INDIAN INSTITUTE OF PETROLEUM & ENERGY, VISAKHAPATNAM

Bids are invited for "Setting up a plant for the production of 1 ton/day (1 TPD) of Hydrogen from flue gas based desalinated water using alkaline electrolyzer / PEM technology with storage, and for extensive and detailed R&D activities at NTPC Simhadri, Andhra Pradesh along with 5 years of O&M"

Indian Institute of Petroleum & Energy (IIPE) invites offers for Setting up a plant for the production of 1 TPD of Hydrogen from flue gas based desalinated water using alkaline electrolyzer / PEM technology with storage, and for extensive and detailed R&D activities at NTPC Simhadri, Andhra Pradesh along with 5 years of O&M.

- Please refer to the technical and financial qualification criteria document in **Annexure -1**. Bidders satisfying the pre-qualification criteria alone need to respond to the tender.
- Please refer **Annexure-2** for Technical Specification and Scope of Work etc.

1 Instruction to the Bidders

1.1 Preparation of Bids

The tender should be submitted under two-bid system (i.e.) Technical bid and Financial bid in GeM portal.

1.2 Opening of the tender

The offer/bid will be opened by a committee duly constituted for this purpose. The technical bid will be opened first and will be examined by a technical committee which will decide the suitability of the bid as per the specifications and requirements with respect to opening the financial bid. The financial bid will be opened only for the technically qualified bidders.

1.3 Clarity in quoting of bids

Bidders are required to submit a single comprehensive amount covering all elements as per the Bill of Materials (BoM)/Bill of Quantity (BoQ) **(Annexure-H)** of this tender document. Before submitting the bid, the bidder is encouraged to visit, inspect and examine the site and its surroundings at his own cost. The bidder before tendering should clearly understand the scope of supply and work. No subsequent claim on account of ignorance shall be entertained. Any further clarification required should be sought from IIPE well in advance of submitting the bid. If the bidder chooses to visit the site, he has to provide specific

date for site visit to IIPE project office for making necessary arrangements.

Project Site address: Simhadri NTPC Power Plant, Visakhapatnam, Andhra Pradesh 531020. Latitude and longitude of the location are 17°35′08.0″N and 83°05′17.7″E.

1.3.1 Prices:

The price should be quoted including all components such as packing and delivery charges to the Project Site. Kindly note that IIPE Visakhapatnam is registered with Dept. of Scientific & Industrial Research (DSIR), Govt. of India and concessional customs duty is leviable vide notification No.51/96-Customs dated 23.07.1996 and relevant certificate will be issued (if required by the vendor).

1.4 Terms of Service

The site is offered on **AS IS WHERE IS** basis for the execution of this project. So, the terms of service include modifications of existing/new constructions for the project, design, fabrication, supply, erection and commissioning of various components, systems, and sub-systems at the project site. The project has to be undertaken as per the tender enquiry. In case of import supply of any equipment, raw material or component, the direct delivery to the project site has to be undertaken and at the cost of the supplier.

1.5 Bid Opening

As per the Tender document.

1.6 Right to IIPE

IIPE, Visakhapatnam reserves the full right to accept/reject this tender at any stage without assigning any reason.

2 Schedule

2.1 Important Conditions of the tender

2.1.1 System of the bid

The offers/bids are invited in two bids system i.e. Technical bid and Financial bid. Financial details of the bid value of this tender should not be presented in the Technical bid.

2.1.2 Earnest Money Deposit (EMD)

The EMD in the form of RTGS for ₹ $1,65,00,000$ should be paid in favour of Registrar, Indian Institute of Petroleum and Energy, Visakhapatnam. Any offer not accompanied with the EMD shall be rejected summarily as non-responsive. The EMD of unsuccessful bidders shall be returned within 30 days of the end of the bid validity period which is 180 days from the bid closing date. Any bidder who withdraws his offer after the opening of the financial bid and during the bid validity period will forfeit his EMD. The Institute shall not be liable for payment of any interest on EMD.

2.1.3 Performance Security

The successful bidder should submit Performance Security for an amount of 10% of the value of the contract. The Performance Security may be furnished in the form of an Account Payee DD, FD Receipt from the commercial bank, Bank Guarantee from any nationalized bank in India. The performance security should be furnished as per terms and conditions (T&C) of GeM.

Performance Security in the form of Bank Guarantee: In case the successful bidder wishes to submit Performance Security in the form of Bank Guarantee, the Bank Guarantee should be routed through the Beneficiary Bank to the end user bank. Otherwise, the Indian Agent of the foreign vendor has to submit a Bank Guarantee from a Nationalized Bank of India. The Bank Guarantee should remain valid for a period of 180 days beyond the date of completion of successful commissioning and PG test of the plant.

In case the seller/bidder submits the EMD in the form of Bank Guarantee/RTGS, the same shall be transmitted to below Institute (IIPE) Bank Account details

Name of the Account:	Indian Institute of Petroleum and Energy,
Name of the Bank:	State Bank of India,
Account Number:	39877553958, IFSC Code: SBIN0003170,
Branch Name:	AU College of Engg. Campus - Visakhapatnam, Andhra Pradesh.

Scan Copy of EMD of requisite value (i.e. ₹ $1,65,00,000$) as per ATC/GTC is to be submitted.

2.1.4

The offer/bids should be sent only for a machine that is available in the market and supplied to a number of customers. Quotations for a prototype machine will not be accepted.

2.1.5 Definition of the Bidder for this Tender

(a) The bidder should be a Legal Entity continuously operational since last 10 Years. Legal Entity of the firm is any of the below. (Supporting documents as mentioned to be submitted).

1. Sole Proprietorship Private Limited [*Supporting document to be submitted*]
2. Public Sector Undertaking [*Supporting document to be submitted*]
3. Private Limited Limited Company [*Supporting document to be submitted*]
4. In case of Company – Copy of Registration/ Incorporation Certificate by Ministry of Corporate Affairs (MCA). [*Supporting document to be submitted*]
5. In case of Sole Proprietorship – Duly notarized Undertaking from Sole proprietor. [*Supporting document to be submitted*]

(b) The bidder should have unblemished record and must not be blacklisted or declared ineligible for corrupt & fraudulent practices by any state/central government department/public sector undertaking as on date of bid opening.

1. The bidder shall provide an Undertaking as per the **Annexure - A**

(c) A consortium/Joint Venture is not allowed to bid for this engagement. A bid of agencies with Joint venture and amalgamation will summarily be rejected.

