639	Fittings and accessories for power transformer
IEC: 60076 (Part 1 to 5)	Specifications for Power Transformer
IS: 9921 Part 1 to 5	Alternating current dis-connectors (isolators) and earthing switches rating, design, construction, tests etc.
IS: 2705 Part 1 to 4 & IEC: 185	Current transformer
IS: 3156 Part 1 to 4	Voltage Transformer
IS: 3070 part 1 to 3	Lightning arrestors
IS: 2544	Porcelain insulators for system above 1000 V
IS: 5350	Part III – post insulator units for systems greater than 1000V
IS: 5621	Hollow Insulators for use in electrical equipment
IS: 5556	Serrated lock washers – specification

5.11 General Requirements

5.11.1 The equipment and accessories covered by this specification shall be designed, manufactured and tested in accordance with the latest relevant standards and codes of practice published by the Bureau of Indian Standards (BIS) as applicable.

5.11.2 All electrical equipment and installation shall confirm to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified for installation and operation of electrical plants. Relevant national and international standards in this connection shall be followed.

5.11.3 All working parts, insofar as possible, are to be arranged for convenience of operation,

inspection, lubrication and ease of replacement with minimum downtime. All parts of equipment or of spare equipment offered shall be interchangeable.

5.11.4 The quality of materials of construction and the workmanship of the finished products/ components shall be in accordance with the highest standard and practices adopted for the equipment covered by the specification.

5.11.5 All items of equipment and materials shall be thoroughly cleaned and painted in accordance with relevant Indian Standards. The finish paint shall be done with two coats of epoxy based final paint of colour Shade RAL 7032 of IS: 5 for indoor equipment.

5.11.6 Any fitting or accessories which may not have been specifically mentioned in the specification but which are usual or necessary in the equipment of similar plant or for efficient working of the plant shall be deemed to be included in the contract and shall be provided by the Contractor without extra charges. All plant and apparatus shall be complete in all details whether such details are mentioned in the specifications or not.

5.11.7 All equipment shall be designed for operation in tropical humid climate at the required capacity. The reference parameters for which the transformers are to be designed are as under:-

Particulars	**Condition**
Maximum ambient temperature	50^0C
Maximum daily average ambient temp	35^0C
Minimum ambient air temperature(Cooling)	10^0C
Climatic Conditions Max. Relative Humidity	Maximum 85% during monsoon Minimum 20% Average 65%
<u>Rainfall</u> Annual average rain Max. for one day Max. intensity Period	 720mm 115mm 38mm/hr June to September
Maximum Wind Speed	15.9kms/hr

5.12 RATINGS AND SPECIFICATIONS (415V / 11 KV TRANSFORMER)

The typical rating and electrical characteristics of the 0.415kV/11 kV ONAN Outdoor type transformer shall be as under however, the ratings may vary subjected to design by the bidder and relevant to the respective IS codes:

SPECIFICATION FOR 415 / 11 KV or 433V / 11KV, (415 V/ 11KV) CLASS DISTRIBUTION TRANSFORMERS OF RATING 63KVA/100KVA/250KVA , 500KVA, 750KVA, 1000 KVA AND 1250 KVA AS APPLICABLE AND SUITABLE WITH SITE SPECIFICATION.

Note- All the technical specification related to transformers and accessories shall have the proper design, drawings, approved specifications and tenderer shall have to obtain the prior approval from HGML.

Note- THE CONTRACTOR SHALL HAVE TO BE FAMILIAR AND FOLLOW THE LATEST SPECIFICATIONS, IS, RELATED STANDARDS, PROCEDURES, METHODS ALONG WITH KPTCL NORMS AND SITE SPECIFIC REQUIREMENTS.

1.0 SCOPE:

The specification covers manufacture, testing at works and supply of 3 phase, 50Hz, core type oil immersed self cooled Distribution Transformers conforming to IS: 1180 and **IS**: 2026 of 1977 and other Technical related and applicable IS specifications as amended from time to time and REC specifications for the specified work with specific site.

One set of drawings showing size, Shape of tank, Core and windings, Radiators etc., for all the capacity of Transformers and an internal clearance drawings are furnished by the Corporation.

The transformers shall be manufactured strictly as per specifications and enclosed drawings without any deviations.

2.0 STANDARDS:

The applicable standards for distribution transformers including various accessories are specified here below:

Note- All the windings of the transformers shall be of copper conductor.

i. Colours for Ready mixed paints &. Enamels - IS: 5/1994

ii. Ready mixed paint, brushing, Zinc chrome, priming - IS: 104/1979

iii. New Insulating oils - IS:335/1993

iv.	Methods for testing of Steel Sheets for Magnetic Circuits of Electrical apparatus	- IS: 649/1997
v.	Outdoor type three Phase distribution transformers Up to and including 100KVA, 11 KV class	- IS: 1180 /1989 (Part I &.II)
vi.	Solid press Boards for Electrical purposes	- IS: 1576/1992
vii.	Power Transformers	IS: 2026/1977 (Parts 1 to 5)
viii.	Bushings for alternating voltages above 1000 volts	- IS: 2099/1986
ix.	Determination of water content by Karl fischer method-Test method	- IS: 2362/1993
x.	Paper covered Copper conductors	- IS: 6162/1971 (Part I & II)
xi.	Rectangular conductors for Electrical Machines	- IS: 6160/1971
xii.	Dimensions for Porcelain Transformer Bushing Dimensions for use in normal And lightly polluted atmosphere	- IS: 3347 (Part I - IV)
xiii.	Electric Power Connectors	- IS: 5561/1970
xiv.	Method of test for specific resistance (Resistivity) of Electrical insulating liquids	- IS: 6103/1971
xv.	Method of test for power factor and Dielectric Constant of electrical Insulating liquids	- IS: 6262/1971
xvi.	Method for Determination of electric strength of insulating oils	- IS:6792/1992
xvii.	Code of practice for selection Installation, Maintenance of Transformers	- IS: 10028/1985 (Part I to III)
xix.	CBIP Manual	- Section B & C

xx.	REC Specification	- No.2
xxi.	REC construction standards K.5 (Capitalization of losses)	- K5 (R-1993)

3.0 SYSTEM DETAILS:

The transformers shall be suitable for outdoor installation with 3Phase, 50 Hz, 11kV System in which the neutral is effectively earthed and the same shall be suitable for service under fluctuations in supply voltage up to 12% permissible under Indian Electricity Rules and the frequency variation of -5% and +2% (47.5Hz to 51.0Hz).

4.0 CLIMATIC CONDITIONS:

The material used in the construction of the Distribution transformers shall be suitable for use under the following climatic conditions.

a. Ambient Air Temperature	- 5° C to 50°C:
b. Relative Humidity	- 0 to 100%
c. Altitude	- 0 to 100 Meters

5.0 RATINGS:

Secondery Voltage	-	11 KV - 3Phase
Primary Voltage	-	433/ 415 Volts. 3Phase

The winding of the transformers shall be connected in delta on the primary side and in star on the secondary side. The neutral of the LT windings shall be brought out to a separate terminal. The vector group shall be Dyn.l1.

6.0 TECHNICAL PARAMETERS:

a) **Percentage Impedance:**

The Percentage Impedance shall be 4.5% for transformers up to 100KVA and 5% for transformers of 250KVA and 500KVA , **750KVA, 1000 KVA and 1250 KVA** with tolerance as per IS: 2026.

b) **Temperature rise:**

The Temperature Rise for top oil over should be 45°C max (measured by thermometer as per IS: 2026) over the ambient temperature.

c) The temperature rise for windings shall not exceed 50°C Max. (Measured by resistance in accordance with IS: 2026) over the ambient temperature.

d) **No Load Voltage Ratio:**

The No Load Voltage ratio shall be 433-240V /11000, for all capacities of distribution transformers at normal tap.

6.0 (A) Losses:

The No load and load losses shall be indicated by the bidder. The losses shall not exceed permissible limits shall be as provided IS 2026 and applicable IS.

7.0 TAPS:

- Tappings shall be provided for 250 KVA and 500 KVA,750 KVA,1000 KVA,1250 KVA, transformers only on the HV voltage windings for variation for HV voltages as under.

    - Voltage Ratio : Range of variation
    - 415V /11000V : +2.5%, 0, -2.5%, -5%, -7.5%,-10%.

- Tap changing shall be carried out by means of an externally operated self position switch and when the Transformer is in de-energized condition.

- Switch position No.1 shall be marked as 1 (High) shall correspond to the maximum voltage tap position switch position No.2 shall be marked as 2 (normal) shall correspond to normal voltage tap position. Switch position 6 ,shall be marked as 6 (Low) shall correspond to the minimum voltage tap position.

- Each tap change shall result in variation of 2.5% in voltage.

- Provision shall be made for locking the tap switch handle in position.

- No taps shall be provided in case of 25/63/100KVA transformers.

8.0 DESIGN & CONSTRUCTION:

Core:

a) The core shall be of high grade CRGO steel sheet of M4 grade or superior to that having low loss and non ageing grain oriented, coated with hot oil proof insulation, bolted together to the frames firmly to prevent vibration or noise. All core clamping bolts shall be effectively insulated.

The complete design of core must ensure permanency of the core losses with continuous working of the transformers. The value of the flux density shall not be more than 1.7 tesla at 50 HZ.

The construction of core, internal clearances minimum effective area of cross section, minimum Nos. of core steps etc., shall be strictly as per the drawings enclosed.

b) The transformers core shall not be saturated for any value of V/F ratio to the extent of 112.5% of the rated value of V/F ratio i.e., 11kV/50Hz. (Due to combined effect of voltage and frequency) upto 12.5% without injurious heating at full load conditions the core shall not be saturated.

The Bidder shall furnish necessary design data in support of this condition

c) The maximum thickness of core laminations shall not exceed 0.3mm. Further the lamination sheets used for top yoke, bottom yoke etc., shall be of single piece.

d) No load current, shall be measured by energizing the transformers at 433 volts 50 C/S on the LT Side of transformer (415v/11kv Transformer). Increase of voltage by 10% shall not increase the no load current disproportionately high. Test for magnetic balance by connecting the LV phase by phase to rated phase voltage and measurement of an, bn, cn, voltage shall be carried out. The no load current shall not exceed 2% in respect of 250KVA and 500KVA, 750KVA, 1000 KVA,1250 KVA Transformers and 4 to 5% in respect of 100KVA and below distribution transformers at rated voltage and frequency.

The minimum

(1) Effective core area
(2) Number of core steps
(3) Internal clearance

Shall be as per the specification and drawings as indicated in the drawings for each capacity.

Minimum effective cross sectional area of the core to be provided are as follows:

1) 25KVA - 41.18 sq.cm.
2) 63KVA - 75.00 sq.cm.
3) 100KVA - 84.60 sq.cm.
4) 250KVA - 146.20 sq.cm.
5) 500KVA - 218.00 sq.cm.
6) 750 KVA,1000KVA,1250 KVA as required specs by manufactures.

Note: If the manufacturer uses the better quality CRGO steel for the core the manufacturer has to furnish the area of cross section of the core along with the design details.

e) The unbalance current in the neutral shall not be more than 2% of the rated current.

9.0 CORE CLAMPING:

1) M.S. Channel 125 x 65mm for 500KVA, 100x50mm for 250 KVA 75 x 40mm for 100 KVA and below transformers on top and bottom shall be used for clamping the core.

2) 2 Nos. of 12mm high tensile vertical bolts in parallel in each side shall be provided. The size of the Bolts to be provided in parallel are as follows:
   a) 25, 63, 100KVA - 2 Nos. of 12mm High Tensile Bolts
   b) 250 KVA - 2 Nos. of 16mm High Tensile Bolts
   c) 500 KVA - 2 Nos. of 20mm High Tensile Bolts
   d). 750 KVA, 1000KVA, 1250 KVA as required specs by manufactures.

3) Channel on LV side to be reinforced at equidistance if hole cutting is done for LT lead so as to avoid bending of channel.

4) M.S. Channels are to be painted by varnish and corrosion oil resistant paint before use.
5) Flat or cut channel shall not be used.

6) Core mounting is to be done with ISF 50x10 for Transformers up to and including 100KVA & 50 X 16 for 250KVA & 500KVA, 750 KVA,1000KVA,1250 KVA as required specs by manufactures of transformer.

7) Clamping arrangement should be strong enough to withstand mechanical forces. The mechanical strength shall be proven by short circuit test.
   TIE BOLTS:

   Four horizontal tie rods (or high tensile steel) of 12mm dia for transformers up to l00KVA, 16mm for 250KVA and 20mm for 500KVA, 750 KVA,1000KVA,1250 KVA as required specs by manufactures. to be used. Rods to be effectively insulated with kraft paper tube of thickness l.5mm.

   i) All top and bottom Yoke nuts bolts and tie rods shall be painted with oil and corrosion resistant paint before use.
   ii) Channel - (top yoke) on LV side to be reinforced at equidistance if hole cutting is done to avoid bending of channel.

   iii) The flat provided at the core shall be as per the drawings enclosed and shall not be cut through the length.
   iv) Tie rods shall be effectively earthed.
   v) Drawing of the building of the core shall be got approved before start of the

work

10.0 WINDINGS:

a) **Material-** Double layer paper covered Copper conductor shall be used.
b) The gauge shall as per the IEC and manufacturing standards.
c) LV winding shall be in even layers
d) The neutral formation shall be at top

11.0 INSULATION, INSULATION MATERIAL & CLEARANCES:

a) Press board blocks at top and bottom of each coil assembly shall be provided. There must be atleast 4 blocks per phase/coil of each of thickness of 30mm. Core wrapper shall be of minimum of 1mm thick.

   The channel at phase barrier board shall be of 2mm thick press board. The tie rod insulation kraft paper shall be of thickness 1mm. Between HV and LV windings addition press Board cylinder of at least 2mm in addition to spacers shall also be provided.

b) No. of vertical/axial wedges up to 100 KVA minimum 18 Nos. and for 250 KVA &. 500KVA, 500KVA 750 KVA,1000KVA,1250 KVA as required specs by manufactures shall be provided depending upon the capacity of transformers between LV and HV windings and equispaced around LV. The wedge shall be minimum 6.5mm thick and 8-12mm wide.

c) The inter layer insulation shall be provided between HV windings layers depending on the design. The details shall be furnished.

d) Double paper covering shall be used for winding insulation both for HV & LV windings. Either performed corrugated cylindrical boards or cylindrical compressed boards with spacers shall be provided between HV & LV windings. Press board of type - D IS: 1576 to be used for top and bottom yoke insulation. The electrical grade insulating paper shall be of F class insulation.

e) HV & LV coils single coil multi layer winding shall be used for all capacities of transformers.

f) Tap lead shall be insulated with 1.5 mm thick paper insulation. Inspection of windings prior to tankings shall be done. Manufacturing drawing for the transformer showing various clearance shall have to be approved HGML.

12.0 TANK:

1) The transformer tank shall be of robust construction and shall be built of electrically welded M.S. Plates (The side wall shall have only two joints). All joints of tank and fittings shall be oil tight and no bulging shall occur during service.

   The tank design shall be such that the core and windings can be lifted freely. The tank plates shall be of such strength that the complete Transformer when filled with oil could be lifted bodily by means of the lifting lugs provided. The tank inside shall be painted by varnish. Top cover shall be slightly sloping towards HV bushings an cover the top with end walls. Shape of the tank shall be Rectangular/Octagonal only. No other shape will be accepted.

   a) Side wall thickness - 3.15 mm
   b) Top and bottom plate thickness - 5.00 mm
   (3.15mm for 25KVA)
   c) As per the Latest applicable IS

2) Suitable reinforcement by welded angle shall be provided on all the outside walls on the edge of the tank. The permanent deflection shall not be more than 5mm up to 750mm length and 6mm up to 1250mm length and 8mm up to 1750mm length when transformer tank without oil is subjected to Air pressure test as per IS:1180.

3) **Lifting lugs:**

   2 Nos, for 25,63 and 100KVA and 4 Nos. for 250 and 500KVA, 500KVA 750 KVA,1000KVA,1250 KVA as required specs by manufactures. transformers of welded heavy duty lifting lugs of M.S. Plate 8mm thick suitably reinforced by vertical supporting flat welded edgewise below the lug on the side wall shall be provided.

   Pulling Lugs:
   4 Nos. of welded heavy duty pulling lugs of M.S plate 8 mm thick for 250 & 500KVA, 500KVA 750 KVA,1000KVA,1250 KVA as required specs by manufactures shall be provided to pull the transformer horizontally,

4) **Top Cover Fixing Bolts: As per latest IS.**

   - 6mm Neoprene bonded cork gaskets confirming to IS-4352 Part-II shall be placed between top cover plate and tank.

   - GI bolts and nuts shall be size 12mrn x 40mm with one plain and one spring washer suitably apart (100mm) to press the cover.

5) Tolerance on tank dimensions shall be limited to -5% to + 10%.

13.0 HEAT DISSIPATION:

a) Heat dissipation by tank walls excluding top and bottom should be 500 watts / Sq. mtr.
b) Heat dissipation by radiator 1.25mm thick shall be considered for heat dissipation calculation. The tenderer shall submit the calculation sheet along with No. of radiators to be provided and type of fixing radiators to the transformer tank.
c) The guaranteed temperature rise of oil and winding shall be found by conducting temperature rise test in presence of the representative of the HGML.

14.0 TOTAL MINIMUM OIL VOLUME:- as per the lates IS.

Sl. No.	Rating	Oil in Ltrs. (inclusive for oil absorbed in core coil assembly)
1	25KVA	85
2	63KVA	115
3	100KVA	140
4	250KVA	340
5	500KVA	420

6. 750 KVA, 1000KVA, 1250 KVA as required specs by manufactures as per IS.2026.

NOTE: If the absorption of oil in the core and winding assembly is more than permissible value first filling oil volume should be increased accordingly detailed calculation of absorption shall be submitted.

15.0 CONSERVATOR: as per the latest applicable IS.

Conservators shall be provided on transformers of rating 63KVA, 100KVA, 250KVA and 500KVA, 500KVA 750 KVA, 1000KVA, 1250 KVA as required specs by manufactures

When a conservator is fitted, the oil gauge and the plain or dehydrating breathing device shall be fixed to the conservator which shall also be provided with a drain plug and a filling hole (1¼ nominal size thread) with cover. In addition, the cover of the main tank shall be provided with an air release plug to enable air trapped within to be released. Unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.

a) Prismatic oil level indicator shall be provided on the side which will be fully covered detachable flange with single neoprene gasket and tightended with M.S. bolts and nuts.

b) The inside diameter of the pipe connecting the conservator to the main tank shall be with in 20 to 50 mm and it should project in to the conservator in such a way that its end is approximately 20 mm above the bottom of the conservator so as to create a

sump for collection of Impurities. The minimum oil level (corresponding to - 5° C) should be above sump level.

c) The pipe from conservator tank connecting to main tank shall be sloping so that the oil falling from the pipe shall not fall directly on the active parts and shall fall on the side walls only.
d) The conservator shall be provided (except for 25KVA) with the drain plug and filling hole with cover. In addition, the cover of the main tank shall be provided with an air release plug (except for 25KVA).

e) Conservator pipes fixing conservator to the top plate of the transformer should be on either side of metal pocket provided for mounting LT bushings with minimum electrical clearance of 110mm between phases and also earth.

16.0 BREATHERS :

Breather joints shall be of bolted type. It shall have die cast Aluminium body and inside container for Silicagel shall be of tin. Makes of Breathers shall be subject to HGML approval.

The volume of the breather shall be

a) 250 grams of silicagel breather shall be provided for 25 KVA, 63 KVA and 100 KVA transformers.
b) For 250 KVA and 500 KVA transformers 500Gms. breather shall be provided.
c) 750 KVA, 1000KVA, 1250 KVA as required specs by manufactures , IS 2026.

The breather shall have an inspection window to view the condition of the silicagel.

17.0 TERMINALS:

a) Brass rods 12mm dia for HT and LT for 25KVA, 63KVA and 100KVA Transformers.

b) Brass rods 12mm dia for HT, 20mm dia for LT for 250 KVA and 12mm dia, for HT and 30mm dia for 500KVA, 750 KVA,1000KVA,1250 KVA as required specs by manufactures transformers shall be provided IS 2026.

c) HT/LT Bimetallic connectors shall be provided to 25KVA, 63KVA and 100KVA transformers.

d) Connecting lugs shall be provided confirming to IS: 3347 for LT terminals of 250 and 500KVA Transformers.

e) The metallic connector shall be L type for LT bushing of distribution transformer of

capacity of 100, 250 and 500KVA.

The L type clamp shall be suitable to take off two/four circuits of 240 Sq. mm aluminum wire (for 250, 500KVA transformers)

f) The HV and LV windings conductor shall not be terminated to the bushing rod directly.

g) The HV winding shall be linked through a terminal lug and copper jumper lead of size 1.6mm dia for 25/63/100KVA, 2.65mm for 250KVA and 3.75mm for 500KVA transformers. The leads shall be enclosed in kraft paper tube.

h) The LV winding shall be terminated using inverted 'S' type link of size 25x3mm Aluminum strip for 25/63/100KVA, 40x5mm for 250KVA and 70x5mm for 500KVA transformers.
   1) All the leads / links shall be immersed in oil.
   2) All the leads/links shall be taken neatly strapped on an insulated press Board/wooden Bus Bar.

18.0 BUSHINGS: As per the latest applicable IS.

I. For 11KV, 12KV Bushings (confirming to IS: 2099/1986) with single gap arcing horns shall be used and for 433 volts, 1.1KV terminal Bushings confirming to IS: 7421/1974shall be used. Bushings of the same voltage class shall be inter changeable. The dimensions of Bushings shall be as per IS-3347 and these Bushings shall be mounted on side of the tank or on the top cover. The bushings mounted on the side shall not have an inclination of more than 30 degrees from the vertical as per CBIP manual and IS-2099. Only sheet metal pocket shall be provided for mounting HV bushings alternately the same can be mounted on pipes. Creepage distance shall not be less than 25mm/KV as per IS: 2099-1986.

II. **Brazing of all internal connections** – All jumpers from windings to bushing shall have a cross section larger than tile winding conductor. For copper, silver brazing alloy to be used. For aluminium, L&T aluminum brazing rods shall be used.

III. The minimum phase to phase and phase to earth external clearances for HV & LV Bushings shall be as follows:

	Minimum clearances	
	Phase to phase (in mm).	Phase to earth
HV Bushings	255	140
LV Bushings	75	40

The above 140 mm. clearance does not apply to arcing horn gap.

19.0 TANK BASE CHANNEL:

a) For 25, 63 & 100KVA Trans. ISMC 75 x 40mm. channel shall be used for base.

b) For 250 KVA transformers 100 x 50mm channel shall be used

c) For 500 KVA transformers 125 x 65mm channel shall be used

Stiffeners (flats) shall be provided to tank base channels, along the length of the tank for 250 and 500 KVA, 750 KVA,1000KVA,1250 KVA as required specs by manufactures transformers shall be provided IS 2026. transformers.

20.0 TERMINAL MARKING PLATE AND RATING PLATES:

The transformer shall be provided with a brass plate showing the relative physical position of the terminal and their markings. The relative position of the Tappings switches shall also be shown in the plate, corresponding to the different tapping voltages in case of 250 KVA, and 500KVA distribution transformers. This shall be in accordance with IS: 2026. The transformers shall be provided with rating plate furnishing the information as specified in IS-2026.

The month and year of delivery shall be indicated on the rating plate. The rating plate shall be embossed / engraved type but not painted. The serial No. of transformer shall follow the code Nos. as detailed below. These shall be punch marked on the transformer tank and also on the top cover.

Alpha	Numeric	Numeric	Numeric	Numeric
	1	2	3	4

Alpha represents code name of manufacturer.
Numeric 1. Represents capacity
I.e., code - 01 for 25KVA
- 02 for 63KVA
- 03 for 100KVA
- 04 for 250KVA
- 05 for 500KVA

Numeric 2 - Represents year of manufacturer.

Numeric 3 - Represents month of manufacture.

Numeric 4 - Represents SL. No. of Transformers.

21.0 FITTINGS:

The fittings on the transformers shall be as under.

1) Rating and Terminal marking plate - 1 No.

2) Earthing terminals minimum M12 - 2 Nos.
with nuts should be provided on the tank

3) Lifting lugs - 2 Nos. for 25, 63, 100 And 4 Nos. for 250/500 KVA.

4) Cap for oil filling (on conservator) - 1 No.

5) Drain valve 20 mm. dia shall be provided with metallic cover by spot welded to tank for 250KVA and 500KVA , 750 KVA,1000KVA,1250 KVA as required specs by manufactures transformers shall be provided IS 2026.transformers (No drain value shall be provided for 25, 63, 100KVA ratings).

6) Conservator with drain plug - 1 No. (except for 25KVA).

7) Thermometer pocket - 1 No. for 250KVA and 500KVA, 750 KVA,1000KVA,1250 KVA as required specs by manufactures transformers shall be provided IS 2026. transformers only.

,

8) Air release plug on main tank (except for 25 KVA).

9) BREATHERS: As per standards.

10) Oil level guage shall be provided indicating 3 positions of oil marked as below:
Minimum (-) - 5 degree C
30 degree C
Maximum (+) - 98 degree C

11) Off circuit tap switch handle shall be provided with locking arrangement in case of more than 250 above KVA Transformers.