(d) The bidder can use its Parent/Associate company's credentials to meet the technical and financial requirements. In such case, the Parent/ Associate company should meet the requirement of 2.1.5 (a) and 2.1.5 (b) supported with the following documents

- Letter of Undertaking supported by the Parent/Associate Company's Board Resolution for technical and financial support for bidder for the execution of the Contract

2.1.6 Period of Validity of bid

The Bid shall remain valid for a period of one hundred eighty (180) days from the deadline set for submission of Techno-Commercial Bid.

2.1.7 Delivery Schedule

The tender response should indicate clearly the time required for undertaking complete project in all respects including successful commissioning. The detailed schedule of the project must be clearly indicated, and commissioning should take place within 12 months from placing of the purchase order (PO)/ contract. In case there is delay in project commissioning, liquidated damages clause will be enforced or penalty for the delayed project completion will be levied. However, IIPE reserves the right for extension if sought under unavoidable circumstances. If there is delay and the extension is not granted by IIPE, the penalty will be @ 0.5% per week of delay subject to a max of 10% of the value of PO as per terms and conditions of GeM, and if the delay exceeds what is considered excusable by IIPE project committee then the contract will be cancelled and liquidated damages will be enforced.

2.1.8 Risk Purchase Clause

In the event of failure of supply of the item/equipment within the stipulated delivery schedule, the purchaser has all the right to purchase the item/equipment from other sources on the total risk of the supplier under risk purchase clause.

2.1.9 Payment terms of the EPC

(a) **Payment terms:** Design, Engineering, Installation of Hydrogen Plant Using Flue-Gas Based Desalinated Sea Water at NTPC-Simhadri and storage

1. 80% of the value of bought out goods (please refer **Annexure - H**) will be paid against receipt of supplied items at site after physical verification and inspection by IIPE.
2. 10% after erection and commissioning of the complete plant and equipment.
3. Balance 10% will be made after successful completion of the performance guarantee test.

(b) **Payment terms:** Operation and Maintenance of Hydrogen Plant Using Flue-Gas Based Desalinated Sea Water at NTPC-Simhadri.

1. Quarterly payment will be made against submission of performance data and evaluation and invoice.

2.1.10

The entire project shall be executed in consultation with IIPE.

2.1.11 On-site Installation

The equipment or machinery has to be installed or commissioned by the successful bidder post undertaking complete constructions as per the project plan and design within the stipulated time frame of the project.

2.1.12 Warranty

1 (One) year warranty period for the machinery/equipment/systems/sub-systems and construction undertaken from the date of successful commissioning of the plant.

2.1.13 Late offer

The offers received after the due date and time will not be considered.

2.1.14 Acceptance & Rejection

IIPE Visakhapatnam has the right to accept the whole or any part of the Tender or portion of the quantity offered or reject it in full without assigning any reason.

2.1.15

Do not quote the optional items or additional items unless otherwise mentioned in the Tender documents /Specifications. The quotes should comprehensively cover all the relevant equipment/components, construction and installation charges in the specified manner as given in **Annexure - H**.

2.1.16 Integrity Pact

To improve transparency and fairness in the tendering process the Buyer is implementing Integrity Pact. Integrity Pact is deemed as part of the contract so that the prospective bidders are bound by its provisions. The Integrity Pact, signed by all the prospective Bidders and the Buyer, shall commit the persons/officials of both the parties, not to exercise any corrupt/fraudulent/collusive/coercive practices in the Tendering process and also during implementation of the Contract. Only those Bidders who have entered into Integrity Pact with the Buyer shall be eligible to participate in the bidding process.

2.1.17 Disputes and Jurisdiction

Settlement of Disputes: Any dispute, controversy or claim arising out of or in connection with this tender including any question regarding its existence, validity, breach or termination, shall in the first instance be attempted to be resolved amicably by both the Parties. If attempts for such amicable resolution fails or no decision is reached within 30 days whichever is earlier, then such disputes shall be settled by arbitration in accordance with the Arbitration and Conciliation Act, 1996. Unless the Parties agree on a sole arbitrator, within 30 days from the receipt of a written request by one Party from the other Party to so agree, the arbitral panel shall comprise of three arbitrators. In that event, the supplier will nominate one arbitrator and the Project Coordinator shall nominate one arbitrator. The Dean of Research and Development (DoRD) of IIPE will nominate the Presiding Arbitrator of the arbitral tribunal. The arbitration proceeding

shall be carried out in English language. The cost of arbitration and fees of the arbitrator(s) shall be shared equally by the Parties. The seat of arbitration shall be at IIPE Visakhapatnam.

2.1.18 The Applicable Law

This Purchase Order shall be consolidated, Interpreted and governed by the Laws of India. The court at Visakhapatnam shall have exclusive jurisdiction subject to the arbitration clause. Any legal disputes arising out of any breach of contract pertaining to this tender shall be settled in the court of competent jurisdiction located within the city of Visakhapatnam in Andhra Pradesh.

(Annexure - 1)

3 Technical and Financial Qualification Criteria for the Tender

"Setting up a plant for the production of 1 ton/day of Hydrogen from flue gas based desalinated water using alkaline electrolyzer / PEM technology with storage, and for extensive and detailed R&D activities at NTPC Simhadri, Andhra Pradesh along with 5 years of O&M"

3.1 Background

Production of hydrogen from green resources in a cost-effective manner, its compression and storage, transportation, and utilization, etc. will contribute to a robust hydrogen economy and will help India develop clean fuel resources in the years and decades to come. The government of India has established ambitious goals for producing and utilizing clean and renewable hydrogen in the next decade. In accordance with the policies of the Government of India and by virtue of the objectives of IIPE as an institute to develop innovative technologies in the field of renewable energy, IIPE is aggressively pursuing R&D activities in this area. Consequently, in this proposed facility to produce1 ton hydrogen per day there will be extensive and detailed research and development activities towards the above goals for high efficiencies at affordable cost.

IIPE has aspirations to become a National Center of Excellence in hydrogen research and development. Currently, there are some R&D projects in progress in the Department of Chemical Engineering at IIPE by the faculty and the research scholars of the institute. They involve lab-scale hydrogen production technologies through advanced electrode development, membrane materials, etc. This project will assume a main role and will pave the way for augmenting other developmental efforts at IIPE.

This tender calls for applications from reputed firms which have a proven track record in each of the areas of design, development, demonstration, generation, storage, performance evaluation, as well as research and development in renewable energy production such as wind, solar PV, solar thermal, geothermal and hydrogen production. The bidder should have established records of significant achievement in scientific research and development in the above-mentioned areas over a long period of time.

Since the research and development activities described above involve a variety of technologies, and IIPE seeks the successful bidder to possess integrated knowledge in the above fields to be able to provide a constructive and comprehensive partnership to IIPE in hardware, software, experimentation, advanced analytical abilities, expertise and innovation in Physics and Chemistry, a consortium is not allowed in this project in order to ensure a close, committed and efficient working relationship with IIPE researchers.