12) HT & LT bushings - 3 Nos. of HT bushings and 4 Nos. of LT bushings shall be provided with terminal connectors. Each bushing of HV and LV shall be provided with 3Nos. of brass nuts and 2 Nos. plain brass washers for connecting terminal. LT terminal connectors for 250KVA and 500KVA, 750 KVA,1000KVA,1250 KVA as required specs by manufactures transformers shall be provided IS 2026. transformers shall be supplied in a separate packing.

13) RADIATORS: Elliptical/fin/tubular type radiator shall be provided as per design.

14) Arcing horns for HT bushings with adjustable type on the ground side.

15) Filter valve - 20mm dia shall provided for 250KVA and 500KVA transformers only, with metal cover box (tack welded).

22.0 TRANSFORMER OIL:

The transformer shall be supplied complete with first filling of oil and tile same shall comply with IS: 335/1993 with latest revisions thereof and ageing characteristics specified.

a) **NEW OIL:**

SL. No.	**Characteristics**	**Requirements**
1	Appearance	Oil shall be clear and transparent and free from suspended matter and sediments.
2	Density (Max) at 29,5° C	0.89 g/cm^3
3	Kinematic viscosity (max)	27 Cst at 27°C
4	Interfacial tension at 27°C (Min)	0.04N/M
5	Flash point (Min)	140°C
6	Neutralization value a) Total acidity (Max) b) Inorganic acidity/Alkalinity	0.02mg KOH/gm. Nil
7	Pour point (max)	-6°C
8	Corrosive sulphur	Non Corrosive
9	Electric strength (break down voltage (min) with 2.5mm gap) a) New Unfiltered oil as in received condition. b) After filtration.	 30KV (RMS) 60KV (RMS)
10	Dielectric dissipation factor (tan delta) at 90°C (Max)	0.002
11	SK Value (Max)	12%
12	Water content (Max)	50PPM
13	Specific Resistance (Min) (Resistivity) a) At 90°C (min) b) At 27°C (min)	 35 x 10^{12} Ohm – cm. 1500 x 10^{12} Ohm – cm.
14	Oxidation Stability a) Neutralization value after oxidation (Max.) b) Total sludge after oxidation (Max.)	 0.40 Mg/KOH/g. 0.1 % by weight
15	Ageing characteristics after accelerated ageing (Open breaker	

SL. No.	Characteristics	Requirements
	method with copper catalyst) a) Resistivity at 27°C b) Resistivity at 90°C c) Dielectric loss factor (tan delta) at 90°C d) Total acidity mg KOH/g e) Sludge Content (Max.)	 2.5×10^{12} Ohm - cm (min) 0.2×10^{12} Ohm - cm (min) 0.2 (Max.) 0.05 (Max.) 0.05 by weight.
16	Presence of oxidation in hibitor (Percent by weight)	The oil shall not contain antioxidant additives

Remarks: Value of 0.05% (max) shall be treated as absence of oxidation inhibitor.

b). The important characteristics of the transformer oil after it is filled in the transformer (with in 3 months of filling) shall be as follows.

SL. No.	Characteristics	Requirements
1	Electric Strength	50kV Min. With 2.5mm Gap
2	Dielectric dissipation factor (Tan delta) at 90°C	0.01 Max
3	Specific resistance (Resistivity) at 27°C	19×10^{12} Ohm-cms.
4	Flash point P.M. (Closed)	140^0C(Min)
5	Interfacial tension at 27°C	0.03 B+N+M or more
6	Neutralization value (total acidity)	0.5mg of KOH/g or less
7	Water content PPm	33 (Max)

All tests to verify the characteristics mentioned as above shall be carried out in accordance with IS: 335/1993.

23.0TESTS:

Type tests, routine tests and acceptance tests shall be conducted on transformers, of each capacity. All the equipment's offered, shall be fully type tested as per the relevant standards.

HGML reserves the right to witness the routine tests at its discretion.

23.1TYPE TEST

The following shall constitute the type tests as per IS-1180 (Part I) and IS: 2026/CBIP manual.

a) Measurement of winding resistance

b) Measurement of voltage ratio and check of voltage vector relation ship
c) Measurement of impedance voltage/Short circuit impedance and load loss.
d) Measurement of no-load loss and current
e) Measurement of Insulation resistance.
f) Induced over voltage withstand test.
g) Separate source voltage withstand test.
h) Impulse voltage withstand test.
i) Temperatures rise test
j) Short circuit test
k) Air pressure test
l) Permissible flux density and over fluxing.
m) Un Balance current test: The value of unbalance current indicated by the Ammeter as shown in the test arrangement of CBIP manual shall not be more than 2% of the full load current.

NOTE:

A) One 415v/11kv Transformers selected at random out of the lot . will be subjected to type test at CPRI at contractor cost..

B) The transformer so selected at random vide item (A) shall also be subject to strip test after all the type tests are conducted. After the strip test the transformer shall be subjected to physical inspection as per ISS.

If the Transformer fails to meet the requirement of type tests, the quantity of transformers ordered on them will be forthwith rejected.

23.2 **Routine Tests:**

All transformers manufactured shall be subjected to the following routine test, at the manufacturer's works - In accordance with IS:1180 (Part I & II) and IS:2026, and other applicable IS.

1) Measurement of winding resistance.
2) Measurement of voltage ratio and Check of voltage vector relationship
3) Measurement of impedance voltage/short circuit impedance and load loss.
4) Measurement of no load loss current and neutral current.
5) Measurement insulation resistance.
6) Induced over voltage withstand test.
7) Separate source voltage withstand test.

23.3 **Type and Routine Test certificates:**

1. All the type and routine tests as stipulated in the relevant standards shall be carried out by the supplier in the presence of HGML representative.

2. Immediately after finalization of tile programme of type/ acceptance/ routine testing, the supplier shall give fifteen days advance intimation to the HGML to enable to depute its representative for witnessing the tests. The routine test certificate shall be submitted along with tile inspection offer.

24.0 TOLERANCES:

Unless otherwise specified herein, the values of different parameters of the transformers supplied shall be within the tolerance permitted in the IS-2026 on the guaranteed values. Positive tolerance is not applicable for losses and negative tolerance not applicable for cross sections of winding specified.

25.0 FINISHING:

The exterior of the transformer tank and other ferrous fittings shall be thoroughly cleaned, scrapped/sand blasted and given a priming coat and two finishing coats of durable oil the weather resistance paints or enamel. The colour of finishing coats for transformers shall be as follows, as per IS: 5.

a) For 25 KVA - Dark admiralty grey shade No. 63

b) For 63 KVA - Dark admiralty grey shade No. 63

c) For 100 KVA - Dark admiralty grey shade No. 63

d) For 250 KVA -
e) For 500 KVA -

750 KVA, 1000 KVA,1250 KVA Dark admiralty grey shade No. 63

26.0 GUARANTEED TECHNICAL PARTICULARS:

The guaranteed technical particulars as per Data Sheet -4 to be filled and uploaded by the Tenderer. The transformers to be supplied against this order shall have the value as per Technical specifications.

27.0 DOCUMENTATION:

27.1 All drawings shall conform to international standards organization (ISO) 'A' Series of drawing sheet/Indian standards specification IS:656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in SI Units.

27.2 List of typical Drawings and Documents enclosed:

1) General drawing showing internal clearance dimensions and active parts.
2) Dimensional sketch for 63KVA – 1250KVA rating Transformer as applicable.

27.3 APPROVAL OF DRAWINGS / WORK BY HGML SHALL NOT RELIEVE THE SUPPLIER OF HIS RESPONSIBILITY AND LIABILITY FOR ENSURING CORRECTNESS AND CORRECT INTERPRETATION OF THE DRAWINGS FOR MEETING THE REQUIREMENT OF THE LATEST REVISION OF APPLICABLE STANDARDS, RULES AND CODES OF PRACTICES. THE EQUIPMENTS SHALL CONFORM IN ALL RESPECTS TO HIGH STANDARDS OF ENGINEERING DESIGN WORKMANSHIP AND LATEST REVISIONS OF RELEVANT STANDARDS AT THE TIME OF SUPPLY AND THE HGML SHALL HAVE THE POWER TO REJECT ANY WORK OR MATERIALS WHICH IN HIS JUDGMENT IS NOT IN FULL ACCORDANCE THERE WITH.

28.0 History Books (as per the proforma enclosed) shall be supplied for all the individual transformers along with the transformers. The size of the History Books shall be 150mm and 210mm for all capacities with different colour for wrappers for early identifications of the Transformers.

29.0 PUNCH MARKING OF TRANSFORMER SERIAL NO.

The serial No. of the Transformer shall be punch marked on the transformers tank and also on the top cover in addition to that indicated on the name plate as per relevant clause.

Particulars	**415V / 11 kV Transformer Specs.**
Continuous kVA ratings	As per design
Type	Oil immersed
Frequency	50 Hz
Type of cooling	Oil Natural Air Natural (ONAN)
No. of phases	3 (Three)
Rating voltage H.V. side	11 kV
Highest System voltage on H.V. side	13 kV r.m.s.
Rated voltage on L.V. side	0.433 kV r.m.s.
Vector Group	DyN11
Connections	
a. H.V. Winding	Delta
b. L.V. winding	Star with Neutral solidly earthed
On load taps on H.V. Side (for H.V. Variation)	+ 5 to – 10.0 % (in steps of 1.25%)
Impedance voltage (%)as per IS 2026	4%
Minimum Creep age distance at 400 phase to	32 mm/Kv
Transformer connections	LV side – Cables/ Bus Duct with weather proof enclosure as per design
	HV Side –Bushing with enclosure

Technical Specification for SF6 circuit Breaker 110kv :

a) The Circuit Breakers shall be of sulphur hexafluoride (SF6) type and shall be complete with all the accessories and auxiliary equipments and mounting structures required for their satisfactory operation in various sub-stations of KPTCL grid. The SF6 gas shall comply with IEC-376, 376A AND 376B and be suitable in all respects for use in the switch gear under the worst operating conditions.

b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the following standards and regulations:

IS: 4379 - Identification of the contents of industrial gas cylinders

IS: 7311 - Seamless high carbon steel cylinders for permanent and high pressure liquefiable gases.

The cylinders shall also meet Indian Boiler regulations.

OPERATING MECHANISM AND ASSOCIATED EQUIPMENTS:

1. The circuit breaker shall be designed for electrical local as well as remote control. In addition there shall be provision for local mechanical control (emergency trip).
2. The operating mechanism shall be of spring charging type (both for closing and opening operation) or semi pneumatic operation type in which closing operation is of spring charging type and opening operation is by pneumatic type or pneumatic type for both opening & closing operations. The mechanism shall be adequately, designed for the specified tripping and re-closing duty. The entire operating mechanism control circuitry, individual breaker compressor unit, hydraulic pump, spring charging motor etc., as required, shall be housed in an outdoor type, steel enclosure. This enclosure shall conform to the degree of protection IP-55 of IS-2147 and shall be suitable for mounting on a separate concrete plinth.
3. all working parts in the mechanism shall be of corrosion resistant material. All bearings which require greasing shall be equipped with pressure grease fittings.
   The design of the operating mechanism shall be such that it shall be practically maintenance free. The guaranteed number of years of maintenance free operation, the number of full load and full rated short circuit current breaking operations without requiring any maintenance or overhauling shall be clearly stated in the tender bid. As far as possible, the need for lubricating the operating mechanism shall be kept to the minimum and eliminated altogether, if possible.
4. The operating mechanism shall be anti-pumping and trip free, for all method of closing operations i.e., electrical, mechanical, pneumatic, semi-pneumatic type and hydraulic type. There shall be no rebounds in the mechanism and it shall not require any critical adjustments at site. Operation of the power operated closing device, when the circuit is already closed, shall not cause damage to the circuit breaker or endanger the operator. Provision shall be made for attaching an operation analyzer to facilitate testing of breaker at site.

a) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.
b) All the control knobs, manual spring charge etc., shall be easily approachable on-ground level. The height of these locations should be not more than 2000 mm from ground level.

5. The supplier shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.
   The detailed drawing indicating all the individual parts of the breakers and control mechanism duly marking parts number shall be furnished.
6. PNEUMATIC OPERATING MECHANISM
   Pneumatic operating mechanism for both closing and opening of the breaker -operations affected by compressed air.
7. Other Requirements like control panel with, interlocking facility , mounting, cabling, etc shall comply KPTCL norms.

STANDARDS :

The circuit breakers shall conform to the latest revision and amendments of standards as given below :

Sl. No.	Standard ref. No.	Title
1	IS : 117	Ready mixed paints, brushings, finishing etc.,
2	IS : 325	Specification for 3 phase induction motor
3	IS : 2099 IEC : 2331	High voltage porcelain bushing
4	IS : 2147	Degree of protection provided for enclosures for low voltage switch gear and control gear
5	IS : 2629	Recommended practice for hot dip galvanizing of iron and steel
6	IS : 3247	General requirement of switch gear and control gear for voltages not exceeding 1000V
7	IS : 4379	Identification of contents of industrial gas cylinders
8	IS : 5561	Electrical power connectors
9	IS : 7311	High pressure cylinder in which SF6 gas is transported and stored at site.
10	IS : 13118	Specification for HV AC circuit breakers
11	CIGRE working group report No. 13-02-1973	Switching over-voltages in EHV and UHV systems with special reference to closing and re-closing transmission lines.
12	Indian electricity rules	

13	IEC : 56	Specification for AC circuit breakers
14	IEC :60	High voltage test techniques
15	IEC : 71 Part I & II	Insulation coordination, terms, definitions, principles and rules
16	IEC : 270	Partial discharge measurements
17	IEC : 376	Specification and acceptance of new supply of SF6
18	IEC : 694	Common clauses for high voltage switchgear and control gear controls.

TECHNICAL SPECIFICATIONS FOR 110KV CLASS POWER TRANSFORMER OF 20MVA & BELOW CAPACITY

Note- All the technical specification related to transformers and accessories shall have the propor design, drawings, approved specifications and tenderer shall have to obtain the prior approval from HGML.

Note- THE CONTRACTOR SHALL COMPLY AND FOLLOW THE LATEST SPECIFICATIONS, IS, RELATED STANDARDS, PROCEDURES, METHODS ALONG WITH KPTCL NORMS AND SITE SPECIFIC REQUIREMENTS.

SECTION-1

1.0 SCOPE:

1.1 This specification covers design, manufacture, shop testing, supply, delivery, supervision of erection, testing and commissioning of 110KV CLASS two winding Transformer with all fittings and accessories, OLTC, RTCC, FCC, parallel operating equipments, first filling of oil and 10% spare oil in non-returnable drums.

The Power Transformers and its accessories shall be SCADA compatible.

1.2 The equipment's offered shall be complete with all components necessary for effective and trouble free operation such component shall be deemed to be within the scope of suppliers supply, irrespective of whether those are specifically brought out in this specification and or / the commercial order or not.

1.3 The transformers shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which, in his judgement, is not in full accordance therewith.

2.0 STANDARDS:

2.01 **THE TRANSFORMERS, ACCESSORIES AND ASSOCIATED EQUIPMENT SHALL GENERALLY CONFORM TO THE LATEST REVISION AND AMENDMENTS OF STANDARDS AS GIVEN BELOW, EXCEPT TO THE EXTENT EXPLICITLY MODIFIED IN THE SPECIFICATIONS.**

THE SUGGESTED MODIFICATIONS AND SPECIFICATIONS SHALL HAVE TO BE IMPLEMENTED AFTER TAKING THE PRIOR APPROVAL FROM HGML.

Indian Standard	Title	International and Internationall y recognized Standard
IS-325	Three Phase Induction Motors	IEC – 60034
IS-335, 1993	Insulating oils for Transformers and Switchgear	IEC-60296, BS-148
IS-778	Gun metal gate, globe and check-valves for general purpose.	
IS-1866 - 2000	Code of practice for Electrical maintenance and supervision of mineral insulating oil in equipment.	
IS-1886	Code of practice for installation and maintenance of Transformers	
IS-2026	Power Transformers	IEC-60076
IS-2099	Bushings for alternating or AC voltage above 1000V	IEC-60137,BS-223
IS-2147	Degrees of Protection provided by enclosures for low voltage switchgear and control gear	
IS-2705	Current Transformers	IEC-60185
IS-3202	Code of practice of climatic proofing of electrical equipments.	
IS-3347	Dimension for porcelain Transformer Bushings	
IS-3401	Silica gel	
IS-3637	Gas operated relays	
IS-3639	Fittings & Accessories for Power transformers	
IS-4253	Cork and rubber	
IS-5561	Electric Power *connectors*	
IS-5578 IS-11353	Guide for marking of Insulated Conductors	
IS-6272	Industrial cooling fans	
IS-6600	Guide for loading of oil immersed transformers	IEC-60076-7
IS-8468	On load tap changer	IEC-60214-1, 2003
IS-8478	Application guide for OLTC	IEC-60214-2
IS-9434	Guide for sampling and analysis of dissolved gas in oil filled equipments.	IEC-60567
IS-12676	Oil impregnated paper-insulated condenser Bushing Dimension and requirements.	
IS-3716	Application Guide For Insulation Co-Ordination	IEC-60071
IS-2071	High Voltage Test Techniques	IEC-60060-3
IS-13947	Low voltage switchgear & controlgear	
	CEA-(Technical Standards For Construction Of Electrical Plants And Electric Lines)Regulations-2010	
	IEEMA Standard Publication- Transformer-I	

CBIP manual on Transformers
Publication No. 317 (April 2013 edition)
the Central Board of Irrigation & Power, Malcha Marg, Chanakyapuri, New Delhi

2. 02. The standards mentioned above are available from:

Standard	Name and Address
IS	BUREAU OF INDIAN STANDARDS, Manak Bhawan, No. 9 Bahadur Shah Zafar Marg, New Delhi-110 001, INDIA
IEC	INTERNATIONAL ELECTRO-TECHNICAL COMMISSION, central de la Commission Electro Technique International, 1, Rue de Verembe, Geneva, SWITZERLAND.

2.03 Equipment meeting with the requirements of other authoritative international standards which ensure equal or better Performance than the standards mentioned above shall also be considered. When the equipment offered by the supplier conforms to other standards, salient points of difference between standards adopted and the standards specified in this specification shall be clearly brought out in the offer. Two copies of such standards with authentic translation in English shall be furnished along with the offer.

3.1 CLIMATIC CONDITIONS :

The equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

a) Maximum ambient air temperature [Deg. C] - 50(as per IS)
b) Minimum ambient air temperature [Deg. C] - 5
c) Average daily ambient air temperature [Deg. C] - 30
d) Relative humidity [%] - 10-100
e) Average rainfall per annum [mm] - 3000 max.
f) Maximum altitude above mean sea level [Mtrs] - 1000
g) Maximum wind pressure [Kg. / Sq. M] - 150
h) Isoceraunic level [days / year] - 46
i) Seismic level [horizontal acceleration] - 0.3g

Moderately hot and humid tropical climate, conducive to rust and fungus growth.

4.1 **CLEARANCES :**

4.2 The overall dimensions of the transformer shall allow for sufficient clearances for installation:

a) In 110kV Switchyard with bay width of 10400mm, boom height at 8500mm, the phase to phase & phase to earth clearance of 110kV Bay is 2700mm and 2500mm. However, the overall width of transformer is limited to 7000 mm or as applicable by KPTCL norms.

5.0	SERVICE CONDITIONS:	
	As per IS 2026 (Part-1) – 2011, Clauses 1.1, 1.1.1 and 1.1.2.	

	RAIL GAUGE: Rail gauges to be available at the station are indicated below:	
	a) In the direction parallel to the line of 110kV bushing	- 1676mm.
	b) In the direction perpendicular to the line of 110kV bushing -1676mm.	

SECTION – II

GENERAL TECHNICAL REQUIREMENTS

1.1 GENERAL DESIGN OF APPARATUS:

The Transformers and accessories shall be designed and manufactured in accordance with IS 2026 and all applicable section of CBIP manual on Transformer, in regard to design, standardization, galvanizing, lables, bolts and nuts, cleaning and painting, oil and prevention of acidity.

1.2 ELECTRICAL CHARACTERISTICS AND PERFORMANCE:

1.2.1 THE TRANSFORMERS, UNLESS OTHERWISE SPECIFIED SHALL BE OIL IMMERSED AND CORE TYPE AND SHALL BE SUITABLE FOR OUTDOOR INSTALLATION.

Transformers designed for mixed cooling shall be capable of operating under the natural cooled condition up to the specified load. The forced cooling equipment shall come into operation by pre-set contacts in WTI and the transformer will operate as a forced cooled unit.

Transformers shall be capable of remaining in operation at full load for 10 minutes after failure of blowers with the calculated winding hot-spot temperature not exceeding 1400C. Transformer fitted with two coolers each capable of dissipating 50 percent of the heat at C.M.R. shall be capable of remaining in operation for 20 minutes in the event of failure of blowers associated with one cooler with the estimated winding hot-spot temperature not exceeding 140^0C as per the latest specifications.

1.2.2 CONTINUOUS MAXIMUM RATING AND OVER LOAD:

The Transformers provided with ONAF cooling shall in regard to rating, temperature and overloads comply with Clause 4.0 of IS 2026, Part-I with latest amendments and as per the latest specifications thereof.

1.2.3 VOLTAGE RATIO:

The voltage between phases on the higher and lower voltage windings of each transformer measured at no load and corresponding to the normal ratio of transformation shall be capable of giving rated volts from the secondary when rated primary voltage is applied at the normal tap and at the rated frequency, as per the latest specifications.

1.2.4 ELECTRICAL CONNECTIONS:

Transformers shall be of Vector Group YNd1.

1.2.5 DUTY UNDER FAULT CONDITIONS:

Except where modified, it is to be assumed that the amount of generating plant simultaneously connected is such that normal voltage will be maintained on one side of transformer when there is a short circuit between phases or to earth on the other side. The transformer may be directly connected to an underground or overhead transmission line and switched into and out of service together with its associated transmission line, as per the latest specifications.

The rated short time rating shall be 100/Z times the rated primary current for 3 seconds where „Z" is % impedance of Transformer,and as per the latest specifications.

The supplier would furnish the detailed calculation to prove the short circuit strength of the Power Transformer, and as per the latest specifications..

1.2.6 **REQUIREMENTS WITH REGARD TO ABILITY TO WITHSTAND SHORT CIRCUIT.**

As per IS 2026 (Part-5):2011, Clause 3 and Sub-Clauses thereof.

The thermal ability to withstand short circuit for duration of 3 secs. shall be demonstrated by theoretical evaluation of the ability to withstand a short circuit event by manufacturer"s experiences supported by IEC guidelines as per IEC 60076-5, 2006 (3rd edition or the latest version)/ IS 2026-5, 2011(or latest version). **The calculation of dynamic ability to withstand short circuit shall be submitted before drawing approval along with thermal stability calculations**, and shall be as per the latest specifications.

The windings shall be capable of withstanding axial and radial forces during fault conditions. **The detailed calculation towards the above should be furnished before drawing approval**, and shall be as per the latest specifications.

The short circuit temperature rise should not exceed the limits, fixed as per IS: 2026. **The calculation towards the above for 110kV, 11kV windings shall be furnished before drawing approval**, and shall be as per the latest specifications..

1.2.7 **DEMONSTRATION OF ABILITY TO WITHSTAND SHORT CIRCUIT:**
As per IS 2026 (Part-5):2011, Clause 4 and Sub-Clauses, and shall be as per the latest specifications thereof.

1.2.8 **LOSSES:**

1.2.8.1 **MEASUREMENT:**
As per Clause 10.4 and 10.5 of IS 2026 (Part-I) 2011, and shall be as per the latest specifications.

1.2.8.2 **TOLERANCE**

As per Clause 9 of IS 2026 (Part-1) 2011, and shall be as per the latest specifications..

1.2.8.3 **GUARANTEED LOSS:**

1.2.8.3.1 **The bidder shall quote transformer losses which should not exceed the losses specified in the technical specification or otherwise, the offers would be rejected.**

i) The bidder while quoting should clearly indicate the guaranteed value of the losses which **shall be firm and without any tolerance limit** in respect of under mentioned losses at normal tap, as required in Annexure-I, and with IS .
   a. No load loss at rated voltage and rated frequency.
   b. Total load losses including auxiliary losses at rated output, rated voltage and rated frequencies.

ii) The transformers will be accepted as long as the measured losses towards No load loss and the Load loss including the auxiliary loss put together is within 10% over and above the sum of the guaranteed losses. And also, the measured losses in respect of No load loss and the Load loss including the auxiliary loss shall not exceed 15% of the guaranteed loss.

iii) The transformers shall be rejected, if the tested/measured losses towards No load loss and the Load loss including the auxiliary loss put together exceeds 10% of the total guaranteed losses and also the individual component of losses (i.e No load loss and the Load loss including the auxiliary loss) exceeds 15% of the guaranteed loss.

1.2.9 **REGULATION AND IMPEDANCE:**

The impedance voltage at principal tap and Rated MVA shall be stated and tolerance shall be in accordance with IS:2026.

1.2.10 **FLUX DENSITY:**

The maximum flux density in any part of the core and yoke, at rated MVA, voltage and frequency at any tap shall not exceed 1.6 Tesla (16,000 Lines per sq.cm.)

1.2.11 **SUPPRESSION AND HARMONICS:**

All the transformers shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave form distortion and from any possibility of high frequency disturbances, inductive effects or of circulating currents between the neutral points at different transforming stations reaching such a magnitude as to cause interference with communication circuits.

2.1 CORES:

2.2 CONSTRUCTION:

The cores shall be constructed from high grade cold rolled non-aging super grain oriented silicon steel laminations specially suitable for Transformer cores. The conventional grain oriented (CGO) core of grade M4 or better shall be used, and shall be as per the latest specifications.

2.3 MAGNETIC CIRCUIT: and shall be as per the latest specifications.

a) The design of the magnetic circuit shall be such as to avoid static discharges, development of short-circuit paths within itself or to the earthed clamping structure and the production of flux components at right angles to the plane of the laminations which may cause local heating.
b) Every care shall be exercised in the selection, treatment and handling of core steel to ensure that as far as is practicable, the laminations are flat and the finally assembled core is free from distortion.
c) The oxide/silicate coating given on the core steel is adequate, however, laminations can be insulated by the manufacturers if considered necessary.
d) Oil ducts shall be provided where necessary to ensure adequate cooling. The winding structure and major insulation shall not obstruct the free flow of oil through such ducts. Where the magnetic circuit is divided into pockets by cooling ducts parallel to the planes of the laminations or by insulating material above 0.25 mm thick, tinned copper strip bridging pieces shall be inserted to maintain electrical continuity between pockets.
e) The frame work and clamping arrangements shall be earthed.
f) The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000V AC for one minute.
g) Transformers shall withstand, without injurious heating, combined voltage & frequency fluctuations, which produce the following over fluxing condition:
   i) 110% - continuous
   ii) 125% - for one minute.
   iii) 140%- for five seconds.

2.4 MECHANICAL CONSTRUCTION OF CORES:

All parts of the cores shall be of robust design capable of withstanding any shocks to which they may be subjected during lifting, transport, installation and service.

All steel sections used for supporting the core shall be thoroughly sand blasted or shot blasted after cutting, drilling and welding. Any non-magnetic or high resistance alloy shall be of established quality.

Adequate-lifting lugs shall be provided to enable the core and windings to be lifted.

Adequate provision shall be made to prevent movements of the core and winding relative to the tank during transport and installation or while in service.

The supporting frame work of cores shall be so designed as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve, or cause trapping of air during filling.

WINDINGS:

3.1 **All delta connected windings of 110kVand above shall be uniformly insulated through out the** length **of the winding. All neutral points shall be insulated for the voltages specified in IS: 2026. All winding conductors shall be of electrolytic grade copper only.** and shall be as per the latest specifications.

3.2 Power transformers shall be designed to withstand the impulse and power frequency test voltages as specified in IS: 2026.

3.3 The windings shall be designed to reduce to a minimum, the out-of-balance forces in the transformer at all voltage ratios.

3.4 The insulation of transformer windings and connection shall be free from insulating composition liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service.

3.5 The stacks of windings shall receive adequate shrinkage treatment before final assembly. Adjustable devices shall be provided for taking up any possible shrinkage of coils in service.

3.6 The coil clamping arrangement and the finished dimensions of any oil ducts shall be such as will not impede the free circulation of oil through the ducts.

3.7 No strip conductor wound on edge shall have a width exceeding six times its thickness.

3.8 The conductors shall be transposed at sufficient intervals in order to minimise eddy currents and equalise the distribution of currents and temperatures along the windings.

3.9 Further, windings shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and that field repairs to the windings can be made readily without any special equipment. The coils shall be supported between adjacent sections by insulating spacers and barriers.

3.10 All threaded connections shall be provided with locking facilities. All leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guides shall be used wherever practicable.

3.11 The windings shall be clamped securely in place so that they will not be displaced or

deformed during short circuits.

3.12 For transformers with HV delta winding, separate tap winding shall be provided instead of tapping from the mid of the HV winding. The tap winding shall be inserted over the HV winding throughout the length.

3.13 The maximum current density in any winding shall not exceed 2.3A/sq.mm.

3.14 BRACING OF WINDINGS:

The windings and connections of all transformers shall be braced to withstand shocks which may occur during transport, or due to switching short circuit and other transient conditions during service.

4.1 **INTERNAL EARTHING ARRANGEMENT:**

All metal parts of the transformer with the exception of the individual core laminations, core bolts and associated individual clamping plates shall be maintained at some fixed potential.

4.2 **EARTHING OF CORE CLAMPING STRUCTURE:**

The top main core clamping structure shall be connected to the tank body by a copper strap. The bottom clamping structure shall be earthed by one or more of the following methods.

a) By connection through vertical tie-rods to the top structure.
b) By direct metal-to-metal contact with the tank base maintained by the weight of the core and windings.
c) By a connection to the top structure on the same side of the core as the main earth connection to the tank.

4.3 EARTHING OF MAGNETIC CIRCUIT:

a) The magnetic circuit shall be earthed to the clamping structures at one point only through a link placed in an accessible position beneath an inspection opening in the tank cover, the connection to the link shall be on the same side of the core as the main earth connection.

b) Magnetic circuits having an insulated sectional construction shall be provided with a separate link for each individual section. Where oil ducts or insulating barriers parallel to the plane of the laminations divide the magnetic circuit into two or more electrically separate parts the ducts or barriers shall be bridged and the magnetic circuit shall not be regarded as being of sectional construction.

4.4 **EARTHING OF COIL CLAMPING RINGS:**

Where coil clamping rings are of metal at earth potential, each ring shall be connected to the adjacent core clamping structure on the same side of transformer as the main earth connections.

4.5 **SIZE OF EARTHING CONNECTION:**

All earthing connections with the exception of those from the individual coil clamping rings shall have a cross sectional area of not less than 0.8sq.cm. Connections inserted between laminations of different sections of core as per Clause 4.02 (b) shall have cross sectional area of not less than 0.2 sq.cm.

1.00 **TANKS:**

5.1 CONSTRUCTION:

Conventional type of tank construction could be used.

The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate thickness. The tanks of all transformers shall be complete with all accessories and shall be designed so as to allow the complete transformer in the tank filled with oil, to be lifted by crane or jacks, transported by road, rail without over straining any joints and without causing subsequent leakage of oil.

The main tank body excluding tap changing compartments, radiators and coolers shall be capable of withstanding vacuum:

Highest system voltage KV	MVA rating	Vacuum gauge pressure KN/sq.m.	(mm of Hg)
Upto 72KV	Up to 1.6 above 1.6 & up to 20	34.7 68.0	250 500
Above 72KV	For all MVA Ratings	100.64	760

The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using plates or rails.

Normally a detachable under base will be used, but in case transport facilities permit, a fixed under base can be used.

Where the base, is of a channel construction, it shall be designed to prevent retention of water.

Tank stiffeners shall be designed to prevent retention of water.

Where possible the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipe. The vent pipes shall have a minimum inside diameter of 15mm except for short branch pipes which may be 6mm minimum inside diameter.

All joints other than those which may have to be broken shall be welded when required they shall be double welded. All bolted joints to the tank shall be fitted with suitable oil-tight gaskets which shall give a satisfactory service under the operating conditions and guaranteed temperature rise conditions. Special attention shall be given to the methods of making hot oil tight joints between the tank and the cover as also between the cover and the bushing and all other outlets to ensure that the joints can be remade satisfactorily at site and with ease with the help of semi-skilled labour.

However the minimum thickness of the plates used for Transformer Tanks shall not be less than 8mm for the sides and not less than 10mm for the bottom plate and top cover. Thickness of radiator sheet shall be 1.25mm.

5.2 LIFTING AND HAULAGE FACILITIES:

Each tank shall be provided with:

(a) Lifting lugs suitable for lifting the transformer complete with oil.
(b) A minimum of four jacking lugs, in accessible positions to enable the transformer complete with oil, to be raised or lowered using hydraulic or screw jacks. The minimum height of the lugs above the base shall be
   (i) Transformers upto and including 40 tonnes weight-300mm (approx.) so as to accommodate suitable jacks beneath the jacking parts.
   *(ii)*Transformers above 40 tonnes weight-500mm (approx.) so as to accommodate suitable jacks beneath the jacking parts.
(c) Suitable haulage holes shall be provided.

In addition the Transformers shall be provided with bollards on the Transformer Tank sides at the top for lifting the Transformer by a crane.

5.3 TANK COVER:

Each tank cover shall be of adequate strength, and shall not distort when lifted.

Inspection openings shall be provided as necessary to give easy access to bushing or changing ratio or testing the earth connection. Each inspection opening shall be of ample

size for the purpose for which it is provided and atleast two openings one at each end of the tank, shall be provided.

A ladder (with anti-climbing lock arrangement)shall be provided for tank above 3m height. The tank shall be designed so as to avoid collection of rain water at the tank top.

The tank cover and inspection covers shall be provided with suitable lifting arrangements. Unless otherwise approved inspection covers shall not weigh more than 25kg. each.

The tank cover shall be fitted with pockets for thermometer and for the bulbs of oil and winding temperature indicators. Protection shall be provided where necessary, for each capillary tube.

The Thermometer pocket shall be fitted with a captive screwed top to prevent the ingress of water.

The pockets shall be located in the position of maximum oil temperature at C.M.R. and it shall be possible to remove the instrument bulbs without lowering the oil in the tank.

5.4 AXLES AND WHEELS:

All wheels should be detachable and shall be made cast iron or steel as required.

Wherever specified, flanged wheels shall be provided suitable for use on gauge track as specified in the detailed specification and shall be so placed that pinchbar can be used to move the transformer.

The direction of motion shall be specified in case of unidirectional movement.

If wheels are required to swivel, they shall be arranged so that they can be turned through an angle of 90 degrees when the tank is jacked up clear of the rails or floor. Means shall be provided for locking the swivel movements in positions parallel to and at right angles to the longitudinal axis of the tank.

The wheels shall be suitable for movement on a rail track, the gauge of which shall be 1676mm standard broad gauge track.

5.5 CONSERVATOR VESSELS, OIL GAUGES AND BREATHERS:

A conservator complete with sump and drain valve shall be provided in such a position as not to obstruct the electrical connections to the transformer having a capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from the minimum ambient temperature to 900C. The minimum indicated oil level shall be with the feed pipe from the main tank

covered with not less than 15mm depth of oil and the indicated range of oil level shall be from minimum to maximum.

If the sump is formed by extending the feed pipe inside the conservator vessel, this extension shall be for at least 25mm. The conservator shall be designed so that it can be completely drained by means of the drain valve provided, when mounted as in service.

One end of the conservator shall be bolted into position so that it can be removed for cleaning purposes.

Normally one oil gauge magnetic/prismatic/plain type as specified shall be provided. The oil level at 300C shall be marked on the gauge.

Taps or valves shall not be fitted to oil gauge.

The oil connection from the transformer tank to the conservator vessel shall be arranged at a rising angle of 3 to 9 degrees to the horizontal upto the Buchholz Relay and shall consist of

(a) For transformers from 1001 to 10,000 KVA, 50mm inside diameter pipes as per IS:3639.
(b) For transformers of over 10,000KVA, 80mm inside diameter pipes as per IS: 3639.

A valve shall be provided at the conservator to cut-off the oil supply to the transformer, after providing a straight run of pipe for at least a length of five times the internal diameter of the pipe on the tank side of the gas and oil actuated relay and atleast three times the internal diameter of the pipe on the conservator side of the gas and oil actuated relay.

Each conservator vessel shall be fitted with breather in which silicagel is the dehydrating agent and designed so that:

(a) The passage of air is through the silicalgel.
(b) The external atmosphere is not continuously in contact with the silicagel.
(c) The moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from distance.
(d) All breathers shall be mounted at approximately 1,400mm above ground level.

However the conservator main tank shall be provided with a magnetic oil gauge and the partitioned conservator tank for the oil in the OLTC chamber shall be provided with a plain glass oil tube gauge.

5.6 FILTER AND DRAIN PLUGS, SAMPLING DEVICES AND AIR RELEASE PLUGS:

Each transformer shall be fitted with the following:

(a) The filter and drain valves as specified.

(b) A drain valve as specified below shall be fitted to each conservator.

For diameter upto 650mm: Size of the valve 15mm

For diameter above 650mm: Size of the valve 25mm

(c) A robust oil sampling device shall be provided at the top and bottom of the main tank. The sampling device shall not be fitted on the filter valves specified under (a) above. However top, middle and bottom oil sampling valves shall be mounted at the tank base through suitable internally located pipe headers.

(d) One 15mm air release plug.

All other valves opening to atmosphere shall fitted with blank flanges.

5.7 COOLER AND RADIATOR CONNECTIONS:

Valves and valve mountings shall be provided as specified under „Cooling Plant" Cl. 7.0, Section-A of CBIP Manual.

All valves shall be of gun-metal or cast steel or may have cast iron bodies with gun- metal fittings. They shall be of full way type with internal screw and shall be opened by turning counter clock-wise when facing the hand wheel.

Means shall be provided for padlocking the bottom valves in the open and closed positions. This required for the valves where opening device like hand-wheel, keys, etc., are the integral part.

Every valve shall be provided with an indicator to show clearly the position of the valve. All valves shall be provided with flanges having mechanical faces.

The drilling of valve flanges shall comply with the requirements of IS: 3939.

5.8 PRESSURE RELIEF DEVICE:

The pressure relief device shall be provided of sufficient sizes of rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of rain.

Unless otherwise approved the relief device shall be mounted on the main tank, and if on the cover shall be fitted with skirt projecting 25mm inside the tank and of such a design to prevent gas accumulation.

If a diaphragm is used it shall be of suitable design and material and situated above maximum oil level.

If a diaphragm is put at the base of pipe, an oil gauge is required on the standpipe for indicating fracture of diaphragm.

One of the following methods shall be used for relieving or equalizing the pressure in the pressure relief device.

(a) An equalizer pipe connecting the pressure relief device to the conservator, or
(b) The fitting of a silicagel breather to the pressure relief device the breather being mounted in a suitable position for access at ground level.

5.9 EARTHING TERMINAL:

Two earthing terminals capable of carrying for 4 seconds the full lower voltage, short circuit current of the transformer. Provision shall be made at positions close to each of the bottom two corners of the tank for bolting the earthing terminals to the tank structure to suit local conditions.

5.10 RATING AND DIAGRAM AND PROPERTY PLATES:

The following plates shall be fixed to the transformer tank at an average height of about 1750mm above ground level:

(a) A rating plate bearing the data specified in the appropriate clauses of IS:2026.
(b) A diagram plate showing the internal connection and also the voltage vector relationship of the several windings in accordance with IS:2026 and in addition a plan view of the transformer giving the correct physical relationship of the terminals. When links are provided in accordance with Clause 2.3 section A, of CBIP manual for changing the transformer ratio, then approved means shall be provided for clearly indicating ratio for which the transformer is connected. No load voltage shall be indicated for each tap.
(c) Where specified a plate showing the location and function of all valves and air release cocks or plugs. This plate shall also warn operators to refer to the maintenance instructions before applying the vacuum treatment for drying.

The above plates shall be of material capable to withstanding continuous outdoor service.

5.11 JOINTS AND GASKETS:

All gaskets used for making oil tight joints shall be of proven material such as granulated cock bonded with synthetic rubber or synthetic rubber gaskets as per IS 4253.

5.12 COOLING PLANT:

The transformer shall be supplied with the requisite number of radiators and coolers.

General:

Radiators and coolers shall be so designed as to avoid pockets in which moisture may collect and shall withstand the pressure tests.

Unless the pipe work is shielded by adequate earthed metal the clearance between all pipe work and live parts shall be more than the clearance for live parts to earth.

Radiators mounted directly to the tank/banked. Detachable radiators as per section JJ of CBIP manual.

Valves shall be provided in the tank at each point of connection to the tank.

Where separate radiator banks are provided, the conservator vessels specified in Clause 6.5, Section-A of CBIP Manual can be mounted thereon.

All coolers shall be suitable for mounting on a flat concrete base. The oil circuit of all coolers shall be provided with the following:

(a) A valve at each point of connection to the transformer tank.
(b) Removable blanking plates to permit the blanking off the main oil connection of each cooler.
(c) A drain valve 25mm at the lowest point of each bank of cooler.
(d) A thermometer pocket fitted with a captive screwed cap on the inlet and outlet oil branches of each separately mounted cooler bank.
(e) A filter valve as specified in Clause 6.6, Section-A of CBIP Manual at the top and bottom of each cooler bank of cooler.
(f) Air release plugs of 15mm.

In addition the following are to be provided only with water cooled oil coolers which shall be as per IS:6088.

(a) A suitable differential pressure gauge or equivalent suitable device fitted with electrical contacts to give an alarm when differential pressure between cooler oil outlet and water inlet pressure drops below a preset value.
(b) Oil and water flow switches, fitted with electrical contacts, in the pipe work adjacent to the coolers.

Water cooled oil coolers shall be designed to facilitate cleaning without any risk of water mixing with the oil. The material of the tube plates and tubes shall be such that corrosion shall not take place due to galvanic action. A report on water analysis shall be furnished, in time, to enable supplier to ensure a suitable material for tube and tube plates.

Any leakage which may take place in the oil cooler shall be of the oil into the water and the reverses, and means shall be provided to ensure that the pressure of the oil in the cooler is always greater than the pressure of the water. The water pressure in the cooler will be kept as low as possible. Further, the cooling water discharge should be free to the atmosphere to reduce the pressure in the cooler.

The necessary oil piping shall be provided for connecting each transformer to the coolers and oil pumps. The oil piping shall be with flanged gasketed joints. Cast iron shall not be used.

The drilling of all water and oil pipe flanges shall comply with IS:3639 (Section-1, Specification For Valves Of Transformer).

A suitable expansion piece shall be provided in each oil pipe connection between the transformer and the separately mounted oil coolers.

Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.

5.13 PAINTING:

The internal and external surfaces including oil filled chamber and structural steel work to be painted shall be shot or sand blasted to remove all rust and scale or foreign adhering matter or grease. All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant, oil insoluble insulating varnish.

All steel surfaces exposed to weather shall be given a primary coat of zinc chromate, second coat of oil and weather resistant varnish of a colour distinct from primary and final two coats of flossy oil and weather resisting light grey paint in accordance with shade No. 631 of IS-5.

All paints shall be carefully selected to withstand extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

The minimum thickness of outside painting of tank shall be 20 microns and the total thickness of painting shall be minimum 80 microns.

6.1 **VOLTAGE CONTROL (ON-LOAD TYPE): (SHOULD BE SCADA COMPATIBLE)**

6.2 a) The transformers shall be fitted with an onload tap changer mechanism.

Each transformer shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on-load and without producing phase displacement.

Equipment for local and remote electrical and local manual operation shall be provided and shall comply with the following conditions. Local remote selector Switch may be housed in remote control panel or in tap changer driving unit.

It shall not be possible to operate the electric drive when the manual operating gear is in use. It shall not be possible for any two electric controls to be in operation at the same time.

Operation from the local or remote control switch shall cause one tap movement only until the control switch is returned to the off position between successive operations.

All electrical control switches and the local operating gear shall be clearly labeled in a suitable manner to indicate the direction of tap changing.

The local control switches shall be mounted in the marshalling box, or driving gear housing.

The equipment shall be so arranged as to ensure that when a tap change has been commenced it shall be completed independently of the operation of the control relays or switches. If a failure of the auxiliary supply during a tap change or any other contingency such as tap changer getting stuck would result in that movement not being completed adequate means shall be provided to safeguard the transformer and its auxiliary equipment.

Suitable apparatus shall be provided for each transformer to give indications as follows.

To give an indication, mechanically at the transformer and electrically at the remote control point, of the number of tapping in use on the transformer.

To give an indication at the remote control point that a tap change is in progress, by means of an illuminated lamp.

All relays and operating devices shall operate correctly, at any voltage between the limits specified in the relevant Indian Standard.

Any enclosed compartment not oil filled and shall be adequately ventilated, metal clad thermostatically controlled heaters shall be provided in the driving mechanism chamber and in the marshalling box, all contactors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.

The tap changer contacts which are not used for making or breaking current like separate selector switch contacts can be located inside main transformer tank where

tap changer construction permits such an arrangement. On load tap changers having separate compartment for selector contacts, the oil in such compartment shall be maintained under conservator head by means of pipe connection from the highest point of the chamber to the conservator. Such connection shall be controlled by suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate Buchholz relay/diverter switch may be provided for this compartment.

It shall not be possible for the oil in these compartments of the tap change equipment, which contain contacts used for making or breaking current, to mix with the oil in the compartments containing contacts not used for making or breaking current.

Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil gauge.

The alternating supply for electrical operation of the control and indicating gear shall be standard 415 volts, three phase, 3 wire, 50Hz, along with 240 volts, single phase, 2 wire, 50 Hz, subject to a variation of +10 to –30% so that the equipment offered can withstand variation in A.C.

Limit switches shall be provided to prevent over running of the mechanism and shall be directly connected in the circuit of the operating motor. In addition a mechanical stop or other approved device shall be provided to prevent over running of the mechanism under any condition.

Limit switches may be connected in the control circuit of the operating motor provided that a mechanical declutching mechanism incorporated.

Thermal devices or other means like motor circuit breakers with shunt trip coil shall be provided to protect the motor and control circuits. All relays, switches, fuses, etc., shall be mounted in the marshalling box or driving gear housing and shall be clearly marked for purposes of identification. They shall withstand the vibration associated with tap changer gear operation.

The control circuits shall operate at 110V single phase to be supplied from a transformer having a ratio of 415V/55-0-55V with the center point earthed through a removable link mounted in the marshalling box or tap changer drive.

The whole of the apparatus shall be of robust design and capable of giving satisfactory service without undue maintenance under the conditions to be met in service, including frequent operation.

A five digit counter shall be fitted to the tap changing mechanism to indicate the number of operations completed by the equipment.

A permanently legible lubrication chart shall be fitted within the driving mechanism chamber, where applicable.

On-load tap changer driving gear Motor shall be of squirrel cage totally enclosed type and shall comply with Indian Standard IS:325. It shall be suitable for direct starting and continuous running from 415 volts, 3 phase supply. Motor shall be capable of continuous operation at any frequency between 48 and 51 Hz. together with any voltage within 10 percent of nominal value. Motor shall have ball or roller bearing and vertical spindle motor shall have bearing capable of withstanding of thrust to the weight of the moving parts. The stator winding shall be adequately brazed and suitably impregnated to render then non-hygroscopic.

The overload protection relay shall be of robust adjustable triple-pole construction. It should provide accurate and reliable protection against overload, single phasing, overheating and short circuit. The relay should be provide with temperature compensating device to offset the effect of ambient temperature variation.

Contactors/Relays shall be of robust and compact construction and shall comply with Indian Standard IS:2959.

The contactors shall be suitable for operation at 110 volts A.C. –15 percent to +10 percent 50Hz. Main and auxiliary contacts of contactors shall be suitably rated. For sufficient long life these contacts shall be of double break type and shall make contacts practically bounce-free.

The control supply transformer shall be single phase having ratio 415V/55-0-55V. Its insulation shall be suitable impregnated to render it non-hyproscopic.

All the control selector switches shall be robust and compact construction and shall comply with Indian Standard IS:4064 and 4047.

Remote tap position indicator mounted on remote control cabinet shall show accurately same tap position as indicated by local tap position indicator on on- load tap changer. "The remote indication can be by means of an analogue indicator, or digital indicator or by means of lamp indications. The remote indicator mounted on control cabinet shall not be affected by normal auxiliary voltages supply variation.

Necessary indicating lamps provided shall be of low watt consumption of LED type.

Space heater of adequate capacity and robust construction shall be provided inside each control cabinet to prevent moisture condensation. Space heaters shall be rated for 240V, 1 phase, 50Hz, supply. Heater shall be complete with miniature circuit breaker or "ON-OFF" switch.

All the wiring shall be carried out for motor circuit with 1100 volts grade PVC insulated stranded copper conductors of size 2.5 sq.mm. and for control circuit with 650 volts grade PVC insulated copper conductor of size 1.5 sq.mm. suitable for tropical atmosphere. All wiring shall be in accordance with relevant IS. Engraved/Printed core identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall of when the wire is removed. All wiring shall be terminated on terminal blocks through suitable lugs. Insulated sleeves shall be provided at all the wire terminations. All wiring shall be neatly bunched and cleated without affecting access to equipment mounted within the cabinet.

Terminal board rows should be spaced adequately apart to permit convenient access to wires and terminations.

Terminal boards shall be so placed with respect to the cable gland plate (at a minimum distances of 200 mm) as to permit satisfactory arrangement of multicore cable tails without undue stress or bends opening of door should not disturb or stress the wire termination.

b) Separate tap winding shall be provided on the HV winding running all along the length. Suitable OLTC with higher insulation shall be provided at the line end of HV delta winding of transformer. The tap change variation shall be in the range of +5% to –15% on HV in steps of 1.25 % i.e. 16 equals steps (Number of position 17)

c) Regarding 110KV class transformers: On-load tap changer shall be of double compartment design, in which diverter switch and tap selector switch are separate. It shall have

   a. A separate selector to select a tap and shall carry current but not make or break current.
   b. A diverter switch to carry, make and break currents in circuits as per IS 8468 –1973, clause 2.12 & 2.13.

The transitional resistance shall be capable of with standing full load current of transformer for 1 sec.