IIPE seeks bids from an organization which should be a legal entity and continuously operational for the past 10 years or more. Legal Entity of the firm shall be a Sole Proprietorship / Private Limited/ Public Sector Undertaking/ Limited Company which has the technological and scientific expertise as well as expertise in designing, procuring, installing, commissioning, operating and maintaining the plant.

The bidders must have significant record of R&D activities and ability to set up and run this research facility with appropriate instrumentation, recording various physical, chemical, electrical and controls parameters and data reduction facilities for analysis of data, interpretation of results and parametric exploration with a view to advance the state of the art in improving efficiencies and reducing production costs of green

hydrogen.

Secondly, the successful bidder will work with IIPE faculty members and research scholars in developing new technologies in green hydrogen production. The technologies to be developed should be consistent with commonly available renewable resources in various places of India so that efficient and distributed production of green hydrogen is facilitated. The approach of IIPE is that the successful bidder will blend his research and technology talents with the IIPE researchers promoting vigorous invention. Hence the bidders should be creative and scientifically and technologically competent. The bidder should be able to set up complex machines, carry out instrumentation, data reduction, optimization by simulation and interpretation facilities. By virtue of their past technological achievements in the last ten years or more the bidders should demonstrate in a compelling and convincing manner the values they bring to IIPE as designers, developers, constructors and researchers.

The bidder should have a respectable track record of reputed research work in the renewable energy area, hydrogen production, water purification, and seawater desalination technology.

The successful bidder should have a detailed working scientific knowledge of the systems they are required to build. This organization should have commitment and dedication to improve the efficiencies of these technologies over the next five years after installation. The bidder should carry out operation and maintenance (O&M) for 5 years after the commissioning of the plant.

3.2 Technical pre-qualification Criteria

Bidder or Bidder along with its Parent/Associate company are to fulfill technical pre-qualifying criteria as shown below.

Criteria	Document(s) Required
At least one EPC ongoing / completed project with same /similar* kind of Project with value not less than ₹ 5,00,00,000 in last three financial years by the bidder or its Parent / Associate company.	Purchase Order (PO) copy / Notification of Award

* Same/ Similar kind of projects means: Projects in Hydrogen generation/water purification/ desalination executed or ongoing by the bidder or its Parent/Associate company.

3.2.1 Financial Qualification Criteria

1. Financial qualification is as per GeM tender document.
2. OEM can be Bidder's parent company.

3.2.2 Evaluation of bids

The bids are evaluated in a Quality Cost Based Selection (QCBS) methodology.

(a) **Basis for the Evaluation of Technical Proposal**

The Selection Process is designed to select a technically strong bidder who can construct the hydrogen plant satisfying all the requirements in a cost-effective manner and carry out advanced research and development activities.

1. The applicants are required to submit both technical and financial proposals. The Maximum marks awarded for the technical proposal is 100 marks.

2. The minimum qualifying marks of the bidder for opening of respective financial bid is 70 marks.

(b) **Marking procedure**

1. The highest technical score will be given the maximum Technical score (TS) of 70 points. The Technical scores of the other bidders will be computed as $TS = 70 \times (H/H_{max})$ where H is the marks awarded for the technical proposal for the individual bidder and H_{max} is the highest technical marks awarded among all the qualified bidders.

2. The lowest financial bid will be given the maximum financial score (FS) of 30 points. The financial scores of the other bidders will be computed as $FS = 30 \times (L_{min}/L)$ where L_{min} is the lowest financial bid value of all qualified bidders and L is the evaluated bid price of the individual bidder.

3. The proposals will be ranked according to their combined technical (TS) and financial scores (FS). The bidder achieving the maximum combined Technical and Financial score, CS (Combined Score) will be awarded the contract.

4. Then the combined score, CS based on the formula: Total score, $CS = TS + FS$.

5. If two or more bidders are getting the same/equivalent/tie scores in both/combined technical and financial evaluation, the preference will be given to highest score secured in the technical evaluation score.

Example

Let us assume that there are five bidders viz. A, B, C, D and E.
Technical score - Bidder A: 76, B: 84, C: 90 and D: 96. E : 65
Bidder E does not qualify for opening of financial bid as the technical score is less than 70.
Financial quote - Bidder A: ₹ 220 lakhs, B: ₹ 240 lakhs, C: ₹ 230 lakh and D: ₹ 320 lakhs.

Bidder	Technical score (TS)	Financial score (FS)	Combined score (CS)	Rank
A	$(76/96) \times 70 = 55.41$	$(220/220) \times 30 = 30$	85.41	4
B	$(84/96) \times 70 = 61.25$	$(220/240) \times 30 = 27.5$	88.75	3
C	$(90/96) \times 70 = 65.63$	$(220/230) \times 30 = 28.7$	94.32	1
D	$(96/96) \times 70 = 70$	$(220/320) \times 30 = 20.63$	90.63	2
E	Not Qualified	-	-	Rejected

(c) **Technical Score:** Bidders or Bidder along with its Parent / Associate are to fulfil all the following technical criteria.

Sl.	**Criteria**	**Documents Required**	**Max. Marks**
1	Certification for in-house R&D recognition for minimum of last ten years.	DSIR Certification for in-house R&D recognition or an equivalent recognition from the Government of India for the last ten years	05
2	The R&D Project should have been executed with Government / PSUs/CFTIs. [2.5 marks shall be awarded for each completed project of same/similar** kind of works/services of having minimum value of Rs. 2.0 cr each]	For each project provide (a) Sanction order/ PO copy, and (b) Completion Certificate or Project completion report or Signed copy of Performance Guarantee Test Report or equivalent.	10
3	2.5 marks shall be awarded for each of two completed EPC projects with same/similar** kind of process plant having minimum value of Rs. 5Cr each	(a) Notification of Award (NOA) /PO copy, and (b) Completion Certificate or Project completion report or Signed copy of Performance Guarantee Test Report or equivalent.	05
4	Experience in flue gas based seawater desalination project: At least one project of Rs. 5 Cr minimum will be awarded 20 marks.	(a) Notification of Award (NOA) / PO copy (b) Completion Certificate or Signed copy of Performance Guarantee Test Report.	20
5	A presentation should be made to IIPE by the Project Program Manager explaining the following details: (i) R&D and EPC Experience of the project team (ii) Project execution methodology (iii) Project Schedule (iv) Project deliverables (v) Technical Description (vi) Performance Guarantee test procedure (vii) O&M Note: No marks shall be awarded if any other person makes the presentation.	Relevant documents are to be submitted and presented as per the criteria mentioned in the left-hand side from (i) to (vii).	50