OLTC shall be of bi-directional type and housed inside the transformer tank.

d) The OLTCs shall be suitable for Delta Configuration of Transformers. The manufacturers shall be competent of manufacturing Delta Application OLTCs and should have a minimum experience of 5 years in manufacturing Delta Application OLTCs. At least 50% of the quantity of OLTCs tendered shall be in successful operation for a period of not less than 2 years. The Delta Application OLTCs shall

have been type tested as per IEC 60214. Copies of Type Test Report shall be furnished.

e) The OLTC shall be suitable for supervisory control an indication on multi- way switch, make before break having one fixed contact for each tap position shall be provided and when specified, wired to the tap changer drive gear. This switch shall be provided in addition to any, which may be required for remote tap changer indication purposes. Supervisory indication shall also be provided when specified in the form of contacts to close on" tap change incomplete".

The make of OLTCs shall be from any of the KPTCL approved vendor.

6.02 OLTC Routine Tests.

Note- Contaractor is advised to understand the IEC Reference and procedures.
OLTC manufacturer shall conduct the following routine tests fully in compliance with IEC 60214-1 and its subsequent amendments on every unit as given below before dispatch to assure the quality of the product.

Sl. No.	IEC Reference	Test description	Acceptance level
1	*60214-1* Cl No. 5.3.1	Mechanical Endurance Test	Minimum 1000 operations
2	*60214-1* Cl No. 5.3.2	Sequence Test	Switching operation with timing less than 50m sec.
3	*60214-1* Cl No. 5.3.4	Pressure Test	10 PSI (0.7kg per Sq.cm.) for 8 hrs. at room temp.
4	60214-1 Cl No. 5.3.4	Vacuum (Helium) Test	Vacuum level of 6x 10(-5)
5	60214-1 Cl No. 5.3.3	Auxiliary circuit insulation tests	Should withstand 2KV relative to earth for 1 min
6	Special Test	Gas Tightness Test	Helium based or any other mutually agreed method
7	Special Test	Contact resistance Test	<2 mili ohms
8	Special Test	Physical & Dimensional Checks	As per approved drawing

All the relevant test reports shall be submitted along with the test report of Transformer for HGML approval.

6.3 REMOTE OLTC / COOLER CONTROL PANEL (RTCC PANEL):

The auxiliary devices for remote electrical control of the OLTC and cooler shall be housed in a separate panel to be placed in the control room. The panel shall be made of sheet steel of not less than 3mm and it shall be duly finished with stove enamel paint. The size of the control cubicle to be supplied by the supplier shall be 610 mm depth and 2312 mm height. The width of the cubicle to be as per suppliers practice. The colour of the finishing paint shall be opaline green corresponding to shade No. 275 of IS : 5, for panel exterior.

Control and signal devices required to be mounted in the RTCC Panel shall comprise of the following :

1. Local - Remote selector switch for OLTC.
2. Actuating switch/push button for electrical raise / lower control.
3. Remote tap position indicator with tap nos. and corresponding rated voltage marked on the instrument. The tap position indicators shall be digital type.
4. One potential free contact per tap for tele- transmission of tap position from switchyard and control room to load dispatch center shall be provided.
5. A four position selector switch having master follower, independent and off position.
6. Remote Winding Temperature Indicator and Oil Temperature Indicator.
7. Name plate for each component.
8. Initiating devices and contacts for alarm as well as for indications for discordance in the tap changer in any of the parallel operating transformers
9. Cubicle lamp actuated by door switch, space heater, power sockets etc shall be provided inside RTCC panel.
10. Separate hooter along with indicating lamp shall be provided for annunciation of tap change in progress.
11. I. Annunciator (facia type) scheme complete with accessories for the following:
    i) Tap changer incomplete.

    ii) Tap changer out of step

    iii) Tap changer motor trip.

    iv) Failure of 415V AC supply to the OLTC local control Kiosk.

    v) a) Running Fan failure of each group.

    b) Standby fan failure of each group.

    vi) 415V cooler control supply failure.

vii) 415V OLTC Supply failure.

viii) OLTC control supply fail.

12. Signal lamps for:

i) Fan 'ON' for each fan.

ii) Cooling system on Local manual / local auto

iii) Cooling system on Remote manual/ Remote auto

iv) 415 Volts cooler Supply 'ON',

v) 415V OLTC supply Healthy.

vi) OLTC control supply ' ON '.

vii) OLTC upper limit reached.

viii) OLTC lower limit reached.

ix) a) OLTC in Remote RTCC Mode.

b) OLTC in Remote SCADA Mode.

x) OLTC in Local Mode.

6.04 **Microprocessor based Numerical RTCC Unit for Tap changer Control & Transformer Monitoring**

7.00 **PARALLEL OPERATION OF TRNASFORMERS WITH ONLOAD TAP CHANGERS:**

Besides the local and remote electrical control specified on – load tap changers, when specified, should be suitable for remote electrical parallel control also.

In addition to the methods of control as in Clause 9, Section – A of CBIP Manual, the following additional provision shall be made.

Suitable selector switch be provided, so that any one transformer of the group can at a time be selected as "Master", "Follower" or "Independent.

Necessary interlock blocking independent control when the units are in parallel shall be provided.

The scheme will be such that only one transformer of a group can be selected as "Master". An out-of-step device shall be provided for each transformer which shall be arranged to prevent further tap changing when transformers in a group operating in "Parallel Control" are one tap out-of-step.

8.00 **BUSHING INSULATORS AND TERMINALS:**

8.01 (a) Transformers shall be fitted with bushing insulators,

Clamps and fittings made of steel or malleable iron shall be galvanized. All bolt threads shall be greased before erection.

The bushing flanges shall not be of re-entrant shape which may trap air.

Bushing turrets shall be provided with vent pipes which shall be connected to route any gas collection through the Buchholz relay.

The clearances in air between live conductive parts and live conductive part to earthed structures shall be as follows:

Rated System Voltage KV rms	**Basic insulation level KV rms**	**Clearances**	
		Phase to Phase (mm)	Phase to earth (mm)
11	75	280	140
33	170	350	320
66	325	700	660
110/132	550	1220	1050

NOTE:- 1. These clearances are applicable to the transformers to be installed upto an altitude of 1000m above sea level.

2. For altitudes exceeding 1000m above sea level, the clearance should be increased by 3 percent for every additional 300m.

3. Air clearance of 3500mm between phase to earth can be relaxed to the maximum of 200mm as far as air release pipe emanating from bushing turret is concerned.

(a) The porcelain components shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

Unless otherwise specified, the glaze shall be brown in colour. The glaze shall cover all exposed porcelain parts of the bushings except those areas which are required to be left unglazed.

The design of the bushing shall be such that stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.

Cement if used in the construction of the bushing shall not cause fracture by expansion or loosening by contraction. Cement thickness shall be as small and even as practicable.

All exposed ferrous metal parts shall be hot dip galvanized wherever possible.

Any stress shield shall be considered as an integral part of the bushing assembly. 52KV and above voltage class bushings shall be Oil Impregnated Paper (OIP) type condenser bushings.

No arcing horns shall be provided on the bushings.

Each bushing shall have marked upon it the manufacturer's identification mark.

The duration and rated short time current of the bushing for various voltage ratings shall be as specified.

Limits of temperature rise shall be in accordance with IS: 2099.

Permissible variation in the value of capacitance and maximum value of dielectric dissipation factor (tan delta) of bushing and the test tap on transformer bushings shall be as per IS:2099 and IEC-60137.

Bushings made of solid insulation and those having a filling which does not flow under service conditions shall be suitable for mounting at any angle of inclination. Unless otherwise specified, those having a liquid filling shall be suitable for mounting at any angle of inclination to the vertical, not exceeding 33^0.

The cantilever strength of the bushing shall be in accordance with IEC-60137 and IS:2099 unless otherwise specified.

The profile of the porcelain and spacing of the petticoats shall suit the duty specified. When specified, the petticoats of desired profile and petticoat spacing shall be offered.

The electrical characteristics of the bushings shall be in accordance with IS:2099.

Rated current voltage, Basic Insulation Level: The rated voltage, current and basic insulation levels of the bushings shall be in accordance with IS:2099.

Interchangeability: All the bushings above 52KV voltage rating shall have dimensions as mentioned in Clause 4.3, Section-P of CBIP Manual, to enable interchangeability with different makes of bushings manufactured in conformity with this specification.

The standardized dimensions shall be kept in view by the transformer manufacturers as well, while designing the transformers, so that the transformer can accept any bushing of the parameters and dimensions specified herein.

Other ratings of bushings, not covered in the specification, shall be supplied, if required. The basic insulation level, rated voltage and current and creepage distances for various voltage class bushings shall be as under:

Voltage rating	BIL (KVP)	Current rating (Amps)	Creepage distance (mm)
145	650	800	3625
72.5	325	400	1810
17.5	95	2000	437.5

The minimum value of creepage distance specified is 25mm/KV of the rated voltage.

For areas with very heavy or extremely heavy pollution the minimum creepage distance shall be as specified by the user.

The bushings shall be provided with oil level indicators as under: 245KV and below – Oil sight window.

The oil level indicator shall be so designed and dimensioned that oil level shall be clearly visible from ground level.

(b) Electrical characteristics of bushings shall be as per latest revision of IS: 2099

8.2 The 110KV Bushings shall be as per IS: 12676-1989 & IS 3347-1982 and shall be provided with Universal Bimetallic Connectors suitable for vertical/horizontal take off. The Connectors for HV bushings shall be suitable for ACSR (DRAKE) of overall diameter of 28.14mm.

8.2.1 The 11 KV L.V. bushings shall be provided with connectors as follows:

a) For 16/20 MVA & 12.5 MVA – 2 Nos. of 50 X10 mm copper flat.

b) For 8 & 10 MVA – 2 Nos. of 50 X 6 mm copper flat.

8.3 The neutral bushing stud shall be suitable for connecting 50 x 6 mm Copper Flat/G.I. Flat. Bus bar with 33KV support insulator, 2 Nos. to be provided for 11KV neutral bushing.

Make of HV & LV bushing shall be BHEL/CGL/ABB/Areva /CJI or any other KPTCL approved make.

9.1 **TEMPERATURE CONTROLLERS:**

9.2 The transformer shall be provided with a 150 mm dial type top oil temperature indicator, fitted with maximum reading pointer, resetting device and two sets of electrical contacts. The contacts shall be with mercury switches, electrically independent ungrounded. The accuracy class shall be $\pm$1.0%. Remote oil Temperature Indicator with 4-20 mA DC dual output shall be provided for the purpose of SCADA.

9.3 The transformer shall be provided with two 150 mm dial type Winding Temperature Indicator (HV & LV), fitted with maximum reading pointer, resetting device and three sets of electrical contacts. The contacts shall be with mercury switches, electrically independent ungrounded. The accuracy class shall be $\pm$1.0%.

9.4 The temperature indicators shall be of dial type, (not less than 150 mm dia) and robust pattern.

9.5 The temperature indicator shall be fitted in a tank mounted, weather proof, marshalling box.

9.6 The tripping contacts of winding-temperature indicators shall be adjustable to close between 60^0C and 120^0C and alarm contacts to close between 50^0C and 100^0C and both shall re-open when the temperature has fallen by about 5^0C.

9.7 All contacts shall be adjustable on a scale & shall be accessible for removal of the cover.

9.8 It shall be possible to check the operation of the contacts and associated equipment.

9.9 Connections shall be brought from the device to terminals placed inside the marshalling box.

9.10 Signal Transmitter for each winding: Signal transmitter shall have additional facility to transmit signal for recording winding temperature at Owners data acquisition system, for

which a duplex platinum RTD with nominal resistance of 100 Ohms at zero degree centigrade shall be supplied. The RTD shall be suitable for 3 wire under grounded system. The calibration shall be as per SAMA (USA) standard. The RTD may be placed in the pocket containing temperature sensing element and image coil for WTI system which will be used for both remote WTI and DAS. Necessary equipment for sending the signal to remote WTI and DAS shall be provided in lieu, separate RTD for each of the functions shall be provided.

9.11 Remote winding temperature indicator: It shall be suitable for flush mounting on Owner"s panel. This shall not be repeater dial of local WTI and will operate by signal transmitter.

9.12 Any special cable required for shielding purpose for connection between cooler control cabinet and remote WTI control circuit, shall be in the scope of contractor. Only one R WTI with a point selector switch shall be provided for all the three windings (HV, IV and LV). Auxiliary supply for R WTI, if required, will be 110V-220V DC, 4-20mA DC dual output only. Drawing showing dimensional details of R WTI shall be submitted to the owner within 2 months from the data of award of contract.

10.0 GAS AND OIL ACTUATED RELAYS:

Each transformer shall be fitted with gas and oil actuated relay equipment conforming to IS: 3637 having contacts which close following oil surge or low oil level conditions.

Each gas and oil actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay.

Where specified to allow gas to be collected at ground level, a pipe approximately 5 mm inside diameter shall be connected to the gas release cock of the gas and oil-actuated relay and brought down to a point approximately 1.25Mtr above ground level, where it shall be terminated by a cock.

A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the pipe and the cross level of the relay.

The design of the relay mounting arrangements, the associated pipe work and the cooling plant shall be such that mal-operation of the relays shall not take place under normal service conditions.

The pipe work shall be so arranged that all gas arising from the transformer shall pass into the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, not shall it be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided.

When a transformer is provided with two conservators the gas and oil actuated relays shall be arranged as follows:

If the two conservators are connected to the transformer by a common oil pipe one relay shall be installed in the common pipe.

If the two conservators are piped separately to the transformer two relays shall be installed, one in each pipe connection.

Adequate clearance between oil pipe work and live metal shall be provided.

11.0 TEMPERATURE RISE:

As per Clauses 3.1 of IS: 2026 (Part-II) – 2010, and shall be as per the latest specifications..

12.0 INSULATION LEVELS:

As per IS: 2026 (Part-III) – 2009, Clauses 3.0, 5.0, 7.0 and sub-clauses, and shall be as per the latest specifications. thereof.

13.0 TERMINAL MARKINGS, TAPPINGS AND CONNECTIONS:

As per IS: 2026 (Part-IV) – 1977. However the transformer shall be designed for constant flux voltage as per Clause 3.2 of the said IS.

14.0 INSULATING LIQUIDS:

Uninhibited Mineral insulating oil shall be used and shall comply with IEC-60296-2012 (Latest version).

Bidder shall furnish type test certificate produced by manufacturer complying to IEC-60296-2012 (latest version) from any NABL accredited oil testing laboratories.

Loose oil to be supplied shall be in sealed oil drums with 10% extra quantity over and above that required for the first filling.

15.1 MARSHALLING BOX: AND SHALL BE AS PER THE LATEST SPECIFICATIONS AND REQUIREMENT.

A sheet steel vermin proof, well-ventilated and weatherproof marshalling box of a suitable construction shall be provided for the transformer ancillary apparatus. The box shall have domed or sloping roofs and the interior and exterior painting shall be in accordance with Clause 1.6 of CBIP manual.

The marshalling box, wherever provided shall accommodate the following equipments alternatively weather proof instruments can be mounted outdoor:

(a) 2 Nos. of WTI, one each for HV & LV to be provided and 1 No. of OTI.
(b) Control and protection equipment for the local electrical control of tap changer, if the same cannot be accommodated in the motor driving gear housing.
(c) Control and protection equipment for the cooling plant, and
(d) Terminal boards and gland plates for incoming and outgoing cables (terminal shall be of Nut & stud type of M4 size (CAT m4))

All the above equipment's except (d) shall be mounted on the panels and back of panel wiring shall be used for interconnection.

The temperature indicators shall be so mounted that the dials are not more than 1600 mm from ground level and the door(s) of adequate size.

To prevent internal condensation an approved type of metal-clad heater shall be provided controlled by a suitable switch. Ventilation louvers shall be provided.

All incoming cables shall enter the kiosk from the bottom and the gland plate shall be not less than 450 mm from the base of box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

Un-drilled gland plate shall be provided for accommodating glands for incoming and outgoing cables.

Note:
1) All cable connections shall be taken from bottom only.
2) 1100 V grade, 2.5mm multistranded PVC copper cable shall
be used for

Wiring of control cable and 1100V grade, 4.0 Sq.mm multistranded PVC copper cable shall be used for wiring of power circuit. The following colors code shall be used.

Power Circuit	-	RYB
Earth	-	Green
Control circuit	-	Black
DC Circuit	-	Grey

SECTION –III

COMPONENTS OF THE TRANSFORMER- AND SHALL BE AS PER THE LATEST SPECIFICATIONS.

The transformer shall generally comprise of the following components/parts.

1) HV line bushing.

2) LV line bushing.
3)
4) LV neutral bushing.

5) Bi-metallic terminal connectors for HV.

6) Bi-metallic Terminal Connectors for LV.

7) Terminal connector for neutral suitable for connecting Copper/G.I. flats.

8) Monogram Plate.

9) Main Conservator with compartment of OLTC as per design with Sump, Drain Valve lifts. Separate conservator for OLTC optional as per design.

10) Oil filling hole with bolted cover for main conservator.

11) 150 mm Dial Magnetic oil level gauge with low level alarm contact.

12) 150 mm Dial winding temperature indicator with alarm trip contacts and maximum reading pointer.

13) 150 mm Dial oil temperature indicator with alarm and trip contacts and maximum reading pointer.

14) Surge Protection Relay with one set of contact and one isolating valve on conservator side for OLTC.

15) Pressure relief device with one set of contact for 110KV and 66KV Transformers. Explosion Vent for 33KV class Transformers with equalizer pipe.

16) Buchholz Relay with alarm and trip contacts and two wheel type isolating valves (50 mm size) with directions of mounting marked on Buchholz relay.

17) De-hydrating Silicagel with oil seal and glass inspection window.

18) Prismatic oil level gauge.

19) Thermometer pocket.

20) Air release plugs on main tank and Bushing turrets.

21) Inspection cover lifting lug.

22) Inspection covers on main tank and side manholes for OLTC conservator.

23) WTI CT Test link box with access window for Transformer of above 5 MVA capacity.

24) Bath for oil temperature indicator with probe for capillary tubing.

25) Bath for winding temperature indicator with probe for capillary tubing.

26) Marshalling box with PVC copper cable wiring 660/1100 grade (Tank mounted weather proof) along with required control cables for connection to Buchholz relay, temperature indicator etc.,

27) ON-LOAD Tap changer with operation counter and Single Phase Preventer if OLTC is of 3-phase 440 V design.

28) Radiator with top and bottom Shut off valve, Lifting lug, Air release and Drain plug.

29) Combined Rating and Diagram Plate and valve schedule line diagram. The rating plate shall be minimum 1 mm thick anodised cadmium steel plate and it should contain wiring diagram of OLTAC also. The additional particulars to be engraved on the Rating plate apart from that specified in IS will be intimated at the time of approval of drawings.

30) Lifting Bollards.

31) Jacking pads 500 mm above the base with adequate pad area.

32) Haulage eyes.

33) Earthing pads suitable to receive plate with M12 tapped holes to suit 4 bolted connections.

34) Earth connection between tank and cover.

35) Drain valve with locking arrangement and blanking plate.

36) Top filter valve (size 50 mm) with blanking plate with 38 mm adopter with locking arrangement.

37) Bottom filter valve (size 50 mm) with blanking plate with 38 mm adopter with locking arrangement.

38) Middle sampling valve (size 15mm) with plugs.

39) Bottom sampling valve (size 15mm) with plugs.

40) Piping arrangement from top and middle valve to the level of the bottom filter valve.

41) Under base – skid type.

42) Bi-directional rollers to suit 1676 mm track with locking arrangements.

43) Top stay bracket for supporting the conservator.

44) Main & Stand By Fans for cooling with fan control cubicle (for 20MVA & above).

45) Provision for connecting Nitrogen Injection Fire Protection System (for 20MVA & Above).

46) Remote OLTC control panel with 2312 height and 610 mm depth with single phase preventor protection for driving mechanism motor and AC voltmeter of adequate rating (for 110KV Transformers)

47) G.I./Copper Bar (2 nos. of Flats) of adequate rating from neutral bushing mounted on insulators to a convenient point near base plate for neutral earth connection with terminal connection.

48) Pressure relief device for external mounted OLTC in case of 110KV class Transformers, as per applicable specification requirenment.

49) Details of bushing:

Sl. No.	MVA	Voltage Category	Rated voltage (KV)/Current (Amps)	
			HV side	LV side
1	10	110/33-11KV	145/400	36/2000*
2	16/20	110/33-11KV	145/400	36/2000(33KV)

50) Detachable ladder/climbing device.

51) RTCC unit for Tap Changer Control.

Note: The accessories required with the transformer shall be SCADA compatible. Potential free contacts for Bucholtz relay, PRV,OSR, OTI, WTI, etc. need to provided. Further for OTI, WTI, TPI, etc. dual output of 4-20mA shall be provided.

SECTION – IV- AND SHALL BE AS PER THE LATEST SPECIFICATIONS.
NOTE- THE CONTRACTOR NEED TO UNDERSTAND THE PARAMETERS OF 10 MVA, PROPOSE ALONG WITH THE KPTCL NORMS FOR APPLICATION.

Technical particulars of Power Transformers covered in this specification are as under:

Sl.	**Particulars**	**110KV Class**
		10-20MVA 10MVA
1.	Type	Outdoor three phase
2.	System frequency	50Hz.
3.	Voltage rating	11KV-110KV
4.	Standard rating HV (in MVA) LV (in MVA)	10MVA 10MVA
5.	Percentage impedance at normal Tap%	
6.	Type of Cooling	ONAF
7.	Winding connection a) HV b) LV	Delta Star
8.	Vector group	YNd1
9.	On Load Taps a) Plus b) Minus c)	5 on HV 15 on HV Taps to be provided on HV
10.	Type of insulation: a) HV b) LV	Fully insulated Fully insulated
11.	Standard losses: a) No load loss in KW b) Load losses in KW	18 8 54 42
12.	Insulation level in KV Nominal system voltage (NSV) Highest system voltage (HSV) Power frequency withstand voltage Lightning Impulse withstand voltage	110KV 33KV 11KV 123KV 36KV 12KV 230KV 70KV 28KV 550KVp 170KVp 75KV(Peak)
13.	Temperature rise	As per IS 2026 Part II 2010

NOTE – 1:

I. HV: High Voltage.
LV : Low voltage

2. Regulation of Transformers: Each tap shall be designed for the full rated MVA without exceeding the temperature and shall withstand continuously 15% voltage above the rated voltage of the tap.

3. Frequency:- the transformer shall be suitable for continuous operation with a frequency variation of ±5% from normal of 50Hz without exceeding the specified temperature rise.
4. Impedance: Supplier shall indicate the guaranteed impedance and tolerance and also the upper and lower limit of impedance which can be offered without any increase in the quoted price. Impedance shall include positive and zero sequence and shall be expressed in terms of the branches of the star connected equivalent diagram, all on the same MVA basis and the range shall be given for each branch of the equivalent circuit in turn, as per the latest specifications and IS.
5. Separate tap winding to be provided on the HV delta winding running all along the length. Suitable OLTC with higher insulation shall be provided at the line end of HV delta winding of transformer.

SECTION - V

OTHER TERMS AND CONDITIONS

1.0 SPARES:

A complete set of spares required for 5 years trouble free maintenance shall be quoted by the supplier. And the propritory spare or parts/ equipments and equivvalents have to be clearly specified.

2.1 TENDER DRAWINGS AND LITERATURES:

Duplicate copies of following drawings and literatures shall be submitted along with tender:

a) GA drawing showing dimensional details.
b) Front and rear views of transformer with instrument and device position marked.
c) Photographs of similar transformer supplied by the manufacturer.
d) Illustrative descriptive literature and General Technical Data.
e) Performance report given by the user/ client.

3.1 CONTRACT DRAWINGS:

Supplier within four weeks of placement of order shall submit drawings in quadruplicate for the approval of the purchaser prior to manufacture in A3/A4 size only. After the drawings are approved SIX copies of drawings shall be supplied for immediate use. The drawings shall be in accordence with the site specific condition.

The supplier shall forward the drawings and literature as follows:

a) ONE set of reproducible original and 4sets+1soft copies of all approved drawings along with 4 sets of literature, commissioning and maintenance manuals to the office of the DGM (Engg), HGML, HUTTI.

b) The following drawings are to be submitted for approval.

i). Foundation drawings indicating the details of foundation plan cross-section suitable for Normal Dry Soil (Soil Test Report to be included) taking SBC as 10 Tons/sq.mt.
ii). Outline dimensional drawings of transformers and accessories.
iii).Assembly drawings and weight of main component parts.
iv).Shipping drawings showing dimensions and weights of each package.
v). Schematic control and wiring diagram for all auxiliary equipment's.
vi).Bushing assembly, plan, elevation, sectional view and details of joints, seals etc.,
vii).Radiator assembly: Sectional View of radiator.

viii). Interconnection diagram between Marshalling box and OLTC, Power Transformer and other associated equipment's.

ix). Dimensional drawings showing cooling passage in transformer core and windings.

x). Individual internal wiring diagram of all devices and elementary wiring diagram of relays for internal wiring.

xi). Electrical connections of windings, number of taps, tapping switchgear terminal vector group polarity etc.

xii). Control circuits and wiring diagrams, schematic circuit diagrams for cooler control, paralleling interlock, wiring diagrams of control cabinets, signaling and indicating devices, block diagram showing inter connection control cable schedule to enable the purchaser to prepare the schedule of control cables etc.

xiii). Assembly of core and coils: Details of winding connection, insulation spacers, barriers clearances, core bolt insulation, etc., which will help the purchaser to replace as set of winding in any future eventuality. The component parts shall be suitably numbered and parts shipped shall have similarly numbered tags.

xiv). Construction details of the switches, terminal blocks and test blocks etc.,

xv). Diagram and rating plates as per details in the specification, temperature rise oil and winding high voltage test figures, etc.,

xvi). Assembly of OLTC gear mechanism: Full details of the main parts, limits and fits wearing parts, timing gear adjustments, etc.

xvii). Detailed assembly drawing to enable the purchaser to do the core and coil assembly. Parts shall be identified by separate numbers.

xviii). Schematic drawings showing the details of interconnection and other details of OLTC, DM, MB and RTCC.