6	Experience and exposure of key personnels in R&D domain and project planning with the following criteria: **R&D and Project Planning Team:** Team Lead (Minimum 1) B.E/B.Tech from IIT/ IISc with post qualification R&D experience of 25 years or more. **Technology expert (Minimum 1):** PhD from IIT/IISc with post qualification experience in R&D for 15 years or more. **Project Program Manager (Minimum 1)** M.E/M.Tech from IIT/IISc with post qualification R&D experience of 10 years or more. **Project Execution Team:** Senior Engineer (Minimum 1): B.E/ B.Tech with post qualification experience of 10 years or more. **Erection Manager (Minimum 1):** Minimum ITI in mechanical trade with post qualification experience of 10 years or more in site supervision, erection & commissioning. Erection manager has to be deployed at the site. Experience in erection and commissioning work at PSU sectors by following all statutory clearances and safety procedures will be desirable.	Each team member's CV	10

** Same/Similar kind of project means: Projects in Research and Development in the renewable energy area/ hydrogen generation / water purification / Desalination executed by the bidder or its Parent/ Associate company.

Note: A project presented to support one of the requirements above cannot be presented again for fulfilling another requirement of the tender to meet the Technical Score.

4 Technical Specification

"Setting up a plant for the production of 1 ton/day of hydrogen from electrolysis of flue-gas based desalinated sea water with storage, and for extensive and detailed R&D activities at NTPC Simhadri, Andhra Pradesh along with 5 years of O&M"

4.1 Project Information

This project is part of an ambitious initiative of IIPE for the production, storage and distribution of green hydrogen. The project duration consists of 1 year of building the plant followed by 5 years of O&M and R&D activities. The goals are to achieve high efficiencies in various processes involved and to achieve low cost of production.

4.2 Project Location

This project will be implemented at the NTPC Power plant, Simhadri, Visakhapatnam, Andhra Pradesh 531020. Latitude and longitude of the location are 17°35′08.0″N and 83°05′17.7″E.

4.3 Intent of the Project

The intent of the project is to generate 1 ton/day of hydrogen using electrolysis technology with 2-ton storage for research and development at NTPC Simhadri. The associated by-product oxygen gas produced shall be vented as per the operational norms. Hydrogen produced is directed to the bottling station, from which end- users will be supplied in cylinders/trucks.

In Section 1 (Background) of Annexure - 1, the strong emphasis placed on research and development activities is described. In this Annexure the specification pertains to the equipment to be supplied.

4.3.1 Technology

The generation of Hydrogen (1 TPD) shall be based on electrolysis from flue-gas based desalinated water source.

4.3.2 Plant input Parameters

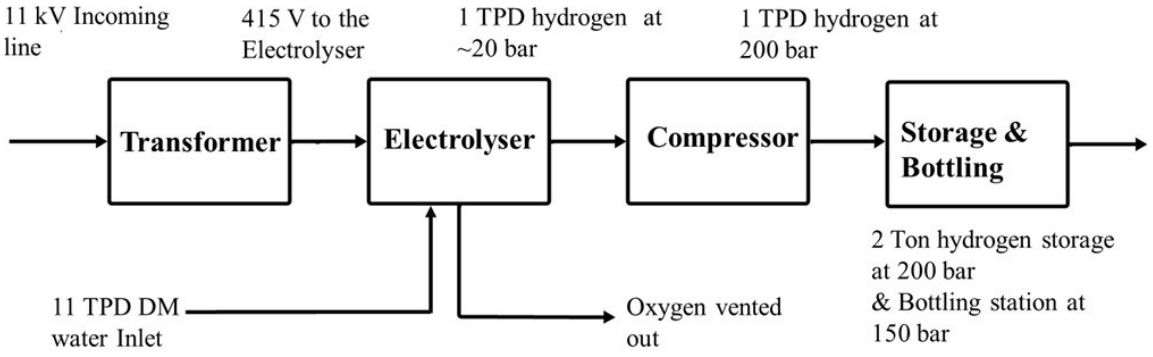
Sl.	**Description**	**Value (Indicative)**
1	Power Grid	Power, 3 Phase, 11kV
2	Quality of Input Water for Hydrogen Production (Water)	Silica: < 0.1 mg/L, Iron (As Fe): Below Detectable Limit, Total Hardness: less than 10 (mg/L), Conductivity: < 10 μS/cm, PH value: 5.6-6.5
3	Cooling water/Raw water	pH: 6.5-7.8, Turbidity: < 12 NTU, Conductivity: 1200-1500 μ S/cm

Note: The water parameters provided are indicative only. The agency must analyze the water samples during engineering and equipment/process to be finalized.

4.3.3 Plant Capacity and Design Consideration

Sl.	Description	Value
1	Electrolyzer Technology	Alkaline/PEM or better Electrolyzer
2	Guaranteed Capacity	1 TPD (41.66 kg/hr)
3	Minimum Percentage Purity	99.99%
4	Hydrogen Compressor	Oil free / Oil Lubricated Standard High Pressure Compressors. (1 Working + 1 Standby)
5	Storage	2 Ton Storage at 200 Bar
6	Bottling Station	1 ton/day

Indicative Schematic is given below

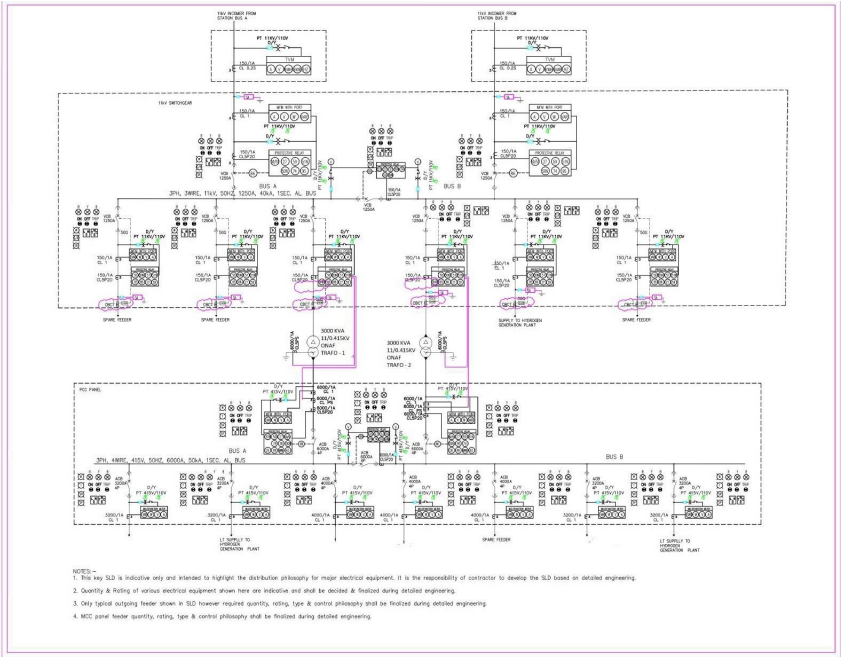


- HT Supply: 11KV SLD provided for distribution arrangement.
- Distilled water from FGD Plant.

4.3.4 Brief Scope of Work

The brief scope of work for the package is as follows:

1. The scope includes Design, Engineering, Manufacturing, Procurement, Packing and Forwarding, Transportation, Unloading, Storage, Installation & Commissioning.
2. Obtaining all Statutory approvals and conducting performance guarantee (PG) tests
3. Five years Comprehensive O&M of the System.



4.3.5 Scope of Package

(a) **Scope of Supply & Services**

All supporting packages and utilities other than those mentioned under the heading 'Terminal Points (VI)' required for the Hydrogen Plant shall be provided by the bidder.

Any items or works though not specifically mentioned in this specification but needed to complete the equipment & systems to meet the intent of the specification shall also be in the scope of work. Broad scope of supply and services are following:

1. Design & Optimization through simulation of PEM/Alkaline electrolyser, to be vetted by IIPE or third party in consultation with IIPE by the bidder.

2. Bidder shall carry out design of process and auxiliary systems, controls, equipment sizing, equipment / selection, material selection etc., with the manufacturer, in a manner which ensures safe and normal / emergency operation and plant shutdown - and obtain approval / Acceptance of IIPE.

3. Bidder shall submit all engineering drawing and documents including (i) Operation & Control Philosophy, (ii) Drawings and Documents pertaining to Design and Engineering. (iii) Datasheets, (iv) Field Quality Plan and its compliance, Calibration & Test certificates. (v) Bill of quantity (BOQ) for supply items and mandatory spares.

4. Submission of list of BOQ, Mandatory Spares.

5. Supply of items listed in BOQ as per the indicated specifications including Mandatory Spares.

6. Packing and forwarding, Clearances and approvals, loading, transportation, unloading, storage and preservation of equipment at the site.

7. Civil, mechanical, electrical and C&I erection including conducting all field tests as per Field Quality Plan (FQP).

8. Compliance of all safety related statutory requirements during erection & commissioning and O&M followed at site (NTPC Simhadri)

9. Labour license permit till the completion of the project in compliance with all legal/ statutory labour regulations of central/state authorities applicable at site (NTPC Simhadri).

10. Performance Guarantee tests after completion of initial continuous trial operation of 3 days duration including, Test procedure, manpower etc.

11. Warranty of complete Hydrogen Generation System for Twelve (12) months after the successful commissioning.

12. Training (Minimum three (3) days) encompassing design, O&M, troubleshooting etc., for Hydrogen Generation Plant.

13. For all bought out items, individual warranty of equipment shall be passed onto employer.

14. Separate Safety officer and personal protective equipment for all working personnel as per the requirement of safety norms followed at site.

15. Soil Bearing Test (SBT), as required, shall be in scope of bidder.

16. Bidders are advised to obtain latest Meteorological data from nearest observatory to the Project location and use the same for design of Hydrogen Generation Plant.

17. Major equipment shall broadly conform with the relevant International/National standard of design, engineering & workmanship and shall be capable of performing the required duties in a manner acceptable to Engineer / Owner, who will interpret the meaning of drawing & the specification & shall be entitled to reject any work or material, which is not in full accordance herewith. The Quality plan of major equipment shall be finalized during detailed engineering.

18. The list of codes and regulations given in this document is not exhaustive. The bidder shall provide a list of all codes and standards that the bidder shall use in their designs, and this shall be submitted to IIPE for approval.

It is not the intent to specify herein all aspects of engineering and construction. The Bidder shall be responsible for providing all materials, equipment and services, specified or otherwise (unless specifically excluded) which are required to fulfil the intent of ensuring operability and the reliability of the complete system covered under this specification. Sub-vendors for all bought- out and out-sourced items shall be finalized in consultation with IIPE, also sub contracts for the erection & commission work shall be finalized in consultation/approval with IIPE.

Brief scope of Comprehensive O&M for the package includes but not limited to the following:

1. Comprehensive O&M (Operation & Maintenance) of the complete plant along with all mechanical, electrical, C&I, Civil, Utilities & Safety systems. Any damages due to the occurrence of any natural calamity shall be under the scope of IIPE.

2. The Scope of Work includes manpower, tools and tackles for a period of five (05) year from the date of successful completion of trial run.

3. Consumables, chemicals, spares during O&M shall be as per actuals under the scope of IIPE.

4. The scope of work also includes maintaining and following all statutory requirement/norms including certification/renewals required for O&M of the plant.

5. Detail scope of work is mentioned in next Section under Clause "Comprehensive Operation & Maintenance".

(b) **General Guidelines**

1. Site Survey: The bidder is advised to inspect and examine the site and its surroundings and should satisfy himself the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and enable himself to prepare bid and see site conditions of operation at his own cost. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the IIPE.

2. Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. However, if the bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.

3. All material supplied/constructed or otherwise shall be property of the owner after billing/receipt at site. However the custodian of the same shall be the contractor (including insurance/storage/protection from damage or loss) till the completion of the facilities and successful handing over of the facility to the owner.

(c) **Facilities Provided by IIPE**

1. **Land:** Outdoor land measuring Approximately 77 m X 50 m is earmarked in the NTPC Simhadri premise marked in the General Layout Plan with terminal points below.

2. **Electricity** 415 V 3 Ph AC electricity required for construction shall be provided by IIPE free of cost at the terminal point. Laying of cabling using existing cabling gallery/trench/new cable gallery/new trench from terminal point to till project site shall be bidder scope.
   11 kV 3 Ph AC electricity required for construction, commissioning, testing and subsequent O&M shall be provided free of cost at the terminal point. Laying of cabling using existing cabling gallery/trench/new cable gallery/new trench from terminal point to till project site shall be bidder scope.

3. Distilled water and Service water will be provided at the below terminal points. laying of piping using existing cabling gallery/trench/new cable gallery/new trench from terminal point to till project site shall be bidder scope.

(d) **Terminal Points**

1. Terminal points indicated are indicative only. However final tie-in points location and routing shall be finalised in mutual discussion during engineering.