Along with the drawings, followings documents are also to be submitted for approval.

i). Guaranteed Technical Particulars.

ii). Type Test Certificates

3.2 FACTORY TESTS

1.2.1 Routine Tests

All standard routine tests in accordance with IS: 2026 Part I: 2011 as per the standard procedures and approved components and methods shall be carried out on transformer.

a) Measurement of winding resistance.
b) Measurement of voltage ratio and check of phase displacement.
c) Measurement of Short-circuit impedance and load loss.
d) Measurement of no-load loss and current.
e) Dielectric routine tests IS 2026 (Part 3): and
f) Tests on on-load tap-changers, where appropriate.
g) Measurement of insulation resistance to earth of windings, and/or measurement of dissipation factor (tan δ) of the insulation system capacitances.

1.2.2 Following additional routine tests shall also be carried out on transformer:

a) Magnetic Circuit Test
   After assembly each core shall be tested for 1 minute at 2000 Volts between all bolts, side plates and structural steel work.
b) Oil leakage test on transformer tank as per Clause 3.2.8.1 below.
c) Magnetic balance test
d) Measurement of no-load current with 415V, 50 Hz ac supply on LV side.
e) Frequency response analysis (FRA)

f) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

1.2.3 Type Tests

Bidder shall furnish the type test certificate from the manufacturer of similar voltage class and rating with respect to following type tests

1.2.3.1 Temp. Rise Test as per IS:2026 (Part-II)
Gas chromatographic analysis on oil shall also be conducted before and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 567. For the evaluation of the gas analysis in temperature rise test the procedure shall be as per IS:9434 (based on IEC:567) and results will be interpreted as per IS:10593 (based on IEC -599).

The temperature rise test shall be conducted at a tap for the worst combination of loading on the three windings of the transformer. The Contractor before carrying out such test shall submit detailed calculations showing alternatives possible, on various taps and for the three types of ratings of the transformer and shall recommend the combination that results in highest temperature rise for the test.

1.2.3.2 Tank vacuum Test as per Cl.no.3.2.8.2(i) below.

1.2.3.3 Tank pressure Test as per Cl.no.3.2.8.2(ii) below.

1.2.3.4 Deleted

1.2.3.5 Dielectric test in all phases as per IS: 2026 Part III:2009

1.2.4 Additional type tests

Following additional type tests to be furnished.

1.2.4.1 Determination of Capacitances windings–to–earth, and between windings.

1.2.4.2 Measurement of zero Seq. Impedance(s) on 3-phase transformer.

1.2.4.3 Determination of sound level.

1.2.4.4 Measurement of power taken by fans and oil pump motors.

1.2.4.5 Measurement of harmonics of the no load current.

1.2.5 Dynamic short circuit withstand test shall be carried out as per IEC 60076-5/ IS 2026-5.

Tests shall be conducted before and after short circuit test as per the relevant clauses of IEC 60076-5/ IS 2026-5

Following shall also be conducted before and after Short Circuit test

i) Dissolved gas analysis
ii) Frequency response analysis.

1.2.6 Routine tests on bushings

The following tests shall be conducted on bushings

1.2.6.1 Test for leakage on internal fillings.

1.2.6.2 Measurement of creepage distance, dielectric dissipation factor and capacitance.

1.2.6.3 Dry power frequency test on terminal and tapping.

1.2.6.4 Partial discharge test followed by dielectric dissipation factor and capacitance measurement.

1.2.7 Type Tests on fittings:

All the following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with the drawings of equipment/ fittings as per the clause no. 9.2 of the Section – GTR. The list of fittings and the type test requirement is:

1. Bushing (Type Test as per IS: 2099/ IEC: 60137)
2. Buchholz relay (Type Test as per IS: 3637 and IP-55 Test on terminal box)
3. OLTC (Temperature Rise of contact, Short circuit current test, Mechanical test and Dielectric Test as per IEC: 214-1 2003 and IP-55 test on drive mechanism box)
4. Cooler Control cabinet (IP-55 test)
5. Pressure Relief device Tests certificate shall be furnished with respect to ; -The pressure Relief Device of each size for increase in oil pressure.The terminal box / boxes of PRD should conform to degree of protection as per IP-55 of IS: 13947.

6. Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.
7. OTI & WTI – Switch setting & operation, Switch differential, Switch rating.
8. Oil pump – Vacuum Test at 250 torr maximum, oil pressure test at 1 kg/cm2 for 24 hrs., Temperature rise test by resistance method, IP-55 degree of protection for terminal box.
9. Cooling fan and motor assembly – Free air delivery, Temperature rise, sound level, running at reduced voltage, IP-55 degree of protection for terminal box.

1.2.8 Tank Tests

1.2.8.1 Routine Tests

Oil Leakage Test

All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air or oil of a viscosity not greater than that of insulating oil conforming to IS:335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/Sq.m (5 psi) measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour for air during which time no leak shall occur.

1.2.8.2 Type Tests certificates for-

(i) Vacuum Test

One transformer tank of each size shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/Sq.m absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below:

Horizontal Length deflection of flat plate (in mm)	Permanent (in mm)
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

(ii) Pressure Test

One transformer tank of each size, its radiator, conservator vessel and other fittings together or separately shall be subjected to a pressure corresponding to twice the

normal head of oil or to the normal pressure plus 35 KN/m2 whichever is lower measured at the base of the tank and maintained for eight hours. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

1.2.9 Pre-Shipment Checks certificates at Manufacturer's Works.

1.2.9.1 Check for interchangeability of components of similar transformers for mounting dimensions.

1.2.9.2 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

1.2.9.3 Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.

1.2.9.4 Gas tightness test to confirm tightness.

1.2.9.5 Derivation of leakage rate and ensure the adequate reserve gas capacity.

1.3 Inspection and Testing at Site

The Contractor shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material stage upto commissioning stage. An indicative programme of inspection as envisaged by the HGML and approved.

1.3.1 Receipt and Storage Checks as per the standards , established and approved.

1.3.1.1 Check and record condition of each package, visible parts of the transformer etc. for any damage.

1.3.1.2 Check and record the gas pressure in the transformer tank as well as in the gas cylinder.

1.3.1.3 Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.

1.3.1.4 Check and record reading of impact recorder at receipt and verify the allowable limits as per manufacturer's recommendations.

1.3.2 Installation Checks

1.3.2.1 Inspection and performance testing of accessories like tap changers, cooling fans, oil pumps etc.

1.3.2.2 (i) Check the direction of rotation of fans and pumps.
(ii) Check the bearing lubrication.

1.3.2.3 Check whole assembly for tightness, general appearance etc.

1.3.2.4 Oil leakage test

1.3.2.5 Capacitance and tan delta measurement of bushing before fixing/connecting to the winding, contractor shall furnish these values for site reference.

1.3.2.6 Leakage test on bushing before erection.

1.3.2.7 Measure and record the dew point of nitrogen in the main tank before assembly.

1.3.3 Commissioning Checks

1.3.3.1 Check the colour of silicagel in silicagel breather.

1.3.3.2 Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.

1.3.3.3 Check the bushing for conformity of connection to the lines etc,

1.3.3.4 Check for correct operation of all protection devices and alarms :

1.3.3.5 Buchholz relay.

1.3.3.6 Excessive winding temperature.

1.3.3.7 Excessive oil temperature.

1.3.3.8 Low oil flow.

1.3.3.9 Low oil level indication.

1.3.3.10 Fan and pump failure protection.

1.3.3.11 Check for the adequate protection on the electric circuit supplying the accessories.

1.3.3.12 Check resistance of all windings on all steps of the tap changer. Insulation resistance measurement for the following:

1.3.3.13 Control wiring.

1.3.3.14 Cooling system motor and control.

1.3.3.15 Main windings.

1.3.3.16 Tap changer motor and control.

1.3.3.17 Check for cleanliness of the transformer and the surroundings.

1.3.3.18 Continuously observe the transformer operation at no load for 24 hours.

1.3.3.19 Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

1.3.3.20 Phase out and vector group test.

1.3.3.21 Ratio test on all taps.

1.3.3.22 Magnetising current test.

1.3.3.23 Capacitance and Tan delta measurement of winding and bushing.

1.3.3.24 DGA of oil just before commissioning and after 24 hours energisation at site.

1.3.3.25 Frequency response analysis (FRA).

1.3.3.26 Contractor shall prepare a comprehensive commissioning report including all commissioning test results and forward to Employer for future record. Technical Parameters.

4.1 PACKING :

The supplier shall provide such packing of goods as is required to prevent damage or deterioration during transport to their final destination. The packing shall be sufficient to withstand, without limitation, rough handling during transport and exposure to extreme temperature and open storage. The packing case, size, weights shall be taken into consideration, where appropriate the remoteness of goods final destination and the absence of mechanized heavy handling facilities at all points in transport. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

5.1 DEVIATION FROM TECHNICAL SPECIFICATION:

The tenderer shall furnish the details of deviations / modifications proposed by him to improve overall performance of the system. The contractor shall have to provide the technical details, drawings, advantages,

Note- The prior approval shall have to obtained from the HGML for any deviation, keeping the no variation in the price

6.1 ERECTION & COMMISSIONING:

The tenderer shall note that their commissioning Engineers have to be deputed for erection and commissioning of transformers in case orders are finalized on them. This has to be taken note of while furnishing the offers.

Note- there shall be a programme earmarked with specific and all activities of the erecting & commissioning of the transformers with consultation of HGML.

7.1 GUARANTEED TECHNICAL PARTICULARS:

The tenderer shall furnish the relevant Guaranteed technical particulars as per Data Sheet-6.

7.2 INSTALLATION & COMMISSIONING

Mainly following activities are required to be carried out before commissioning of Power Transformers:-

a) Assembling of Power Transformer accessories.

b) Testing activities in presence of Purchaser such as

i. Ratio Test
ii. Megger Value
iii. Magnetic balance.
iv. Oil BDV
v. Earth Resistance
vi. Buchhloz Relay checking.
vii. WTI/OTI/MOLG (oil level) checking.
viii. Checking of points of leakage of oil from Transformer body/ Radiator/Valve
ix. Setting of Relays in Panel

7.3 AUXILIARY TRANSFORMER

The transformer used for auxiliary distribution within the plant must be in accordance with the reference standards. The ratings of the transformer shall be suitably designed by the bidder. The guaranteed technical particulars of the auxiliary transformer must be supplied along with the bid. The bidder shall also provide the list of auxiliary loads considered for the project.

7.4 INSTRUMENT TRANSFORMER

7.4.1 The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshalling box for a set of three single phase units. The tank as well as top metallic shall be hot dip galvanized or painted Grey colour as per RAL 9002.

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

7.4.3 Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block. The insulators shall have cantilever strength of more than 500 kg.

7.4.4 Current Transformer, Voltage Transformer, Circuit Breaker and Relays should match STU requirements.

7.5 CURRENT TRANSFORMER

7.5.1 Current transformers may be either of the bushing type or wound type. The bushing types are normally accommodated within the transformer bushings and the wound types are invariably separately mounted. The location of the current transformer with respect to associated circuit breaker has an important bearing upon the protection scheme as well as layout of, substation. Current transformer class and ratio is determined by electrical protection, metering consideration.

7.5.2 Technical specifications – Current ratings, design, Temperature rise and testing etc. should be in accordance with IS: 2705 (part I to IV).

7.6 TYPE AND RATING

7.6.1 The current transformer should be of indoor/ outdoor type, single phase, oil immersed, self-cooled and suitable for operation in 3 phase solidly grounded system.

7.7 VOLTAGE TRANSFORMER

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

7.7.2 The secondary shall be protected by 3A HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings. The secondary terminals shall be terminated on stud type non- disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP 55. The access to secondary

terminals shall be without the danger of access to high voltage circuit.

7.7.3 The accuracy of metering core shall be maintained through the entire burden range up to 75 VA on all three windings without any adjustments during operations.

7.7.4 The PTs should be single phase oil immersed self -cooled type suitable for outdoor.

7.7.5 The core should be of high grade non – ageing electrical silicon laminated steel of high permeability. The PTs should be hermetically sealed to eliminate breathing and prevent air and moisture entering the tank.

7.8 110 KV METERING BAY (STU) AS PER THE LATEST SPECIFICATIONS, STANDARDS AND KPTCL NORMS..

7.8.1 The current & potential transformers shall be of outdoor type single phase, 50 Hz, oil immersed self-cooled suitable for operation in the climate conditions specified shall be complete in all respects.

7.8.2 The instrument transformers shall be hermitically sealed to eliminate breathing and entering of air and moisture in the tank. Provision of pressure releasing device is not permitted.

7.8.3 The CT core, to be used for protective relays shall be of accuracy class, specified or appropriate class suitable for back up, over current and earth fault, differential, bus bar and other protections as prescribed.

7.8.4 Applicable Standards:

Unless otherwise modified in this specification, 110 KV CTPT Metering Sets shall comply with the following Indian Standard Specification (latest version):

IS: 2705-1992	Specification for current transformers.
IS: 3156-1992	Specification for voltage transformers.
IS: 5621-1980	Specification for Hollow insulators and accessories
IS: 2099-1986	Specification for insulators/ bushing
IS: 3347-1986	Specification for the dimension of Porcelain transformer IS:
335-1983	Specification for new insulating oil

7.8.5 The core of instrument transformers to be used for metering and instrumentations shall have saturation factor, low enough to avoid damage to the instruments, in the event of maximum short circuit current.

7.8.6 Nuts and bolts (or screws used for fixation of interfacing porcelain bushings for taking out terminals) shall be provided on flanges, cemented to the bushing and not on the porcelain i.e. Flange type 110 KV bushing for CT/PT, shall be provided.

7.8.7 For gasket joints, wherever used, Nitrile Butyl rubber gaskets shall be used. The gasket shall be fitted properly with adequate space for accommodating the gasket under compression.

7.8.8 The metering sets shall be supplied with first filling of insulating oil conforming to IS: 335 (including latest amendment).

7.8.9 The outer surface of metal tank shall be Hot Dip Galvanised, whereas, the inner portion shall be painted with oil resistive, insoluble paint. The purchaser reserves right for stage inspection during manufacturing process of tank / CT/PT.

7.8.10 The external surfaces of tanks of CT-PT sets shall be painted with one coat of primer and two coats of synthetic enamel paint of shade No.631 of IS: 5, the internal surfaces of the tank shall be painted with two coats of suitable heat resistant oil insoluble paint.

7.8.11 The instrument transformers shall be suitable for mounting on steel structures or concrete pedestals.

7.8.12 The 110 kV CT PT sets shall three nos. of single phase PTs. The primary winding of 3 single phase PT shall be connected in star formation in the tank with common neutral of 110 KV brought outside the tank through 3 KV bushing for earthing.

7.8.13 The secondary terminal box shall have cable gland/ flange suitable to receive two Nos. control cable of size 6x4 sq.mm and 4x2.5 sq.mm at the bottom of the secondary box for metering connections to secondary winding of 110 kV CT-PT circuits respectively.

7.8.14 The 110 kV CT PT Set shall have 3 Nos. incoming and 3 Nos. outgoing outdoor type bushing complete with 6 Nos. bimetallic terminal connectors suitable for Dog/ Panther Conductor

7.8.15 General Parameters: **110 kV CT (Owners Bay and Metering Bay)as per the latest standards and specifications as applicable.**

Particulars	**Details**
Normal system voltage (kV rms)	110 kV
Highest system voltage (kV rms)	122 kV
Frequency	50 Hz
Impulse withstand voltage (kVp) (on assembled CT/ PT set)	170
One minute power frequency dry withstand voltage (on assembled CT-PT set) Primary (r.m.s.) Secondary (r.m.s.)	70 kV 3 kV

Particulars	**Details**
Transformation ratio (CT Ratio)	400/1 A or as per requirement
Rated output (VA burden)	10 VA
Class of accuracy	0.2 S
Rated continuous thermal current	1.2 times of rated primary current.
Short time thermal current rating for 1second.	25kA for 400/1 A Current density corresponding to Short Time Thermal Current should not exceed 160A /mm sq.
Rated dynamic current	2.5 times of short time thermal current rating.
Number of cores	One
Instrument security factor	Not exceeding 5
Max. ratio error	As per IS:2/05/1992

7.8.16 General Parameters: **110 kV VT (Owner's Bay & Metering Bay)**

Particulars	**Details**
Nominal system voltage (kV rms)	110
Highest system voltage (kV rms)	122
Nos. of phases	Three
Impulse withstand voltage (kVP)(on assembled CT-PT set)	170
One minute power frequency dry withstand voltage (on assembled CT-PT set) Primary (kV r.m.s.) Dry secondary (kV r.m.s.)	 70 3
Frequency	50 Hz
Transformation ratio (PT Ratio)	110 kV/ 110V

Particulars	**Details**
Rated output (VA burden)	30 VA per phase
Class of accuracy	0.2 (As per IS:3156/1992)
Winding connection	Star/ Star
Rated voltage factor and time	1.2 Continuous & 1.9 for 30 seconds.
Temp. rise over max. Ambient temp.	Within limits of IS:3156/1992
Phase angle error max.	-do-
Max. Phase angle error	-do-
Ratio error (Max.)	-do-

7.9 CIRCUIT BREAKER AS PER LATEST SPECIFICATIONS, APPLICABLE STANDARDS AND KPTCL NORMS.

7.9.1 The circuit breakers shall be capable of rapid and smooth interruption of currents under all conditions completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small currents or leading or lagging reactive currents. The circuit breakers shall be 'Restrike-Free' under all operating conditions. The details of any device incorporated to limit or control the rate of rise of re-striking voltage across, the circuit breaker contacts shall be stated. The over voltage across, the circuit breaker contacts shall be stated. The over voltage caused by circuit breaker while switching inductive or capacitive loads shall not exceed 2.5 times the highest phase to neutral voltage. The actual make and break times for the circuit breakers throughout the ranges of their operating duties shall be stated in the offer and guaranteed

7.9.2 Applicable Standards: The materials shall conform in all respects to the relevant Indian Standard Specifications/ IEC Standards, with latest amendments indicated below:

IS-13118/1991	General requirements for Circuit breakers for voltage above 1000 V IEC 62271-100-1/2001
IS-2705/1992	Current Transformers
IS-2099/1986	Bushings for alternating voltages above 1000 V

ISS-2633/1964	Methods of testing uniformity of coating of zinc coated articles
IS-3231/1986	Electrical relays for power system protection
IS-1248/1983	Specification for Ammeters & Voltmeters
IS-335/1983	New insulating oils Electrical IEC 71 (For oils in CTs) Clearances
IS-2147/1962	Degree of protection provided by enclosures for low voltage switchgear & control gear

7.9.3 The arc quenching chambers shall have devices to ensure almost uniform distribution of voltage across the interrupters.

7.9.4 Appropriate & adequate Capacity 415V AC indoor air Circuit Breaker as per the IEC 60898 / IEC 62271 – 100 or equivalent Indian Standards along with control circuit and protection relay circuit, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

7.9.5 Circuit breaker shall be C2/MI class under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 6 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.

7.9.6 The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 110 kV transformers. It shall also be capable of breaking line charging currents as per IEC- 62271-100 with a voltage factor of 1.4.

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

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

7.9.9 Bidder shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.

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

7.9.11 The critical current which gives the longest arc duration at lock out pressure of

7.9.12 All the duty requirements specified above shall be provided with the support of adequate test reports.

7.10 OPERATING MECHANISM

7.10.1 Circuit shall be vacuum type with electrically spring charged mechanism.

7.10.2 The operating mechanism shall be anti-pumping and trip free (as per IEC definition) electrically under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the leakage of operating media and / or gas. The circuit breaker shall be able to perform the duty cycle without any interruption.

7.10.3 Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. 'Local / remote' selector switch and close & trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided. The VCB coil DC supply through appropriately rated battery bank and charger to be supplied by the Bidder.

7.10.4 Operating mechanism and all accessories shall be in local control cabinet. A central control cabinet for the three poles of the breaker shall be provided along with supply of necessary tubing, cables, etc.

7.10.5 Mounting and supporting structure for Circuit Breaker: The circuit breakers should be self-supporting type. However, if necessary for the purpose of minimum ground clearance the circuit breakers should be mounted on raised steel structures which should be included in the scope of supply of circuit breaker. Following information and data for design of foundations from the supplier of the circuit breaker be obtained.

7.10.6 Max. Impact loading in terms of equivalent static load both compression and upward due to opening/closing of the breakers. It shall be clearly stated whether these forces shall act simultaneously or at different timing.

7.10.7 Necessary connecting materials such as clamps, bolts, nuts, washers etc. and fixing bolts for mounting the equipment on the supporting structures wherever required should be

obtained from the circuit breaker supplier.

7.10.8 General parameters: SF6 **Circuit Breaker**: as per KPTCL Norms.

Particulars	**Details**
Type of circuit breaker	SF6
Highest System Voltage	122 Kv
Rated operating voltage	110 Kv
Rated frequency	50 Hz (+3% to -5%)
Number of poles	Three (3)
Rated/ minimum power frequency Withstand Voltage	70 kV
Rated lightning impulse Withstand voltage	170 kV
Rated operating duty cycle	0 - 0.3 sec. - CO – 3 min. – CO
Rated line charging breaking	As per IEC
Reclosing	Single and three phase high speed auto reclosing
Maximum fault level	25 kA (rms) for 1 sec.
Auxiliary contacts	As required plus 6NO and 6NC contacts per pole as spare.
Noise level	Maximum 140dB at 50m distance from base of circuit breaker
Seismic acceleration	0.4 g horizontal

7.10.9 Co-ordination of rated voltages, short circuit breaking current and rated normal current for guidance as per IS 13118 for rated voltage 110 kV and above as commonly used are as given in bellow table.

Rated voltage (kV)	**Rated short-circuit breaking current (kA)**	**Rated normal current (A)**

Rated voltage (kV)	**Rated short-circuit breaking current (kA)**	**Rated normal current (A)**				
122	8	630	1250	1600	2500	4000
	16	630	1250	1600		
	40					

7.10.10 Circuit Breaker Protection against

a) Over Current
b) Earth fault
c) Under voltage & over voltage protection
d) Under frequency & over frequency
e) SF6 gas pressure low (where applicable)
f) DC supply failure

7.11 ISOLATORS

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

7.11.2 Each isolating switch should have the following particulars under the site conditions for the system under design (typical values for 122 kV system are given).

7.11.3 General Parameters: 110 kV Isolators

Particulars	**Details**
Operating mechanism of Isolator and Earth Switch	Motor operated
Nominal system voltage	110 kV
Highest system voltage	122 kV
Type	Outdoor (IP 65)
Rated short time current of isolator and earth switch	40 kA (rms) for 1 sec. Or appropriate as per design

Particulars	Details
Rated dynamic short time withstand current of isolator and earth switch	80 kA (peak) Or appropriate as per design
Impulse withstand voltage with 1.2/50 micro sec. wave	325 kVp to earth 195 kVp across isolating distance
One minute power frequency withstand Voltage	140 kV (rms) to earth & 150 kV (rms)across isolating distance
Temperature rise	As per Table-IV of IS: 9921
Rated mechanical terminal load	As per 62271-102

7.12 INDICATING AND INTEGRATING METERS/INSTRUMENTS:

All indicating instruments shall be of switchboard type, back connected, suitable for flush mounting and provided with dust and vermin proof cases for tropical use and finished in suitable colour. All instruments shall have practical laboratory means for adjustment of accuracy. The limits of errors for ammeters/voltmeters shall be those permissible for class 0.5 instruments as per IS: 1248.

7.12.1 A.C. Static HT Tri vector Meter:

A.C. Static HT Tri vector Meter shall be as per STU norms and shall be intimated while placement of order. The meters shall be located at eye level to facilitate observations of readings correctly.

7.12.2 The ammeters and voltmeters shall be suitably scaled to indicate the current/voltage for all the rating of current/voltage transformers. A phase selector switch with four/six position shall be used to measure the current/voltage of each phase/line. The Bidder shall provide test certificate and calibration certificate along with the supply of the instrument.

7.12.3 The meters shall be located at normal eye level to facilitate observation of readings correctly.

7.13 SURGE ARRESTORS

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

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

7.13.3 Arrestors shall be complete with insulating base for mounting on structure. Suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit with necessary connection.

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

7.14 PROTECTIVE RELAYS

7.14.1 The Solar PV system and the associated power evacuation system interconnections should be protected as per IEC 61727 Ed.2, norms. Over current relays, reverse power relays, differential protection relays and earth fault relays have to be essentially provided. All relay should be numerical type & should be remote operating and controlling facility from the control room.