2. TP1, Distiled Water: IIPE shall provide water supply for hydrogen generation purpose at the distance of approximately 1500m to 2500m (indicative) from Hydrogen Generation Plant. Further distribution by using existing pipe gallery/trench/new pipe gallery/new trench from terminal point to till project site shall be bidder scope as per requirement of Hydrogen Generation Plant.
   The bidder is advised to include any/all water treatment system required for electrolysis unit to enhance the water quality suitable for the electrolysis process.

3. TP2, service water will be provided at a range of 1500 to 2500 m (indicative) from Hydrogen Generation plant. Service water of the following quality shall be provided for construction, commissioning, testing and O&M period by IIPE at the Terminal Point.
   The bidder is advised to include any/all water treatment system required for other utilities/cooling etc.

4. TP3, Fire Fighting: Fire hydrants post are available within a distance of 1500m to 2500m(indicative)from the plant boundary. It will be in the scope of agency to extent the hydrant and sprinkler line to project site far fire-fighting system. All necessary equipment system after the, hydrant tap off point shall be in the scope of bidder. Any other system or material like smoke detectors, response indicators Manual Call Points, Hose cabinet/ box. Branches / Nozzles, Hose-reels, Hose pipe. Sprinklers. Fire Extinguishers, repeater panel. FAS panel etc. required for completing the fire fighting system shall be in the scope of the vendor

5. TP4, Electrical: IIPE shall provide 3 phase 11 kV AC power supply of adequate rating to feed 1TPD Hydrogen Generation Plant. Any other voltage level, if required for the system, shall be arranged by the Bidder. The electrical supply extension system from termination point (TP4) to Hydrogen Generation Plant and HT/LT switchgear shall be under the bidder's scope. The terminal point has been summarized below along with the description of its tapping point.

6. Terminal point Summary Table

Sl.	**Resource Point**	**Approximate Distance from site (m)**
TP 1	Distilled water	1500 - 2500
TP 2	Service water	1500 - 2500
TP 3	Fire Fighting water	1500 - 2500
TP 4	Electrical: 11kv, 3- Phase	1500 - 2000

4.3.6 Standards

1. The Hydrogen Generation System/Process should comply with the following mentioned standards along the all relevant National and Internationals standards for safe and reliable operation of Hydrogen Generation system.

ISO 22734:	Hydrogen generators using water electrolysis- Industrial, commercial, and residential applications

2. The gas storage containers to store the hydrogen gas shall comply with the following mentioned standards

ISO 19884:	Gaseous hydrogen - Cylinders and tubes for stationary storage
ISO 9809-1	Gas cylinders - Refillable seamless steel gas cylinders - Design, construction and testing - Part 1: Quenched and tempered steel cylinders with tensile strength less than 1100 MPa
ISO 11114-1	Transportable gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 1: Metallic materials
ISO 11114-4	Transportable gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement

4.3.7 General Operational Criteria and Conditions

1. The Hydrogen Generation plant shall be designed for continuous duty.
2. The Hydrogen Generation plant shall be designed to operate in Indian Environmental conditions (Up to Ambient temperature of 50 degree Celsius).
3. The Hydrogen Generation plant shall have the flexibility to operate in part load.(50% to 100% load).
4. The Hydrogen Generation Plant shall be equipped with all required protections to safe shutdown/trip the plant in any case of exigencies and emergencies with respect to operation of Hydrogen Generation plant and safety of equipment and persons.
5. The Hydrogen Generation System/Process should comply with the following mentioned standards along the all relevant National and Internationals standards for safe and reliable operation of Hydrogen Generation system.

ISO 22734:	Hydrogen generators using water electrolysis - Industrial, commercial, and residential applications

4.3.8 Performance Guarantee (PG) Test

1. PG Test shall be carried out to demonstrate the 1 Ton/Day i.e. 38 Kg/hr of Hydrogen Production Capacity production capacity while simultaneously meeting the purity of Hydrogen as mentioned above under the head 'Design Considerations'.
2. PG Test shall be carried out after completion of 'Trial Operation'.
3. Liquidated damage for deviation in performance shall be computed as per following formula:

$$\text{Deviation in performance} = \frac{(\text{Test capacity of H2 production}) - (\text{Guaranteed capacity of H2 production})}{\text{Guaranteed capacity of H2 production}}$$

$$\text{Liquidated damage} = (\text{Contract value}) \times (\text{Deviation in performance})$$

4. PG Test duration shall be 24 continuous hours.
5. Bidder shall provide the PG Test procedure for approval of NTPC.
6. PG test shall be carried out as per the approved PG Test procedure. PG test procedure shall be submitted and finalized within the mutually accepted date from the date of Notification of Award.
7. The Bidder shall be responsible for providing all material, equipment and man power, consumables specified or otherwise, which are required to carry out PG Test.
8. There shall be no incentive / reward in case of positive performance deviation i.e when tested capacity of hydrogen generation is more than the guaranteed capacity.
9. Contractor's aggregate liability to pay Liquidated Damages (LD) for failure to attain the performance guarantee shall not exceed ten percent (10 %) of the Contract Price.
10. In case it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met, Employer will accept the equipment/system/plant after levying liquidated damages.

4.3.9 Details of Equipments

The scope of work for the equipment and accessories to be furnished in accordance with this Sub- section "Intent of specification" shall include design, manufacture, engineering, inspection and testing at suppliers works, packing, forwarding to site, unloading, erection, supervision, pre- commissioning, testing and commissioning and performance testing of the equipment/system and works indicated in this Sub-section of the technical specification. Any item or works though not specifically mentioned in this specification but needed to complete the equipment & systems to meet the intent of the Specification shall also be furnished by the contractor.

(A) **Electrolyzer Unit**

1. **Electrolyzer**
   (a) The system may be containerized/non-containerized.

(b) The Electrolyzer to be designed to operate at part load of normal capacity without any disconnection, interruption of operation and shall produce the hydrogen gas of specified purity and dryness.

(c) All measuring instruments, controller and control valves shall be provided.

(d) Appropriate Safety devices are to be provided for Hydrogen Generation System for safe release of Hydrogen, pressure build up etc.

(e) Hydrogen leak detection system: Hydrogen leak detection and interlock system shall be provided in generator and hydrogen filling area for alarm and trip of hydrogen generation plant.

(f) To be designed so that it can be dismantled, cleaned and reassembled easily.

(g) Proper sealing shall be provided by Bidder while crossing the wall to avoid any leakage to the Rectifier room. (if non-containerized).

(h) Relevant IS/IEC standards shall be applicable for Rectifier Assembly for Hydrogen Generation Plant.

2. **Rectifier**

(a) Adequate numbers/rating of rectifiers to cater to the load of each of the Electrolyzer.

(b) The rectifier equipment shall be complete in all respect with rectifier transformer, thyristor converter, electronic control and annunciation, filter choke, etc. mounted in the suitable panel.

(c) Relevant IS/IEC standards shall be applicable for Rectifier Assembly for Hydrogen Generation Plant.

3. **Feed-water tank**

(a) One number feed water storage tank of adequate capacity shall be provided for requirement of hydrogen gas generation on a continuous basis at the rated capacity.

(b) The tank shall be fitted with level switches/transmitter/ level indicators etc.

4. **De-oxy units**

(a) The suitable automatic operation based de-oxy unit shall be provided to remove the oxygen as impurity.

(b) The de-oxy unit should have accessories and necessary equipment to provide the mentioned purity.

(c) The operation of De-oxy System shall be automatic and should be appropriately interfaced with PLC.

5. **Drying system for Hydrogen gas**

(a) The suitable Hydrogen Dryer with a standby shall be provided to remove moistures from Hydrogen

(b) The operation of Drying System shall be automatic and should be appropriately interfaced PLC command.

6. **Flushing/Purging System**

(a) The complete flushing/Purging system- filled cylinder/tonner/Cartridge to be provided for four rounds of Purging.

(b) The system shall be provided with necessary connection with proper isolation devices, valves, manifold piping to enable purge the system with nitrogen for commissioning (if required) and each maintenance work.

7. **Piping**

(a) All pipe to conform with ANSI/ASME/ASA pressure piping code and seamless type.

(b) The piping system shall conform all relevant National/ International standards of handling Hydrogen gas.

Standard No.	**Title**
OISD 118	Layout for oil and gas Installations
NFPA2	Hydrogen Technologies Code

(c) All high-pressure joints shall be of welded construction.

(d) All vents to be fitted with flame arrestor.

(e) All piping systems shall be hydro tested at 1.5 times the design pressure subject to regulation of 374 IBR or as per standards for Hydrogen piping. However, for such systems where it is practically not possible to do hydro tests, the tests as called for in hydrogen handling (ASME B31.12) & Utilities (ASME B31.3) in lieu of hydro test shall also be acceptable.

(B) **Hydrogen compression, storage and bottling unit.**

1. **Hydrogen Compressor**

(a) The type of compressor shall be oil free or oil lubricated. Number 2 $\times$ 100% capacity

(b) Standard: API 618 or equivalent suitable for hydrogen handling

(c) The inlet of the compressor shall be hydrogen (99.99% purity) and the inlet of the compressor should match with the Electrolyzer outlet flow and pressure.

(d) The compressor shall be design (with respect to stage/cylinder etc) and equipped with unloaded VFD to optimise the power consumption in continuous and in non-continuous load conditions.

(e) The output of the compressor shall be hydrogen at pressure of 200 bar with same purity level as inlet (99.99%).

(f) Necessary closed loop cooling system (Air/liquid cooled) shall be equipped with compressor to maintain the operating temperature.

(g) Automatic oil leak detection and control system that monitors the integrity with respect to contamination free compression.

(h) The compressor should be skid based mounting with automatic positive priming, aftercoolers and fully instrumented for PLC based control system with remote/local operation with Automatic on/off system, Flow control system, Motor starter, Pressure and Temperature gauges. Switches. Transmitters, Pressure control system, Pulsation Dampeners, Receiver Tank, Separators, Suction filters, relief and safety valves, H_2 gas leak detection system.

2. **Hydrogen Storage**

(a) The purity of the hydrogen to be stored in the cylinders shall be monitored on line as per Gas Cylinder Rules and only after the gas meets the required purity it shall be filled in the cylinder. For the subsequent use the Hydrogen needs to meet the purity level of 99.99%

(b) Hydrogen to be stored in Quads/Cascade formed of refillable High-Pressure Seamless Steel Gas Cylinder confirming to IS 7285 complete with neck ring, valve and cap, valve as per relevant IS:3224, painted as specified under Gas Cylinder Rules 1981 and supported with Manufacturer's Test Certificate and approval from the PESO/ other safety agencies.

(c) The PESO / any other safety approvals required shall be under the scope of the bidder with proper documentation and has to be renewed as required for the complete O&M period of 5 years.

(d) The Normal working pressure of the Quads/Cascade/cylinder is minimum 200 bar

(e) The Quads/cascade to be designed with manifold including necessary pigtails, pressure gauges, pressure regulators, safety relief valves, flow control valves, purge valves etc such that the storage system can be filled (from compressor) in a safe and reliable manner.

(f) The Hydrogen storage area shall be equipped with leak/fire detector and control system in compliance with NFPA and PESO/CCOE guidelines. The storage area layout shall be as per applicable norms and certified by the authorities.

(g) Each batch of cylinders shall be covered by a certificate signed by the inspecting authority's representative to the effect that the cylinders meet the requirements of this standard in all respects. Following certificates should be given for all the gas cylinders.

- Ownership certificate for all gas cylinders in the name of employer
- The ownership over the usage certificate shall be obtained from employer so as to fulfill the statutory approval.
- Along with the cylinders, the supplier should provide one copy of inspection/ test certificate duly signed by BIS authority and approval letter from PESO / any other safety agencies, permitting filling of hydrogen in these cylinders.
- Manufacture's test certificates and approval from PESO / other safety agencies.
- Hydraulic test certificates of all the cylinders.

3. **Hydrogen Bottling Unit**

(a) The bottling facility has to be installed to have 150 bar, 46.7 L standard cylinders for the complete production in a day.

(b) The facility must also have appropriate provisions for filling of hydrogen in truck mounted skid/tanker.

(c) The offloading of the bottles shall be done based on the customer requirements.

(d) The bottles needed for bottling need not be considered as a part of the facility.

(e) The scope of the bottling ends with the connection cap for bottling arrangement.

(f) Suitable Leakage detection system, fire detection, protection and fighting system must be installed. The plant layout shall be designed in compliance with NFPA and PESO/CCOE guidelines/norms.

4.3.10 Mechanical requirements

Intent of this section is to prescribe requirements which are 'technology neutral', but at the same time, which has bearing on life, reliability and availability of the plant. Other 'technology specific' requirements, shall be finalized during the stage of 'detailed engineering' with the approval/acceptance of IIPE.