7.14.2 The numerical relays shall have RS 485 port for communication.

7.14.3 The operating voltage of the relays shall be 110 V DC as per battery bank rating.

7.14.4 Detailed Design calculations shall be provided on fault power computations and the philosophy of protective relaying with respect to short circuit kA calculations. Design, drawing and model of protection relay shall be approved by Owner/STU.

7.14.5 The bidder must submit the relay setting chart as a part of design documents

7.15 EARTHING FOR PV ARRAY

7.15.1 The photovoltaic modules, BOS and other components of power plant requires adequate earthing for protecting against any serious faults as guided by IEC 60364.

7.15.2 The earthing system shall be designed with consideration of the earth resistivity of the project area. The earth resistivity values shall be measured prior to designing the earthing system. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, CEA 2010/, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed.

7.15.3 The permissible system fault power level at 110 kV also shall be kept in consideration while designing the earthing system. Each array structure of the PV yard, LT power system, earthing grid for switchyard ,all electrical equipment ,control room ,PCU, All junction boxes, ACDB& DCDB ,all motors and pumps etc .shall be grounded properly as per IS

3043 - 1987. All metal casing / shielding of the plant shall be thoroughly grounded in accordance with Indian electricity act / IE Rules.

7.15.4 The earthing for array and LT power system shall be made of 3.0 m long 40 mm diameter perforated GI pipe / chemical compound filled, double walled earthing electrodes including accessories, and providing masonry enclosure

7.15.5 with cast iron cover plate having pad-locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS: 3043.

7.15.6 Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

7.15.7 Each string/ array and MMS of the plant shall be grounded properly.

7.15.8 For each earth pit, a necessary test point shall be provided.

7.15.9 Earthing Mesh is to prepared and installed in entire power plant.

7.15.10 The array structures are to be connected to earth pits as per IS standards. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

7.15.11 The complete earthing system shall be mechanically & electrically connected to provide independent return to earth.

7.15.12 In compliance to Rule 11 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode.

7.15.13 The Bidder should submit the earthing system design calculations along with the system layout for Owner approval. Prior to the installation of the system

7.15.14 Unless otherwise specified, the earthing system primary and secondary grid conductors, equipment connections shall be constructed with galvanized iron flat. However the earthing of transformer neutrals, plc and inverter terminals and electronic earthing shall be provided using copper earthing conductor only.

7.16 ISOLATOR AND ISOLATOR-CUM-EARTHING SWITCHES

7.16.1 The Isolators and Isolator-cum-Earthing Switched shall comply with the requirements of the IS: 9921 and IEC: 129 (latest edition) except specified herein. The Insulators shall comply with the requirements of IS: 2544 and IEC: 168-1988 (latest edition).

7.16.2 The Isolators shall be double break, outdoor, gang operated type, with blades rotating in

horizontal plane. The design shall be for upright mounting. If required, and the Isolators shall be convertible for right or left hand control with minimum labour and replacement of part. The live parts shall be so designed that as far as possible, sharp points, edges and other corona producing surface are eliminated. Except the Insulator caps and bases, all other live parts shall be non-ferrous. Bolts, Screws and Pins shall be provided with locking arrangement and shall be of the best materials.

7.16.3 Each pole shall have three Pedestal type of Insulator's stacks. Necessary arrangements shall be provided for proper alignment of the contacts. Gang operated links shall be so designed that all phases shall make and break simultaneously.

7.16.4 The design of Isolators and Isolator-cum-Earthing Switches shall be provided for positive control of blades in all positions with minimum mechanical stress on the Insulators. Fixed guides shall be so provided that proper setting of contacts shall be obtained, when a blade is out of alignment even by 25mm in either direction. All movable parts which may be in current path shall be shunted by flexible copper conductor of adequate cross-section and capacity, which shall be furnished under bill of material.

7.16.5 The length of the handle for manual operation shall not be more than one meter and shall be stated on the drawing. The rotating parts shall have a smooth movement.

7.16.6 The clearance of 4000 mm from live parts to ground as per provision of I.E. Rules shall be considered while manufacturing of isolators & to decide location of operating mechanism box. Height of structure of isolator from ground is to be considered as 2900 mm including 150mm for muffing.

7.16.7 Contacts:

a) The moving & fixed contacts shall be made of hard drawn electrolytic grade copper strips and shall be heavy duty self- aligning & high pressure type preferably which applies pressure to the contact surfaces after the blades are fully closed and release the pressure before they start to open. High pressure type contacts shall wipe the contact surfaces, while opening and closing. The contacts shall be so designed that wiping, action shall not cause securing or abrasion on the contact surfaces. The wiping action shall be sufficient to remove oxide film, formed during the operation of the switches. The pressure shall be developed by rotation of the entire blade.
b) The temperature rise of contacts due to the flow of rated short circuit current for a period of 3 seconds shall not cause any annealing or welding of contacts.
c) The moving contacts, if provided, shall close first and open last so that no damage is caused due to arcing whatever to the main contacts. The Bidder shall give full details of such contacts with necessary drawings.
d) The arcing contacts, if provided shall close first and open last so that no damage is caused due to arcing whatever to the main contacts. The tender shall give full details of such contacts with necessary drawings.
e) The female contact and its tensioning by spring shall be such that there will, always, be

a positive contact with adequate pressure to give enough contact surface for the passing of current. The springs provided should not go out of alignment or get entangled with the male contact during operation. The details of springs shall be furnished on the G.A. drawing.

7.17 EARTHING BLADES

7.17.1 The Isolators controlling the transmission line shall be equipped with earthing blades. The Earthing blades shall be counter balanced to ensure easy operation.

7.17.2 Line earth switch shall consist of three Earthing links per Isolator which will normally rest against the frames, when the connected Isolator is in closed position. The Earthing links of all three phases shall be suitable for fitting on either side of the Isolator.

7.17.3 Short time current withstand capacity of earthing blades of Isolator Earthing Switch shall be same as that of the main blades of Isolator. The material of the earthing Isolator, Each earthing blade shall be provide with flexible copper connections of adequate length of not less than 60mm2 are for connection between the operating shall and the base frame.

7.17.4 The rated making capacity of earthing switches shall be as specified in the applicable standard of isolators

7.18 INSULATORS

7.18.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137. Hollow column insulators shall be manufactured and tested in accordance with IEC: 60233/IS: 5261. The support insulators shall be manufactured and tested as per IS: 2544 / IEC: 600168/IEC: 600273. The insulators shall also conform to IEC 815 as applicable. Bidder shall furnish the technical particulars of all type of insulators used.

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

7.18.3 Bidder may offer silicone rubber housed composite type insulator as an alternative to the above porcelain insulator with equivalent creep age distance.

7.18.4 Data sheets for the insulators with cantilever strength and compression strength, etc. shall be submitted.

7.18.5 Insulators shall be rated for not less than 6kN for bus bar supports and 4kN for isolators.

7.19 BUS BAR

7.19.1 The outdoor bus-bars and equipment connections shall be with ACSR conductor (Panther/ suitable size as per design).

7.19.2 The bus-bars and the connection jumpers shall be supported on post insulators wherever required.

7.19.3 The ACSR bus bars strung between two supporting structures and supported by strain type insulators. The stringing tension may be limited to 500-900 kg depending upon the size of the conductor used. These types of bus bars are suitable for earthquake prone areas.

7.19.4 Bus bar Material – The materials in common use for bus bars and connections of the strain type are ACSR conductor.

7.19.5 Since aluminium oxidises rapidly great care is necessary in making connections. In the case of long spans expansion joints should be provided to avoid strain on the supporting insulators due to thermal expansion or contraction of pipe.

7.19.6 The bus bar sizes should meet the electrical and mechanical requirements of the specific application for which they are chosen.

Note: Unless otherwise specified, all equipment and materials shall confirm to the latest applicable Indian Standards. Equipment complying with any other International Standards will also be considered if it ensures performance of equipment equal to a superior to Indian Standard.

7.20 CONTROL & RELAY PANEL SPECIFICATIONS

General Requirement:

7.20.1 The control & relay panel shall be free standing, simplex type, floor mounting type, fabricated from 2 mm thick MS sheet for main enclosure and 1.6 mm thick MS sheet for internals and partitions. The main enclosure shall be mounted on a base frame fabricated out of 100x50 ISMC mild steel section.

7.20.2 The enclosure external finish colour shade shall be decided by the Owner, The internal surface shall have a glossy white finish all over.

7.20.3 The control & relay panel shall contain the following metering and protection devices:

a) Metering, Indications & Controls
b) Ammeter – 0 – …….. A
c) Ammeter selector switch
d) Voltmeter – 0 – 12/122 kV
e) Voltmeter selector switch
f) Load manager to display the following parameters : MW, MVA, MVArh, MVAr Cos Ø, Hz,

g) Indication lamps for R, Y, B phases, Breaker 'ON' (R), Breaker 'OFF' (G), Breaker 'TRIP' (A), Spring charged (W), Trip Circuit Healthy (B)
h) TNC switch, spring return to neutral position shall be provided for circuit breaker operation.
i) Local / Remote selection switch for circuit breaker operation
j) Semaphore indicators (LED type) for CB and Isolator 'Open' & 'Close' positions
k) Mimic diagram for the 110 kV systems with aluminium / Copper strips and 'ON' 'OFF' indications for isolators

7.21 LOW VOLTAGE SWITCHGEAR

7.21.1 This specification is for the 415V TPN Power Control Centre (PCC).

7.21.2 The PCC shall be rated for the maximum output of the supply transformer feeding the system. The short circuit withstand rating (1 sec) at rated voltage of the switchgear shall be relevant to the existing electrical system short circuit ratings.

7.21.3 The configuration of the PCCs shall be as per the Single Line Diagram of the system.

7.21.4 Power Control Centres (Construction)

a) Single front / compartmentalized, modular design, degree of protection IP52 with provision of extension on both sides.
b) Incomer feeders: mains incomer - Electrically operated draw out type Air Circuit Breakers (ACBs).
c) Outgoing feeders: Electrically operated draw out type Air Circuit Breakers (ACBs) / Moulded Case Circuit Breakers (MCCBs)
d) The colour finish shade of switchgear enclosure for interior shall be glossy white & for exterior it shall be light grey, semi glossy shade 631 of IS: 5. if a different exterior shade is desired by the PURCHASER, the same shall be intimated to the supplier.
e) The PCC shall be fabricated out of CRGO sheet steel; 2 mm thick for the outer shall all-round. The internal walls and separators shall be of 1.6 mm thick CRGO sheet steel
f) The gland plates shall be 3 mm thick

7.22 CONTROL CIRCUIT

7.22.1 Control supply for breaker closing / tripping - 110V DC

7.22.2 Air Circuit Breaker spring charge motor – 240 V AC, 1 phase

7.22.3 Moulded Case Circuit Breakers – 240 V AC, 1 phase

7.22.4 Indications, annunciation – 110V DC
7.22.5 Space heater, sockets, etc. – 240 V AC, 1 phase

7.23 BUS BAR & CABLE CAVITY

7.23.1 The material for main bus bars and tap off bus bars shall be electrolytic grade aluminium with HR PVC sleeved insulation.

7.23.2 Bus bars shall be suitable for short circuit rating and current suitable for all connected load.

7.23.3 Bottom cable entry for incoming and outgoing cables.

7.23.4 A suitable gland plate shall be supplied for termination of power, control and instrumentation cables.

7.23.5 Whenever feeders are housed in multi-tier configuration, these tiers shall be segregated by sheet metal barriers.

7.23.6 Earthing: Earthing bus bar shall be terminated at both ends of the switchgear to suit the connections to outside earthing conductor. All components inside the module are required to be earthed individually and are to be looped and connected to the horizontal earth bus.

7.24 TERMINALS:

7.24.1 CT circuit - Isolating link type terminals with shorting facility.

7.24.2 PT circuit – clip on type terminals.

7.24.3 Spare contacts shall be wired up to terminal block. 10% spare terminals shall be provided for each module

7.25 SPECIFIC REQUIREMENT

7.25.1 All ACBs shall be 4 pole, electrically operated, draw-out type, with closing coil, spring charge motor, trip coil, TNC switch for close and trip, manual closing and tripping push buttons, door I/L, test and service position micro switches, emergency P.B., safety shutters, etc. The circuit breaker shall be provided with anti-pumping feature.

7.25.2 ACBs shall be complete with microprocessor release and shall be provided with over current, short circuit and earth fault protections.

7.25.3 Minimum10% spare feeders of each rating shall be provided in the switchgear.

7.25.4 All current transformers shall have 5/1A secondary and all meters shall be suitable for 5/1 A operation.

7.25.5 All indicating lamps shall be of LED cluster type. ACB feeders shall be provided with ON, OFF, AUTOTRIP, SPRING CHARGED, TEST, SERVICE, TRIP CIRCUIT HEALTHY indications.

Color code shall be followed as applicable.

7.25.6 All indicating instruments shall be flush mounting, Digital, 96 sq.m size.

7.25.7 Window annunciator with hooter and accept, test, reset button shall be provided. Necessary auxiliary relays for contact multiplication shall be provided in the panel.

7.25.8 The maximum temperature of the bus bars, droppers and contacts at continuous current rating under site reference ambient temperature of 50° C shall not exceed 105° C.

7.25.9 Instrumentation: Switchgear instrumentation shall be provided as follows:

a) Mains Incomer – Voltmeter with selector switch
b) Ammeter with selector switch
c) Power Factor meter
d) Frequency meter
e) TVM + MD meter
f) Potential indicating lamps
g) Outgoing Feeders
h) Ammeter with selector switch on all feeders

7.26 GENERAL TECHNICAL SPECIFICATIONS (LV SWITCH GEAR PANEL)AS PER LATEST SPECIFICATIONS.

7.26.1 The panel shall be self-supporting, free standing, floor mounted, modular type with construction having degree of protection of IP 54 as per IS 2147.

7.26.2 The panel shall be fabricated from 14 SWG CRCA sheet steel for frame & load bearing surfaces. Partitions may be fabricated from 16 SWG CRCA if no components are mounted on them.

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

7.26.4 Stiffeners shall be provided at corners & between modules to make panel rugged. The stiffeners will necessarily be required for relay compartments or doors where heavy components are mounted.

7.26.5 The openable covers shall be provided with lift off type hinges, quarter turn door locks and flexible copper wire for earth connection.

7.26.6 The panel shall be dust and vermin proof. Synthetic or neoprene gaskets shall be provided at all openings.

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

7.26.8 Panel shall be provided with fluorescent lamp of 20W capacity operated by door operated limit switch. Panel shall also have space heaters and thermostat arrangement.

7.26.9 Panel shall be provided with 3 pin switch socket combined unit of 5 Amp capacity.

7.26.10 Lifting hooks shall be provided at the top of the panel.

7.26.11 The hardware components used in the panel shall be hot dipped galvanized.

7.26.12 The control components shall be fixed on mounting plate by drilling & tapping.

7.26.13 Aluminium anodized legend plates shall be provided for all the components. For components mounted on front face, legend plate from inside shall also be provided.

7.26.14 Pre-treatment by 7 tank process shall be done before painting / powder coating the panel.

7.26.15 Panel shall have provision of drawing pocket.

7.26.16 The panel shall be designed to ensure maximum safety during operation inspection, connection of cables and maintenance. Inside panel, checking and removal of components shall be possible without disturbing other units.

7.26.17 Cable entries will be from bottom. The opening of cable entry shall be covered by 3 mm thick gland plates.

7.26.18 The panel shall be provided with all necessary components / devices and instruments as per the enclosed schematic diagram and functional requirements.

7.26.19 The components such as protective relays, auxiliary relays, push buttons, switches, instruments shall be flush mounted on the front side of a panel.

7.26.20 The control wiring shall be done with PVC insulated flexible copper wire. For CT secondary circuits 2.5 sq.mm wire shall be used. For control wiring 1.5 sq.mm wire shall be used.

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

7.26.22 The panel shall be fully wired all the terminals shall be brought out for cable connections.

7.26.23 10% spare terminals shall be provided on each terminal block. Separate terminal block

shall be provided for different voltages. All wire shall have P.V.C. ferrules as per wiring diagram.

7.26.24 Proper shrouding to incoming and outgoing terminals shall be provided to ensure safety during operation, inspection and maintenance.

7.26.25 Indicating lamps shall be with multiple LEDs & shall be suitable for the voltage specified.

7.26.26 All the components in the panel shall be properly labelled. The labels shall be made of non- rusting metal or engraved PVC material properly fixed by screws.

7.26.27 The panel layout shall be made in such a way that it will always facilitate easy removal and reconnection of control cables without disturbing other wiring.

7.26.28 Centre lines of control switches, push buttons and indicating lamps shall be matched so as to give neat appearance. Similarly top lines of indicating instruments and relays shall also be matched.

7.26.29 The panel shall be provided with electrolytic grade aluminium bus bar of suitable cross section so as to maintain max current density of 0.8 AMP/ Sq.mm.

7.26.30 Bus bars shall be provided with colour coded heat shrinkable sleeves.

7.26.31 Bus bars shall be supported by high quality epoxy insulators provided at specified distances so as to withstand to the given fault level.

7.26.32 The bus bar chambers shall be provided with suitable ventilation arrangements so as to limit the maximum temperature of 85°C while carrying rated current.

7.26.33 Proper clearance of minimum 25 mm shall be maintained between phase bus bars and between bus bars.

7.26.34 The panel shall be inspected at manufactures works before dispatch to site at the discretion of HGML.

7.26.35 All routine tests shall be carried out on the panel in presence of HGML or their representative or its representative. These tests shall include following:

a. Verification of components ratings and operation.
b. High voltage measurement test.
c. Insulation Resistance measurement.
d. Control testing
e. Bidder shall provide 110 kV transmission with bay and metering on Turnkey basis as per STU requirement/ as applicable.

7.27 METERING SYSTEM AS PER KPTCL NORMS.

7.27.1 ABT energy meter shall be provided as approved by STU to measure the delivered quantum of energy to the grid for sale. Interface metering shall conform to the Central Electricity Authority (Installation and Operation Meters) Regulation 2006 and amendment thereof Commercial settlement of solar Photovoltaic Grid Interactive based power project.

7.27.2 The responsibility of arranging for the meter, its inspection/calibration/testing charges etc. rests with the Bidder. All charges incurred on Meter testing, shall be borne by the Bidder. ABT energy metering system is to be approved by STU.

7.27.3 Meter must be provided with the necessary data cables.

7.27.4 Separate metering system has to be provided for L.T. (incoming) and H.T. (outgoing) supply.

7.27.5 Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment existing at the station either through a synchronization pulse received from the time synchronization equipment or through a remote PC synchronized to GPS clock shall also be in the scope of Bidder.

7.27.6 All charges for testing and passing of the meter with relevant government agency shall be borne by Bidder, the Employer will assist Bidder for necessary document as an when required.

7.27.7 ABT compliant Energy Meters shall have technical specification as given below (not limited to specified requirement, Bidder can provide Meter with latest facilities):

7.27.8 Shall be microprocessor-based conforming to IEC 60687 / IEC 6205211/ IEC 62053-22 / IS 14697.

7.27.9 Shall carry out measurement of active energy (both import and export) and reactive energy (import) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.

7.27.10 Shall have an accuracy of energy measurement of at least Class 0.2 for active energy and at least Class 0.5 for reactive energy according to IEC 60687, and shall be connected to Class 0.2 CT cores and Class 0.2 VT windings.

7.27.11 The active and reactive energy shall be directly computed in CT & VT primary ratings.

7.27.12 Shall compute the net MWh and MVARh during each successive 15- minute block metering interval along with a plus/minus sign, instantaneous net MWh, instantaneous net MVARh, average frequency of each 15 minutes, net active energy at midnight, net reactive energy

for voltage low and high conditions at each midnight.

7.27.13 Each energy meter shall have a display unit with a seven digit display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MW demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.

7.27.14 All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.

7.27.15 At least the following data shall be stored before being over-written for the following parameters.

S.No.	Parameters	Details	Min No of days
1.	MWh	15 min. block	90 days in meter
2.	Average Frequency	15 min. block	90 days in meter
3.	MVARh for > 103%	15 min. block	90 days in meter
4.	Cumulative MWh	At every peak hrs	30 days in meter/ 90 days in PC
5.	Cumulative MVARh for >103%	At every peak hrs	30 days in meter/ 90 days in PC
6.	Date & time blocks for VT failure on any phase		

7.27.16 Shall have a built in clock and calendar with an accuracy of less than15 seconds per month drift without assistance of external time synchronizing pulse.

7.27.17 Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment existing at the station provided by Bidder.

7.27.18 The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be less than maximum 2 VA.

7.27.19 The power supply to the meter shall be healthy even with a single- phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory.

7.27.20 Even under the absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.

7.27.21 Shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software.

7.27.22 The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.

7.27.23 The Owner shall have the right to carry out surprise inspections of the Metering Systems from time to time to check their accuracy.

7.28 SCADA AND REMOTE MONITORING SYSTEM

7.28.1 The plant shall be automatically operated and shall be controlled by microprocessor based control system SCADA and should be Open Platform Communications (OPC) compliant. There shall be simultaneous data logging, recording and display system for continuous monitoring of data for different parameters of different sub systems, power supply of the power plant at DC side and AC side.

7.28.2 An integrated SCADA shall be supplied which should be capable of communicating with all inverters and provide information of the entire Solar PV Grid interactive power plant.

7.28.3 Computer-aided data acquisition unit shall be a separate & individual system comprising of different transducers to read the different variable parameters, A/D converter, multiplexer, de multiplexer, interfacing hardware & software, which will be robust & rugged suitable to operate in the control room Environment.

7.28.4 Reliable sensors for solar insolation, temperature, and other weather and electrical parameters are to be supplied with the data logger unit.

7.28.5 The Bill of Materials associated with the equipment must clearly indicate especially the details about the PC and Printers, etc.

7.28.6 The Data Acquisition System should be housed in a desk made of steel sheet.

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

7.28.8 SCADA shall measure and continuously record electrical parameters and provide following

data at a 5-15 minute interval.

a) Energy export to grid at 110 kV
b) Main combiner box parameters
c) Inverter level parameters
d) Parameters at LV terminal (415V)
e) Power characteristics of HT side
f) Ambient temperature near array field
g) Module surface temperature
h) Wind Speed and direction
i) Solar irradiation/isolation
j) Any other parameter considered necessary by supplier based on current prudent practice

7.28.9 SCADA shall provide 15 minute daily, monthly and annual average of following parameters:

- Exported Energy to grid at 110 kV
- Energy, DC and AC voltage, power and pf of each inverter
- Solar Radiation
- Temperature (ambient and module surface)

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

7.28.11 SCADA shall have feature to be integrated with the local system as well remotely via the web using either a standard modem or a GSM/WIFI modem. The Bidder shall provide compatible software and hardware so that data can be transmitted via. Standard modem.

7.28.12 SCADA shall be provided with reliable power supply along with backup supply for at least one hour to cater to outage of grid.

7.28.13 The SCADA shall be compatible to the requirements for measuring and reporting the performance-ratio of the power plant.

7.28.14 The Contractor shall provide all administrative rights/ privileges/passwords of the SCADA system to the Employer.

7.28.15 The Bidder shall submit the data sheet with technical specifications of the SCADA system.

7.28.16 The C O M P U T E R shall be of Industrial type, rugged & robust in nature to operate

in a hostile environment. The SYSTEM shall have minimum Intel Core i5 processor having 2 X 500 GB HDD with 4 GB RAM. 40'' LED HD Colour monitor, DVD Drive with Writer, , USB drive, optical Mouse,, along with necessary licenced operating software, anti virus software and necessary applications..

7.28.17 The printer shall be of industrial type, rugged & robust in nature and of reputed make. The printer shall be equipped for printing, scanning, copying and fax.

7.29 DC BATTERY & CHARGER

7.29.1 Adequate capacity DC battery Bank should be provided for control supply of inverters, control / protection system & emergency lighting at buildings. A appropriate capacity battery charger (float cum boost charger – FCBC) with relevant IS/IEC standards & protection and automatic change over system should be provided to charge the battery bank along with relay circuit, fuses, annunciations and remote operating and controlling facility from the Main Control Room.

7.29.2 A DC power supply Distribution panel/board should be supplied along with the Charger (FCBC) with low battery cut off, as per relevant IS standards. Control room DC Battery Bank & DC supply system theoretical design, calculations and detailed explanations along with drawing shall be provided and approved by the Employer.

7.29.3 DC Batteries the batteries shall have the following specifications:

a)	Type	: VRLA Stationary, sealed type, storage battery.
b)	Rating	: 110 V D.C., Minimum 80 Ah at 8 Hour rate of discharge.
c)	Standard	: IS 1651 – 1979; performance as per IS 8702
d)	Container	: Plastic Resin, ABS or PP
e)	Terminal Posts connections	: Designed suitably to accommodate external bolted

7.29.4 The battery shall be provided with epoxy paint coated exhaust fan for removal of gasses released from the battery cells.

7.29.5 The data sheet for the battery shall be submitted along with the bid for evaluation.

7.30 HARDWARE FOR TRANSMISSION INFRASTRUCTURE

7.30.1 Metal fittings of specified material for string hardware meant for power conductor and earth wire shall have excellent mechanical properties such as strength, toughness and high corrosion resistance. The suspension and tension clamps shall be made from aluminium alloy having high mechanical strength. Suspension and tension clamps offered shall be suitable for ACSR / AAAC conductor as per design.

7.30.2 All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching insulators to the tower or to the power conductor shall be so designed as to reduce (to a minimum) the damage to the conductor, insulator or the fitting arising from conductor vibration.

7.30.3 All drop-forged parts shall be free-from flaws, cracks, or other defects and shall be smooth, close-grained and of true forms and dimensions. All machined surfaces shall be true, smooth and well-finished.

7.30.4 All ferrous parts of hardware shall be galvanized in accordance with IS 2629.

7.30.5 The galvanization shall withstand four dips of 1-minute duration each in copper-sulphate solution as per the test procedure laid down in the relevant ISS.

7.30.6 The threads in nuts and tapped holes shall be cut after galvanizing, and shall be well-lubricated/greased. All other threads shall be cut before galvanizing.

7.30.7 Both the suspension and the tension hardware shall be of ball and socket type, and shall be with `R' and `W' type security clip of stainless steel or phosphor Bronze conforming to IS 2486. The tension clamps of both compression type and bolted type as shown in the relevant drawings shall be offered. Arcing horns shall be provided on the line side for both the suspension type and compression type hardware.

7.31 DANGER PLATES

Size of each Danger Notice plates shall be 200 mm x 150 mm made of mild steel sheet and at least 2 mm thick, and vitreous enamelled white on both sides and with inscription in signal red colours on front side as required. The inscriptions shall be in Kannada and English.

7.32 FIRE ALARM SYSTEM

7.32.1 The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.

7.32.2 Liquefied CO2 fire extinguisher shall be upright type of capacity 10 kg having IS: 2171. 7 IS: 10658 marked. The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes, Electrical Wiring, Live Machinery Fires, and All Flammable Liquid & Gas. Bidder shall provide portable fire extinguisher as per the recommendation by relevant fire safety authority.

7.32.3 The minimum 2 no. of fire extinguishers (CO2 and Foam type each) shall be provided at every buildings.

7.32.4 Sand bucket should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546.

7.32.5 The plan for fire extinguishing must be provided by the bidder to HGML for the approval.

7.33 TESTING INSTRUMENTS FOR ELECTRICAL & ELECTRONIC

Bidder shall also provide required set of onsite testing instruments/equipment viz. earth resistance tester, rheostats, insulation tester, millimetres, clamp meters, CRO, Function Generator, Transformer oil BDV kit, Relay testing kit, infra-red thermal imaging hand held temperature meter, inverter testing kit etc. All testing equipment shall possess valid calibration certificate issued from approved NABL labs.

7.34 GENERAL GUIDELINES

7.34.1 Any civil or electrical work which is not mentioned or included in this tender document but necessary for the plant shall be borne by the Bidder.

7.34.2 Selected Bidder shall prepare all designs / drawings have based on the specifications given in the tender and in light of relevant BIS standard.

7.34.3 The Employer reserves right to modify the design at any stage, to meet local site conditions / project requirements.

7.34.4 All work shall be carried out in accordance with the latest edition of the Indian Electricity Act and rules formed there under and as amended from time to time.

7.35 SPECIFICATION OF LIGHTING IN SOLAR POWER PLANT

7.35.1 Scope

This specification covers design of Array yard and sub-station, street light using 80W LED luminaires, tubular poles (from main gate up to the control room/switchyard gate and periphery wall of the plant) distribution pillar boxes, PVC cables, conduit steel trays etc. which shall be supplied by the contractor for installation of luminaires, their control gear and wiring on them. The bidder will also design, supply and install lighting fixtures and accessories based on LED for equipment room and control room building and entry points/ gates. The Bidder shall furnish Guaranteed Technical Particulars.
The emergency standalone pole mounted and roof top LED lights shall be placed at critical locations in the plant area.

All LED luminaires shall be supplied with proper diffuser to avoid direct visibility of LED with proposer thermal management for longer life. Renowned brands available in the market need to be used.

7.35.2 Lighting Levels

a) The average LUX level of 10 lm is to be maintained in switchyard. However, a lux level

of 20 lm (10+10) additional switchable on requirement only) is to be maintained in switchyard on transformer.

b) Lighting in other areas such as control room, office rooms and battery room & other areas(i.e. street light) shall be such that the average LUX level to be maintained shall be as under:

Sl. No	**Area**	**LUX**
1.	Control Room and equipment rooms	500
2.	Office	300
3.	Battery & other rooms	150
4.	Other areas including periphery wall	10
5.	Transformer yard	20
6.	H – pole and metering point	10

7.35.3 Emergency Light Points:

a) Light points using LED lamps of 15-20 W (at 240 V) shall also be provided as given below:

i. Control room and equipment room 4 Nos.
ii. Battery room 1 Nos.
iii. Office 1 Nos.
iv. Corridor 1 Nos.

b) These lights shall operate on AC/DC changeover supply from the DC distribution Board.
c) Separate wiring and distribution board shall be provided from these lights.
d) The lighting level shall take into account appropriate light output ratio of luminaires, coefficient of utilization maintenance factor (of 0.7 or less) to take into account deterioration with time and dust deposition.
e) LED luminaires shall meet the following parameters

PARAMETER	**SPECIFIED VALUE**
Input voltage	170-260 V
Input Frequency	50 HZ +/-1 HZ
Power Factor	0.95 (Minimum)
Power Efficiency	>96%
LED efficacy	>130 lumens per watt
Dispersion Angle	Minimum 120°
Usage hours	Dusk to dawn

PARAMETER	**SPECIFIED VALUE**
Total Harmonic Distortion	< 15 %
Working Temperature	-5° to +50° C
Working Humidity	10% - 90% RH (Preferably Hermetically sealed unit)
Index of Protection Level	Minimum IP 65
Lamp Casing	Powder coated metal / Aluminium.
Life	> 50000 Hrs.
LED Type	Power LEDS from reputed makes.
Colour Temperature	2800° K/3000° K
Colour Rendering	>75
Junction Temperature	< 60° C
Electrical Connector	Lead wire with 2 meter long –or as required by the customer at site.
Expected Life of components	Passive electronic components life greater than >100,000 hours
Moisture protection in case of casing damage	IP 65 (preferably Totally encapsulated)

f) Luminaire Compliances:

i. Luminaire Specification:
Control gear specification:
EN 61347-2-13: 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.

ii. Luminaire EMC specification:
EN 61000-3-2: Electromagnetic compatibility (EMC). Limits for harmonic current emissions (Equipment input current < 16 A per phase)
EN 61000-3-3: Limitation of voltage fluctuation and flicker in low voltage supply systems for equipment with rated current < = 16 A

g) Additional information:

i. The LED luminaire housing, heat sink, pole mounting bracket, individual LED reflectors and front heat resistant tempered glass should be provided.
ii. The LED luminaire housing should be made of non-corrosive high pressure die cast

aluminium and the housing should be power coated grey, so as to ensure good weatherability.

iii. Each individual LED source should be provided with a asymmetrical distribution high reflectance aluminized reflector, which should ensure that the light distribution of the luminaire is suitable for road lighting applications (wide beam distribution) and should ensure high pole to pole spacing.

iv. The luminaire should be provided with in built power unit and electronic driver. The luminaire should be should be so constructed to ensure that the gear and LED modules are replaceable, if required.

v. The luminaire should be suitable for both standard street light poles with a typical pole diameter of 50 mm – 60 mm and should be suitable for both side entry and bottom entry (post top).

D. Performance Measurement procedure

8. PERFORMANCE RATIO TEST PROCEDURE

1.1 PR - PROVISIONAL ACCEPTANCE TEST VERIFICATION PROCEDURE

1.1.1 The Performance ratio test aims at the comparison of the actual PV plant energy production with the guaranteed value for a limited operation time of the PV plant of 7 consecutive days.

1.1.2 After Commissioning of the Plant and after receiving all the satisfactory results regarding the correct operation of the plant, there will be continuous monitoring of the performance for 7 days. This monitoring will be performed on the site under the supervision of the Employer / Employer's engineer.

Third party evaluation also can be carried out for the final acceptance.

1.1.3 The final tests to prove the guaranteed performance parameters shall be conducted at site by the Contractor in presence of the Employer. The Contractor's commissioning / start-up Engineer shall make the plant ready to conduct such tests. The Performance Guarantee Tests (PG tests) shall be commenced, within a period of one (1) month after successful Commissioning. Any extension of time beyond the above one (1) month shall be mutually agreed upon. These tests shall be binding on both the parties to the contract to determine compliance of the equipment with the guaranteed performance parameters.

1.1.4 The test will consist of guaranteeing the correct operation of each plant individually over 7 days, by the way of the efficiency rate (performance ratio) based on the reading of the energy produced and delivered to the grid and the average incident solar radiation.

1.1.5 The Efficiency or performance ratio (PR) of the PV Plant is calculated as follows (according to IEC 61724)

$$\textbf{Performance Ratio (PR)} = \textbf{YA} / \textbf{YR}\ [1 - \alpha * (T_{Cell\ avg.} - T_{Cell})]$$

Where;

Y_A = Final PV system yield (representing the number of hours that the system would need to operate at its rated output power P_{Nom} to contribute the same energy to the grid as was monitored)

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

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

Or $YR = IR\ Site / IR\ STC$

E_{ac} = AC energy injected into the grid during a clearly specified amount of time (kWh) P_{Nom} = Installed nominal peak power of modules (Flash test rating at STC) (kWp)

IR Site = Irradiation on the module plane of array during a clearly specified amount of time (measured with a pyranometer installed on the array plane) (kWh/sq. m)

IR STC = Irradiance at STC (kW/ sq. m)

$T_{cellavg}$ = Average cell/ module temperature (^{o}C) T_{cell} = STC cell/ module temperature (^{o}C)

α = temperature coefficient of power (negative in sign) corresponds to the installed module (%/^{o}C)

1.2 Monitoring System for PR Verification

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

a) Power Meter at the delivery point.
b) Power Meter for each inverter for reference only.
c) One nos. calibrated pyranometer to determine irradiance on the plane of array (with a target measurement uncertainty of ± 2).
d) One nos. calibrated pyranometer to determine irradiance on horizontal plane (with a target measurement uncertainty of ± 2)
e) Two nos. thermocouples to measure module temperature with a measurement uncertainty of ±1 °C.
f) Shielded ventilated thermocouple with a measurement accuracy of ±1°C.
g) An anemometer mounted on a 10m mast to measure wind speed (without additional shadowing on modules).

1.3 Data measurement shall be witnessed in the format mutually agreed before the start of PR test by the employer and the contractor jointly for the said period.

1.4 The bidder shall show the specified PR for Operational Acceptance and committed CUF for Final Acceptance.

E. Civil Works

DETAILED CONTOUR SURVEY & SOIL INVESTIGATION OF THE SITE

The turnkey contractor 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 contractor must submit the detailed soil investigation report, bore log records, ERT reports and contour survey to HGML.

Topographical survey

Topographical survey shall have to be done by the Selected Bidder of the proposed site at 5 m interval with the help of Total Station or any other suitable standard method of survey. 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 formation levels of the proposed power plant have to be fixed with reference to High Flood Level of the proposed site. The ground level and plinth level of structures shall be fixed taking into consideration the highest flood level and surrounding ground profiles.

9.1 **Soil Tests:**

The Contractor is advised to and is solely responsible to carry out detailed Geotechnical 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 / piling for module mounting structures, HT lines, etc. The Contractor shall carry out soil investigation t hroug h any Govt. approved / certified soil consultant. These reports shall be furnished to the Employer prior to commencing work. All RCC works shall be provided of required grade of concrete as per relevant IS specifications as well as soil data considering appropriate earthquake seismic zone, wind velocity, whether effect, soil characteristics etc.

9.2 **Soil Investigations:**

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.

9.3 **Other investigations**

Selected Bidder shall obtain and study earthquake and wind velocity data for design of module mounting structure, and considering all parameters related to the weathers conditions like Temperature, humidity, flood, rainfall, ambient air etc.

The Selected Bidder shall carry out Shadow Analysis at the site and accordingly design strings and arrays layout considering optimal use of space, material and man-power and submit all the details / design to Employer for its review / suggestions / approval.

9.4 **Land Development for site activities**

The turnkey contractor 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. It is to ensure that land must be graded and levelled properly for the flow of water. It is advisable to follow the natural flow of water at the ground. If the land pocket needs any filling of sand, it is to ensure that the filled earth must be well compacted as per the relevant IS standards. In case the filled earth is brought out from outside the plant, the contractor shall provide the necessary challans. On the other hand, additional earth, if any, must be disposed of properly. Bidder shall take reasonable care to ensure that the plant is aesthetically designed.

9.5 **Foundations:**

9.5.1 The contractor is responsible for the detailed soil investigation and subsequent foundation design of the structures in the plant. The foundation of the module mounting structures, buildings and other important structures must be approved by HGML prior to construction. The contractor must provide the detailed design and calculations of the foundation.

9.5.2 The foundations should be designed considering the weight and distribution of the structure and assembly, and a maximum wind speed of 180 km per hour. Seismic factors for the site have to be considered while making the design of the foundation. Selected Bidder shall also plan for transport and storage of materials at site.

9.6 **Switch yard civil works**

Switchyard civil work includes step up transformer plinth, HT Switchgear kiosk plinth, two pole 4 pole structure foundation, earth pits, metal spreading curb wall in and around switchyard and fencing. The transformer/ HT switchgear kiosk plinth shall be made of brickwork or Random Rubble masonry conforming to relevant standards. The height of transformer /HT Switchgear kiosk plinth shall be decided based on 110 kV ground clearance. Earth pit construction shall be of brickwork covered with RCC (1:2:4) slabs. Switchyard/ double pole area must be surrounded by chain link fencing with pre-cast RCC post/ galvanized MS angle of suitable size with double leaf gate will be provided. Area enclosed within this perimeter must be filled with gravel.

9.7 **Buildings**

Buildings are required to be constructed for housing the electrical equipment/ panel and central control room with office cum store building for the operation & maintenance of Solar Photovoltaic Power Plant. Security rooms shall also be required at strategic locations to secure the plant from any theft. The building shall be constructed with conventional RCC framed structure with brick partition walls. Equipment room shall be designed as per the OEM recommendations to ensure desired life of equipment. Bidder shall furnish the drawing of the proposed buildings to the Employer for approval, prior to construction. The construction of the same shall be as under-

9.7.1 RCC Works

All RCC works shall be as per IS 456 and the materials used viz. Cement, reinforcement steel etc. shall be as per relevant standards.

9.7.2 Brick Works

Brick works in cement mortar (CM) 1:6 for 9" thick and 4½" thick wall respectively. All brick works shall be using 1st class bricks of approved quality as per IS 3102.

9.7.3 Doors & Windows:

Steel framed doors, Windows and ventilators shall conform to IS – 1081 with necessary glass panels including of all fixtures and painting etc. complete. Doors and windows shall be made of aluminium sections. All sections shall be 20 microns anodized. Sections of door frame and window frame shall be adopted as per industrial standards. Door shutters shall be made of aluminium sections and combination of compact sheet and clear float/ wired glass. The control room shall require a number of windows/ louvers to provide ventilation/ fresh air circulations.

9.7.4 Plastering

Plastering in cement mortar 1:5, 1:6 and 1:3 shall be applied to all internal, external walls and ceiling of slab respectively as per IS 1542.

9.7.5 Flooring

Flooring for stores shall be of cement flooring in concrete mix 1:2:4 using 10 mm aggregates as per IS 2571. Flooring for control building, equipment room and other places, if needed, shall be of vitrified tiles 8 mm. For toilet area, the floor shall be of ceramic tiles 8 mm thicknesses. The floor finishing must include skirting up to a suitable height. The wall tiles, if proposed, shall be glazed tiles of 6 mm thickness and provided up to lintel level.

9.7.6 Roofing

The roof of the building shall be insulated and waterproofing shall be done as per relevant IS standard.

9.7.7 Plinth Protection

Plinth protection 1000mm wide shall be provided around all the buildings.

9.7.8 White washing & colour washing.

White washing and colour washing work shall be conforming to IS 6278.

a) Internal walls - Acrylic distempering as per IS 427.
b) External walls – Heat reflective synthetic enamel as per IS 428.
c) For cement painting IS 5410 shall be followed.
d) For painting of steel doors, ventilators IS 2338, IS 1477 (Part I & II) shall be followed.

9.7.9 Rolling Shutters.

Rolling shutters made of cold rolled strips shall conforming to IS 4030 with approved gauge thickness shall be provided with all fixtures, accessories, painting all etc. complete.

9.7.10 Water supply.

GI pipes of Medium quality conforming to IS 1239 (Part I) and IS 1795 for Mild Steel pipes shall be used for all water supply and plumbing works.

9.7.11 Plumbing and Sanitary:

Sanitary fittings, which include water closet (EWC/IWC), wash basins, sink, urinal fitting including flushing tank, and necessary plumbing lines shall be provided for office cum stores building and Security house.

9.7.12 Electrification of Building

Electrification of buildings shall be carried out as per IS 732 and other relevant standards. The lighting design of the buildings shall be carried out as per IS 3646. The building shall be provided with adequate quantity of light fittings, 5A/ 15A 1 phase sockets, fans etc., controlled by required ratings of MCBs and MCB, DBs. Supervisor room must be fitted with suitably sized HVAC system. It is encouraged that bidder shall use the latest energy efficient equipment for the electrification and illumination.

9.7.13 Toilet:

Toilet shall be designed for 15 persons; and constructed with following finish

a) Floor: Vitrified tiles/ ceramic tiles
b) Door window: made out of aluminium sections, 6mm float glass
c) Ventilators: Mechanical exhaust facility
d) Plumbing fixtures: Repute make
e) Sanitary ware: Repute make
f) EWC: 390 mm high with health facet, toilet paper roll holder and all fittings
g) Urinal (430 x 260 x 350 mm size) with all fittings.
h) Wash basin (550 x 400 mm) with all fittings.
i) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
j) CP brass towel rail (600 x 20 mm) with C.P. brass brackets
k) Soap holder and liquid soap dispenser.
l) GI pipes (B class) of reputed makes
m) Overhead water tank equivalent of 1,000 litre capacity

9.7.14 Drainage for Toilets:

Drainage pipes shall be of PVC (6 kg/cm2) Supreme, Prince or equivalent make. Gully trap, inspection chambers, septic tank for 15 person and soak well to be constructed for abovementioned requirement.

9.7.15 Air Conditioner for Control Room:

The control room shall be equipped with appropriate numbers of fans for effective heat dissipation. The SCADA cabin shall have split type air conditioning units.

9.7.16 Fire Extinguishers:

Liquefied CO_2 fire extinguisher shall be upright type of capacity 10 kg having IS: 2171. 7, IS: 10658 marked. The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes, Electrical Wiring, Live Machinery Fires, and All Flammable Liquid & Gas. Bidder shall provide 4 no. of portable fire extinguisher as given below.

9.7.17 Sand Bucket:

Sand buckets should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546. Bucket stands with four buckets on each stand shall be provided in the Transformer Yard – 4 Nos.

9.8 **Roads within Solar Power Plant**

9.8.1 Roads are to be constructed with sufficient width (minimum 3.75m) followed by 0.5m well compacted shoulders on each side. The road must be well compacted as per the relevant IS standards and MORTH updated till date.

9.8.2 All peripheral roads and pathways from central road to Inverter room road shall be WBM road. Also, all cable crossings and other crossings shall be provided with GI/ Hume pipes.

9.9 **Peripheral Boundary/ peripheral wall:**

9.9.1 The objective to provide a peripheral wall is to demarcate the boundary and to keep away the unauthorized access to plant. The contractor shall provide GI chain link with 65x65 'L' angle all around the periphery of the plant. The GI chain link shall be secured above the raft foundation. The fence height must be minimum of 2 meter from the GL. The boundary wall must be provided with a rugged main entry gate. The construction of peripheral fence and the main entry gate must conform to the relevant IS standards and practice.

9.9.2 All the drawings/ specifications for the peripheral fence and main entry gate design/ planning must be submitted to HGML for approval prior to construction for their accord.

9.10 **Drainage**

9.10.1 The storm water drainage shall be planned for the plant to ensure no water stagnation in the plant. The drains must be constructed with brickwork/ RCC/ RR masonry as suitable for the site conditions. The drains outfall must be connected to the nearest drain outside the plant premises. It is advised that the drainage for the plant must be designed keeping the natural flow of water to the nearest exit point.

9.10.2 Bidder is to provide RCC hume pipe at the crossing of road and drains and at required locations. The peripheral drain shall be of brick pitching which is backed up by cement mortar bed and all joints are filled up with cement mortar in C.M. 1:4, no pointing and plastering is required. All other internal drains i.e. on both side of central road, pathways to inverter room, control room, switchyard are to be done by excavating the drain of required size and with required trapezoidal section.

9.11 **Painting & Finish:**

9.11.1 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.

9.11.2 After Phosphate treatment, two (2) coats of yellow zinc chromate primer shall be applied followed by two (2) coats of epoxy based synthetic enamelled paint. Shade shall be Siemens Grey RAL- 7032. Thickness of paint shall be not less than 75 micron.

9.11.3 All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

9.12 **Watchmen / Security Cabin:**

Contractor shall provide adequate numbers of RCC Watchman's Cabin at strategic locations with in of the plant. The Minimum size of watchmen's (Security Cabin) cabin is 3.5 metre x 4.0 metre size and height of 3.0m with appropriate roof at the top. Location of the watch Cabin (Security Cabin) will be as directed by the HGML.

9.13 **Underground RCC water Tank**

Contractor has to design as per relevant IS codes, submit and take approval from client/ consultant and construct 2 x 75 kl underground RCC water tank with silting chamber for filtration of the water before the inlet which will match with invert level of Storm water drain. Design of RCC water tank shall be such that it shall resist Earth pressure and Water pressure and satisfy all IS codes.

F. Inspection & Testing

10 **INSPECTION:**

10.1 HGML shall have free access to Bidder's manufacturer's works to inspect, expedite and witness shop floor tests. Any materials or work found to be defective or which does not meet the requirements of the specification will be rejected and shall be replaced at Bidder's cost. Owner reserves the right to carry out stage wise inspection of fabrication and components. The Bidder shall furnish a detailed quality assurance plan (QAP) for review by the Employer.

10.2 The test & inspection shall be carried out at manufacturer's work and at the site with the Bidders obligation. The test and Inspection shall be done in accordance with the relevant standards and the Manufacturer's standard before the delivery to site as well as after the erection and commission at site. The bidders shall give the list of tests that they will carry out at site to show the performance of plant.

10.3 A detailed 'QAP' for Manufacturing and Inspection shall be submitted by the Bidder for Owner's approval. The data of each test and inspection shall be recorded and submitted as soon as the test/ trials are conducted and will also be a part of final documentation.

10.4 The shop test shall be carried out to prove the performance parameters of the offered model. The testing shall be done in the presence of the representatives of the department.

10.5 The Employer will nominate its representatives (max. of 2 nos.) for inspection of stage manufacturing and testing at works & 7 days training at premises of SPV module and PCU manufacturer. The notice of such inspection shall be given 30 days in advance in case of countries outside India and 15 days in India.

10.6 Manufacturer has to submit procedure for Test carried out at their Factory:

a) Start Up Trials
b) Load Test
c) Records & Measurements
d) Safety Device List
e) Setting values for all sensors for Pressure and Temperature
f) Dimensional Check-up, Overall Inspection, Completeness of Scope of Supply
g) Shop Test/Load Test for Solar Power Plant

11. LOAD TRIALS & RELIABILITY TEST AT SITE

11.1 Performance Guarantee Test at Site for Grid Connect Solar Power Plant, HT Panel etc.These tests will be conducted at site as per site conditions at available load and after performing all pre-commissioning check and trials and after readiness of the entire Solar Power Plant system which are required to carry out the load trials.

11.2 All the tests which are mentioned in the load test of Solar Power Plant will be carried out in presence of HGML Representative at Hutti site at site conditions and the parameters checked in accordance with the data sheet and guaranteed parameters given by the Contractor.

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12. Warranty / Guarantees

12.1 PV modules used in grid connected solar power plants must be warranted performance for peak output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.

12.2 The modules shall be warranted for at least 05 years for failures due to material defects and workmanship.

12.3 The mechanical structures, electrical works and overall workmanship of the grid connected solar power plant must be warranted for a minimum of 25 years.

12.4 The Contractor must ensure that the goods supplied under the Contract are new, unused and of most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the Contract.

a) Power Conditioning Units (PCU): PCUs shall be warranted for the guarantee period provided by the original equipment manufacturer. Same should be furnished with its Bid.
b) Transformers, associated switch gear and others: Bidder must furnish in detail its warranties/ guarantees for these items.

12.5 During the period of Warranty / Guarantee the Contractor shall remain liable to replace any defective parts, that becomes defective in the plant, of its own manufacture or that of its sub-Contractors, under the conditions provided for by the Contract under and arising solely from faulty design, materials or workmanship, provided such defective parts are not repairable at Site. After replacement, the defective parts shall be returned to the Contractors works at the expense of the Contractor unless otherwise arranged.

12.6 At the end of guarantee period, the Contractor's liability shall cease. In respect of goods not covered by the first paragraph of this clause, the Employer shall be entitled to the benefit of such guarantee given to the Contractor by the original Contractor or manufacturer of such goods.

DATA SHEET-1

Guaranteed Technical Particular data Sheet for Solar PV Module

(To be furnished by the bidder along with Technical Bid)

S. No.	Description	Particulars	Remarks
1.	PV Module Manufacture name & Country		
2.	PV Module type (Thin/ Crystalline- Mono/Multi)		
3.	Product Code		
4.			
5.	No. of PV cells per Module		
6.	Mounting arrangement for Solar Module		
7.	Solar Module frame material		
8.	Module dimensions		
9.	Output Cables (viz., Polarized Weather Proof DC rated multi-contact connector)		
10.	Weather resistant HDPE Junction Box (IP65)		
11.	Construction front back		
12.	Temperature rise of solar cells under severe working conditions over Max. Ambient Temp.		
13.	Nominal voltage		
14.	Nominal Wattage		
15.	Power Tolerance (3%)		
17.	Peak power voltage (Vmp)		
18.	Peak power current (Imp)		
19.	Open circuit voltage (Voc)		
20.	Short circuit current (Isc)		
21.	Weight of each module (Kg)		
22.	Fill Factor		
23.	Standards/Approvals from International Agencies	IEC 61215 IEC 61730 IEC 61646 TUV	
24.	Module is suitable to operate at 50^0C ambient	Yes/No	
25	Cell efficiency	%	

S. No.	Description	Particulars	Remarks
26	Module efficiency	%	

DATA SHEET- 2

Guaranteed Technical Particular data Sheet for SMU along with combiner /junction Boxes

(To be furnished by the bidder along with Technical Bid)

S. No.	Description	**Particulars**	Remarks
1	MAKE		
	MODEL		
	NO OF STRINGS PLANNED		
	INDIVIDUAL STRING CAPACITY		
	TOTAL CAPACITY		
	VOLTAGE RANGE		
	CURRENT RANGE		
	TYPE OF PROTECTION		
	LOAD BREAK SWITCHES if any		
	BREAKER DETAILS		
	(Along with this additional information on SMU may be provided along with product standards.)		

DATA SHEET- 3

Technical Particular Data Sheet for Power Conditioning Unit

(To be furnished by the bidder along with Technical Bid)

Description	**Particulars**	**Remarks**
AC Side		
Nominal AC power @ 25°C		
Nominal AC power @ 50°C		
Output AC voltage		
Frequency		
Total Harmonic Distortion		
AC over / under voltage over / under frequency Protection		
Phase shift (cos phi)		
DC Side		
Maximum Input DC power		
Maximum DC voltage		
MPPT voltage range		
Maximum DC current		
DC over voltage protection		
DC voltage ripple		
Others		
Minimum Efficiency (CE)		
Euro Efficiency		
Ambient temperature range		
Humidity (non-condensing)		
Quiescent power		
Degree of protection		
Dimensions approx. (HXWXD)		
Weight		
Compliances (Reference Standards)		

DATA SHEET -4

TECHNICAL PARTICULARS OF 415V/11 kV STEP-UP TRANSFORMER

(To be furnished by the bidder along with Technical Bid)

Sl. No.	**Description**	**particulars**	**Remarks**
1.	Rated Capacity KVA		
2.	Service		
3.	Make		
4.	Type		
5.	Location		
6.	Rated frequency Hz		
7.	Winding (Copper Double wound)		
8.	Number of phase HV side LV side Neutral (separate outside)		
9.	Rated Voltage a) HV winding kV b) LV winding kV		
10	Vector group		
11	Type of cooling (ONAN)		
12	Insulation level a) Power frequency withstand -kV rms. (HV/LV) b) Impulse withstand voltage -kV (HV/LV)		
13	Method of Earthing		
14	Duty		
15	Short circuit level		
16	Off circuit tap changer: a) Range % b) In steps of c) Tapping provided on HV side		
17	Tap changer type		

Sl. No.	Description	particulars	Remarks
18	% of Impedance		
19	Impedance voltage at 75°C a) At principal tapping %		
20	Temperature rise above 50°C ambient a) Top of oil by thermometer °C b) Womdomg by resistance °C		
21	Terminal details a) HV side b) LV side		
22	Losses (at 75°C and principal tapping) a) No load loss at rated voltage kW and frequency b) Load loss at rated current kW (ONAN) c) Total loss at maximum rated power kW		
23	Efficiency at 75°C and 0.9 PF a) At full load (ONAN) % b) At 75% load (ONAN) % c) At 50% load (ONAN) %		
24	Hot spot temperature in winding limit to °C		
25	Shipping dimensions a) Height m b) Breadth m c) Length m		
26	Painting		
27	Reference Standards		

DATA SHEET – 5

TECHNICAL PARTICULARS for SF6 Circuit Breaker:

(To be furnished by the bidder along with Technical Bid)

S.no	Description	Particulars	Remarks
	Circuit Breaker Rating		
1	General		
	a. Name of the Manufacturer		
	b. Country of Manufacture		
	c. Type of Circuit Breaker		
	d. Standard Applicable		
	e. Rated Voltage (kV ms)		
	f. Rated Current :		
	i. Under normal condition (A)		
	ii. Under site conditions (A)		
	g. Rated frequency (Hz)		
	h. Number of poles		
	i. Whether 3 pole or single pole unit		
	j. Whether all the 3 poles ganged electrically or mechanically		
	k. Whether dead tank or live tank design		
	l. Type of installation		
	m. No. of break per pole		
	n. Latching Current (kA)		
2	Guaranteed Ratings		
	a. Rated short circuit breaking current		
	i. Symmetrical component at highest system voltage (kA)		
	ii. DC Component (%)		
	iii. Asymmetrical breaking current at highest system voltage (kA)		
	b. Rated Making Capacity		
	i. At higher rated voltage (kAp)		
	ii. At lower rated voltage (kAp)		
	c. i. Maximum Total break time under any duty condition for any current up to rated breaking current with limiting conditions of voltage and pressure (ms)		

	ii. Rated breaking time (ms)		
	d. Closing time (ms)		
	e. Minimum opening time under any condition with limiting voltage and pressure (ms)		
	f. Maximum opening time under any condition with limiting voltage and pressure (ms)		
	g. Maximum close open time under any condition with limiting voltage and pressure (ms)		
	h. First pole to clear rating		
	i. Short time current rating (kA) for 1 Sec.		
	j. Rated operating duty		
	k. Maximum breaking capacity under kilometric faults and rated TRV characteristic (kAp)		
	l. Maximum breaking capacity under phase opposition (kAp)		
	m. Maximum line charging breaking current with temporary over voltage up to 1.4 p.u. (A)		
	n. Maximum over voltage (p.u.) on switching transformer on no load and corresponding charging current		
	o. Maximum period between closing of first contact & last contact in a pole (ms)		
	p. Maximum pole discrepancy (ms)		
	q. Maximum arc duration and corresponding current under lockout pressure.		
	r. Small fault current breaking capacity (kAp)		
	s. Pre-insertion resistor (if applicable)		
	i. Value / pole (Ohms) with tolerance		
	ii. Minimum and Maximum duration of insertion per pole (ms)		
	t. Maximum temperature rise for main contacts over design ambient temperature of 50°C		
	u. Rated pressure and limits of pressure of operating mechanism		
	v. Rated pressure and limits of pressure of extinguishing medium		

DATA SHEET – 6

GUARANTEED TECHNICAL PARTICULARS FOR 20/10 MVA, 11kV/110kV POWER TRANSFORMER AS PER THE LATEST STANDARDS AND PROCEDURES, INCLUDING KPTCL NORMS.

Sl No.	Description			
1	Name of the Manufacturer and country of origin			
2	Reference standard			
3	Service [Indoor/outdoor]			
4	Continuous rating under service conditions specified in IS-2026 Part-I, 2011 Clause No.1.1	: HV		
		: LV		
5	Ratings :			
	a. 1. With ONAN cooling - MVA			
	2. With ONAF cooling - MVA			
	b. Rated no load voltage			
	HV - kV			
	LV - kV			
6	a. Rated Frequency : (Hz)			
	b. Number of phases			
7	Current at rated voltage and on principal tap-Amp	:HV		
		:LV		
8	Maximum hot spot temperature rise calculated by formula ^{0}C over the maximum yearly weighted average ambient temperature			
9	Flux density at rated voltage and rated frequency in tesla			

Sl No.	**Description**			
10	Temperature rise of top oil, ^{o}C by the thermometer (above Max. Ambient Temperature).			
11	Temperature rise of winding measured by resistance (above Max. Ambient Temperature).			
	i. With ONAN cooling ^{o}C			
	ii. With ONAF cooling ^{o}C			
	iii. Period of operation of transformer at full load without calculated winding hot spot temperature exceeding 140^{o}C and when			
	50% coolers fail			
	100% coolers [Refer Cl. No. 1.2.0.1] fail			
12	No. of windings			
13	Connections	HV		
		HV Tap Wdg		
		LV		
		Neutral LV		
14	Connection Symbol and vector group			
15	Tappings :			
	i. Type of tap changer			
	ii. Tap step (percent)			

Sl No.	**Description**			
	iii. Total tap range (+) percent to (-) percent			
	iv. Tappings provided at			
	v. Type of regulation :			
	Constant flux regulation			
	Variable flux regulation			
	Combined regulation vi)Insulation level of tap changer			
16(A)	Magnetization data at no load, at rated frequency			
	i. Current in Amps			
	ii. Power factor			
	iii. Loss in KW (core loss + dielectric loss)			
	iv.Max.flux density in lines/sq.cm.			
A	At 90% rated no load voltage			
B	At 100% rated no load voltage			
C	At 110% rated no load voltage			
D	At maximum rated primary voltage (i.e. 105% rated no load voltage)			
16(B)	i) No-load loss at rated frequency at Principal Tap (KW)			
	ii) No-Load loss at voltage corresponding to the Highest Tap (KW)			

Sl No.	**Description**			
17	Load loss including cooler loss, at *rated output*, at rated frequency, at rated current at 75 ^{o}C winding temperature.	At Lowest Tap	At Principal Tap	At Highest Tap
	i. For ONAN rating CuL in KW			
	ii. For ONAF rating CuL in KW+CL in KW			
	NOTE : 1. CuL : Copper loss			
	2. CL : Cooler loss			
	Note for Sl. No. 16 & 17: Guaranteed values of the losses shall be indicated which shall be firm & without indicating the tolerance limit.			
18	Impedance at rated current and frequency at 75^{o}C winding temperature on rated MVA base.		HV to LV	
	i. At normal tap in %			
	ii. At max. voltage tap in %			
	iii. At min. voltage tap in %			
19	Reactance at rated current and frequency and normal tap on rated MVA base:			
	HV to LV %			
20	Zero sequence impedance at reference temperature of 75^{o}C at principal tap ……%			

Sl No.	**Description**			
21	Resistance at 75 ^{o}C			
	HV winding in Ohms in %			
	LV winding in Ohms in %			
22	Efficiency at 75^{o}C winding temperature as derived from guaranteed. loss figures	At Unity p.f	At 0.8 p.f	
	a. At 125% full load			
	b. At 100% full load			
	c. At 75% full load			
	d. At 50% full load			
23	a. Maximum efficiency …….%			
	b. Load at which maximum efficiency occurs (% of full load)			
24	Regulation at full load and at 75^{o}C			
	a. At unity p.f. in %			
	b. At 0.8 p.f. (lag) in %			
25	a. Short time thermal rating of LV winding in KA & duration in seconds.			
	b. Short time thermal rating of HV winding in KA & duration in seconds.			
26	Permissible overloading – HV			
	- LV			
27	Test voltages	HV	LV	
	i. Lighting impulse withstand kV (peak)			
	ii. Power frequency voltage withstand kV (ms)			
	iii. Switching impulse withstand kV (peak)			
28	Partial discharge level at $1.5U_m / \sqrt{3}$ kV_{rms} (pC)			
29	RIV at 1.1 times minimum phase to ground voltage			

Sl No.	**Description**			
30	Noise level when energized at normal voltage and normal frequency at no load (db)			
32	External short circuit withstand capacity (MVA) & duration (seconds)			
33	Over flux withstand capability of the transformer :			
34	Insulating and cooling medium			
35	Approximate weights			
	a. Core with clamping (Kg)			
	b. Winding with insulation (Kg)			
	c. Core & Winding *(Kg)*			
	d. Tank & Fittings with accessories (Kg)			
	e. Oil required for first filling *(Kg)*			
	f. Untanking weight (Kg)			
	g. Total weight with oil weight & fitting (Kg)			
	h. Weight of total insulation *(Kg)*			
36	Required quantity of oil in litres			
37	Terminal arrangement			
	HV			
	LV			
	Neutral LV			
38	Miscellaneous data / details and checks			

	ADDITIONAL TECHNICAL PARTICULARS:			
1	Details of Core Tolerance (along with if any):			
	a. Type of core configuration			
	b. Type of core joints			

	ADDITIONAL TECHNICAL PARTICULARS:			
	c. Flux density at 90% of rated voltage and frequency at Principal Tap	Tesla :		
	d. Flux density at 110% of rated voltage and frequency at Principal Tap	Tesla :		
	e. (i) Material of core lamination			
	(ii) Thickness of core lamination (mm)			
	f. Approximate core weight (please indicate core weight only)			
	g. Type of Joints used between core limb and yoke			
2	Details of Windings:			
	a. Conductor area in sq.cm and current density in Amps/Sq.cm (at rated current).	Current density A/sq. cm	Conductor area sq.cm	
	HV			
	HV TAP WINDING			
	LV			
	Regulating			
	b. Material of winding conductor			
	c. Approximate weight of winding (along with tolerance if any)in kgs			
	d. Type of windings			
	HV			
	HV TAP WINDING			
	LV			
	e. Winding insulation	Type and Class	Graded or ungraded	
	HV			
	HV TAP WINDING			
	LV			
	f. i. Insulating material used for :			
	1. Regulating winding			

	ADDITIONAL TECHNICAL PARTICULARS:			
	2. HV winding			
	3. HV TAP WINDING			
	4. LV winding			
	ii. Between HV and TAP WDG and LV as applicable			
	iii. Between core & LV side.			
	iv. For core bolts, washers and end plates			
	v. Regulating winding & earth.			
	g. i. Type of axial coil support			
	HV winding			
	HV TAP WDG			
	LV winding			
	ii. Type of Radial coil support :			
	HV winding			
	HV TAP wdg			
	LV winding			
	h. Core bolt insulation voltage			
	i. Details of special arrangement provided to improve surge voltage distribution in the windings			
	j. Approximate weight of winding (Kgs) (Tolerance if any on the above)			
	k. Minimum clearance (mm)	In oil		
		Between Phases	Phase to ground	Between Phases
	HV			
	LV			
3	Details of Tank :			
	a. Material for Transformer Tank			

	ADDITIONAL TECHNICAL PARTICULARS:			
	b. Type of the tank			
	c. Minimum thickness of sheet			
	i. Sides (mm)			
	ii. Bottom (mm)			
	iii. Cover (mm)			
	iv. Cooling tubes/Radiators (mm)			
	d. Vacuum recommended for hot oil circulation (torr)			
	e. Vacuum to be maintained during oil filling in transformer tank (torr)			
	f. Vacuum to which the tank can be subjected without distortion (torr)			
		Transverse Axis	Longitudinal Axis	
	g. No. & size of bi-directional wheels provided.			
	h. (i) Track gauge required for the wheels-longitudinal axis & transverse axis			
	(ii) Size of rail recommended for the track			
4	Details of painting at works and site			
5	(a) Minimum clear height for lifting tank cover and for lifting core & windings from tank (mm) (untanking height).			
	(b) Minimum clear height for lifting (mm)			
	i. OLTC			
	II. Bushings – HV			
	- LV			
6	Shipping details :			
	i. Parts detached for transport			
	ii. Weight of heaviest package in Kgs			
	iii. Weight of other heavy packages in Kgs			
	iv. Dimensions of largest package			
	a. Length in mm			

	ADDITIONAL TECHNICAL PARTICULARS:			
	b. Breadth in mm			
	c. Height in mm			
	v. Dimensions of other heavy packages:			
	a. Length in mm			
	b. Breadth in mm			
	c. Height in mm			
	vi. Transformer will be transported with oil / gas			
7	Details of Bushings	HV	LV	
	a. Make & Type			
	b. Rated voltage class – KV			
	c. Rated current – Amps			
	d. One minute dry withstand power frequency voltage - kV (ms)			
	e. One minute wet withstand power frequency voltage - kV (ms)			
	f. (i) 1.2 / 50 micro sec. Lighting impulse withstand voltage - kV (Peak)			
	(ii) Switching surge withstand test voltage kV (peak)			
	g. (a) Creepage Distance in air			
	(b) Creepage Distance (protected)			
	h. Quantity of oil in bushing and specification of oil used (Kgs)			
	i. Whether test tap is provided			
	j. Weight of assembled bushing			
	k. Phase to earth clearance in air of live parts at the top of bushing.			
	l. Minimum clearance (mm)	In Air		
		Between Phases	Phase to ground	
	(i) HV			
	(ii) LV			
	m. Partial discharge level			

	ADDITIONAL TECHNICAL PARTICULARS:			
8	Cooling system			
	a. Grade of oil			
	b. Total weight of oil in radiator in Kgs/litres			
	c. Total weight of radiator without oil in Kgs.			
	d. Total radiating surface in square meters			
	e. Method of drying out transformer at site			
	f. Type and make of material used for the radiators with size.			
	g. Type of radiator			
	h. Total number of Radiators/Banks for transformer and over all dimensions (LxBxH)			
	i. Rating of Transformer with one radiator bank out of service.			
	j. Total weight of radiators in Kgs			
	k. Type of mounting			
	l. Vacuum withstand capability			
9	Cooling equipment	Fan Motor	Pump Motor	
	a. Make and Type (Details)			
	b. Number of connected units (nos.)			
	c. Number of standby units (nos.)			
	d. Rated Power (KW)			
	e. BHP of driven equipment			
	f. Capacity (cu m/min) or (Litres/Minute)			
	g. Rated voltage (Volts)			
	h. Locked rotor current (Amps)			
	i. Temperature range control for which is adjustable			
	j. Efficiency of motor at full load (percent)			
	k. Temp. rise of motor at full load (^{o}C)			
	l.Whether the fan and/or pumps suitable for continuous operation at 85% of their rated voltage			

	ADDITIONAL TECHNICAL PARTICULARS:			
	m. Estimated time constant in hours for			
	i. Natural cooling			
	ii. Forced air cooling			
10	**On Load Tap Changing gear (should be SCADA *Compatible*)**			
	a. Make			
	b. Type			
	c. Power flow (uni-directional or bi-directional or restricted bi- directional)			
	d. Rated voltage to Earth kV			
	e. Rated maximum current Amps			
	f. Step voltage V.			
	g. Number of steps			
	h. Control: Manual/Auto/Local/Remote/Independent / Parallel.			
	i. Auxiliary supply details			
	j. Voltage control (whether automatic or manual)			
	k. Line drop compensation Provided / Not provided.			
	l. Protective devices			
	m. Time for complete tap change (one step) sec.			
	n. Divertor selector switch Transient time - Cycles.			
	o. Value of maximum short circuit current Amps.			
	p. Maximum impulse withstand test voltage with 1.2/50 micro seconds full wave between switch assembly and earth (kV peak)			
	q. Maximum power frequency test voltage between switch assembly and earth - kV rms.			
	r. Maximum impulse withstand test voltage with 1.2/50 micro seconds across the tapping range (kV peak).			

	ADDITIONAL TECHNICAL PARTICULARS:			
	s. Approximate over all dimensions of Tap changer mm			
	t. Approximate over all weight Kgs.			
	u. Approximate over all quantity of oil-ltrs/Kgs.			
	v. Particulars of the OLTC control panel for installation in the control room.			
	w. **OLTC Routine test shall be conducted on each Transformers.** i) Mechanical Endurance Test (Min. 1000 operations)			
	ii) Sequence Test			
	iii) Pressure Test			
	iv) Vacuum (Helium) Test			
	v) Auxiliary Circuit Insulation test			
	x. OLTC Drive Mechanism Box: Make & Type			
11	Over all dimensions of transformer including cooling gear, tap changing gear etc.			
	a. Length –mm			
	b. Breadth –mm			
	c. Height –mm			
	d. Reference drawing No.			
12	Whether oil temperature indicator provided (Yes/No).			
13	Type of oil level indicator and whether supervisory alarm contact for low oil level provided (Yes/No)			
14	Type and size of Gas operated relay and whether supervisory alarm and trip contacts provided and their size and Nos.			
15	Temperature indicators	Oil Temp. indicator	Winding temp. indicator	
	a. Make and Type			
	b. Permissible setting ranges for alarm & trip.			
	c. No. of contact			
	d. Current rating of each contact			

	ADDITIONAL TECHNICAL PARTICULARS:			
	e. Whether remote indicator provided, if, so, whether equipment required at purchaser's control room is included.			
	f. Size and No.			
16	Ratio and Type of CT used for winding temperature			
	a. Ratio			
	b. Type			
17	Type and size of Thermostat used			
18	No. of Breathers provided (No.)	For Tr.Tank	OLTC	
19	Type of dehydrating agent used for Breathers			
20	a. Capacity of conservator vessel litres			
	b. Volume between the highest and lowest visible oil level (litres)			
21	Valve sizes and number required/Fitted			
	i. Drain valves - mm - No.			
	ii. Filter valves - mm - No.			
	iii. Sampling valves - mm - No.			
22	a. Type and make of pressure relief device			
	b. No. of each type of devices per transformer unit (Nos.)			
	c. Minimum pressure at which the device operates (Kpa)			
23	Lifting jacks			
	a. Governing standard			
	b. No. of jacks in one set			
	c. Type & make			
	d. Capacity (tonnes)			
	e. Pitch (mm)			
	f. Lift (mm)			

	ADDITIONAL TECHNICAL PARTICULARS:			
	g.Height in closed position (mm)			
	h.Mean diameter of thread (mm)			
24	Characteristics of Insulating oil to be Used			
	1 – Function			
	Viscosity at 40 °C in mm²/s			
	Viscosity at -30 °C in mm²/s			
	Pour point in °C			
	Water content in mg/kg			
	Breakdown voltage in kV			
	Density at 20 °C in g/ml			
	DDF at 90 °C			
	Particle content			
	2 – Refining/stability			
	Appearance			
	Acidity in mg KOH/g			
	Interfacial tension in mN/m			
	Total sulphur content			
	Corrosive sulphur			
	Potentially corrosive sulphur			
	DBDS in mg/kg			
	Inhibitors of IEC 60666 in %			
	Metal passivator additives of IEC 60666 in mg/kg			
	Other additives			
	2- Furfural and related compounds content in mg/kg			
	Stray gassing			
	3 – Performance			

	ADDITIONAL TECHNICAL PARTICULARS:			
	Oxidation stability for uninhibited oil – 164 hrs			
	-Total acidity in mg KOH/g			
	-Sludge in %			
	-DDF at 90 °C			
	Gassing tendency			
	ECT			
	4 – Health, safety and environment (HSE)			
	Flash point in °C			
	PCA content in %			
	PCB content in mg/kg			
	5 – N-dm Analysis CA %			
	CM %			
	CP %			
	6. Details of oil preserving equipment offered.			

25, Miscellaneous data / details and checks.

Preferred List of Equipment Manufacturer

Sl.No.	Component	Supplier
1	PV Modules	BHEL,CSUN,,Renesola, Trina, Hanwha, TNBE, Jinko, CandianSolar or Teir 1 equivalent approved by MNRE, OATA, IEC.
2	Inverter	ABB, Bonfiglioli, Hitachi, Vacon, SMA or Equivalent approved by MNRE, GoI Recognised Accredited Agencies and Test LABs
3	Switchgears/Breakers	Bhel,Siemens, ABB, L&T, Equivalent approved by KPTCL Accredited Agencies and Test LABs
4	DC Cables	Top, Advance, Lapp, Siechem, Polycab, Equivalent approved by GoI Accredited Agencies and Test LABs
5	Jointing Kits / MC4 Connectors	RPG, Raychem, mseal or, Equivalent approved by, GoI Accredited Agencies and Test LABs
6	AC Cables	Unistar brand universal or Nicco or KEI or equivalent, Equivalent approved by, GoI Recognised Accredited Agencies and Test LABs
7	SCADA	Neo-Silica, L&T, ABB, Siemens,GE OR, Equivalent approved by, GoI Recognised Accredited Agencies and Test LABs
8	Transformer	BHEL, CGL, Voltamp, Bharat Bijlee, KEC, Alstom, EMCO or equivalent, Equivalent approved by, GoI Recognised Accredited Agencies and Test LABs
9	Module Mounting Structures	SIAL, TATA Steel, or equivalent, Equivalent approved by, GoI Accredited Agencies and Test LABs
10	String Monitoring Boxes	Hensel, L&T, Statcon, ABB , Trinity, Schneider Electric, OR, Equivalent approved by, GoI Recognised Accredited Agencies and Test LABs
11	Weather Monitoring System	Kipp and Zonen or equivalent, Equivalent approved by, GoI Accredited Agencies and Test LABs
12	Lightning Protection System	JEF Techno, PT, VNT or equivalent, Equivalent approved by, GoI Recognised Accredited Agencies and Test LABs
13	Transmission Line	As per KTPCL speficiations and site specific.
14	HT / LT cables	Universal, NICCO, RPG or equivalent, Equivalent approved by, GoI Accredited Agencies and Test LABs
15	Single Aixs Tracking System	Smart Track or equivalent system, Equivalent approved by, GoI Accredited Agencies and Test LABs
16	CCTV System	Bosch, pelco, sony.