(A) **Pumps**

1. **Capacity:** All pumps shall be 2 x 100% capacity.
2. **Material:**
   (a) Process / DM / Condensate Pumps: SS304 / SS316L or better for Impeller, Casing, Shaft
   (b) Cooling Water Pumps: (i) SS410 or better for Impeller & Shaft, (ii) CS or better for Casing
3. **Design Code:**
   (a) All centrifugal pumps shall be designed as per the standard industrial practice.
   (b) All positive displacement pumps shall be designed as per standard industrial practice.
4. **Other Design Considerations:**
   (a) Design Flow: Flow of pumps to be based on 15% margin over maximum flow envisaged during operation.
   (b) Design Head: Design head of pumps shall have 10% margin over the maximum required head required during operation.
   (c) Pumps shall give satisfactory performance at any point on the H-Q characteristics curve over the operating range (generally 40% to 120% of rated flow) for sustained period of operation.
   (d) Maximum efficiency of pumps shall be preferably within 10% of the rated design flow.
   (e) First critical speed shall be at 130% of the rated speed or higher.
   (f) The characteristic curves of pump should be continuously rising type with decrease in flow and shut off head shall be in the range of 115% to 130% of TDH at design point.
   (g) NPSH margin: NPSH (A) at design flow with lowest suction level and maximum pressure drop across suction strainer shall be at least 2 times the NPSH (R) at 3% head drop. Further, NPSH (R) at 3% head break shall be well below NPSH (A) under all conditions.
   (h) Minimum recirculation circuit and minimum flow protection in accordance with the pump design
   (i) Mechanical seals: (i) Double mechanical seal to be provided for all solvent / solvent solution pumps, (ii) Single mechanical seal to be provided for all other pumps.
   (j) Coupling: The Pump and motor shaft shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall be provided.
   (k) Base Plate: A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, suitable ribbed and reinforced.
   (l) Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

(m) The pumps shall be capable of starting with discharge valve fully open and close condition, other than positive displacement pumps. Motors shall be selected to suit to the above requirements.

(n) Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

(o) In case of Reciprocating pump shall have pressure relief valve at discharge.

(p) Pump Noise Level: < 85 dB(A) at 1-meter distance.

(q) Field Tests: After installation, the pumps shall be operated to prove its satisfactory performance.

(r) Motor rating at 50 °C ambient shall not be less that the maximum load demand of pump in entire frequency variation range.

(s) Motor shall be complete with gland, mounting hardware etc.

(B) **Feed Water Tank**

1. **Material of shell and Internals:** SS304 or better.

2. **Other Design Considerations:**

   (a) Operating Temperature/ Pressure: 40-70 °C, 1 atm (g)- indicative

   (b) Breather Valve/PVRV: Required.

   (c) Size of PVRV shall be calculated during Detailed Engineering.

   (d) Optimization of Height & Diameter shall be done during Detailed Engineering with the approval of IIPE.

(C) **Fire Detection and Control System**

1. The scope includes Engineering, Supply, Construction, Erection, Testing and Commissioning of Fire Detection and Protection System as per applicable PESO/NFPA standard and requirement.

2. Hydrant system consists of pipes, hydrant valves, landing valves, water monitors, hoses, branch pipes and nozzles etc. shall be provided as per NBCITAC norms. Fire hydrants posts are available at the terminal point indicated (TP4). It will be in the scope of agency to extent the hydrant line to project site for firefighting system

3. Automatic fire detection cum water spray system shall be provided as per requirement from applicable standards. The spray system consists water mains, Deluge valve, isolation valves, sprayers, Y type strainers, Detection system, Instrumentations, Local Control Panels, cables etc.

4. Fire alarm system consisting of multisensory detectors, cabling, junction boxes, instrumentation, fire alarm cum control panel etc for various areal equipment as detailed out for HVWIMVW system in plant area shall be provided. The fire alarm cum control panel shall be interfaced with control room PLC for information exchange.

5. Additionally, H2 flame detection sensor and remote display integrated with the Main Control system shall be provided.

6. The bidder shall provide required portable and mobile types of fire extinguishers.

(D) **Gas Leak Detection and Control system**

1. All the leak detection sensors provided with individual equipment (Electrolyzer, Compressor, storage quad) shall be integrated to central control system with appropriate automated control sequence for safe and quick shutdown of the system.

2. As per the applicable NFPA/PESO guidelines H_2 gas leak detection sensors may be provided in the pipeline or other section which may be susceptible to leakage.

4.3.11 Electrical Requirement

1. **General:** The Bidder's scope shall include design, manufacture, engineering, inspection & testing at supplier's works, packing, forwarding to site, unloading, storage, erection, testing & commissioning of the Electrical equipment/system and works as required for putting into successful operation of the Hydrogen Generation Plant covered under this specification. The Electrical system shall be complying with below the standards mentioned or equivalent. The list is indicative but not exhaustive, other relevant standards which are not mentioned here and if their compliance shall be required for safe, secure, reliable and desired operation of Hydrogen Generation system shall be equally applicable.

IS-13408(Part-1)	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres.
IS-2189	Code of practice for selection, installation and maintenance of automatic fire detection and alarm system.
IS-5572	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installations.
IS 5780/IEC 60079-11	Electrical apparatus for explosive gas atmospheres - Intrinsic safety "I"
IS- 6381/IEC 60079-7	Electrical apparatus for explosive gas atmospheres Increased safety type "e"
IS/IEC 60079-15	Electrical apparatus for explosive gas atmosphere -Part-15 Construction, test and marking of type of protection "n" electrical apparatus
IS/IEC 60079-0	Electrical apparatus for explosive gas atmospheres - General requirements.
IS/IEC 60079-1	Equipment protection flameproof enclosures "d"
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)

2. **Design Philosophy**

   (a) The design and engineering of the electrical installation shall be in accordance with established codes & specification, sound engineering practices and shall meet the statutory requirements & local regulations.

(b) Electrical equipment and material shall comply with their relevant specification, Data sheet & Project specification & latest edition of the codes & standards (Including any amendments) applicable shall be followed.

(c) All electrical equipment, system and their installation shall be designed for operation under site conditions as required.

(d) All equipment & material shall be suitable for operation in service conditions typical of oil & gas processing plants.

(e) VFD & UPS shall be air-conditioned to increase reliability of heat sensitive electronic components. Switchgear room shall be force ventilated.

(f) Battery room shall be ventilated with exhaust fans. However, failure of cooling or ventilation shall not affect the equipment.

(g) For electrical earthing calculations (soli electrical resistivity) and cable rating calculations (soil thermal resistivity) the data of the area shall be used.

(h) 415V incomers from transformers or ties between switchgear shall be through bus ducts wherever switchgear rating is 1600Amp and above.

(i) Where necessary, all electric apparatus and equipment's and conduits carrying electric wiring in a hazardous area shall be treated with a suitable protective paint.

(j) 9 Tank paint process shall be followed with min. 85 micron.

(k) All the cables and bus ducts feeding switchboards from transformers shall be sized based on transformer ratings. All the cables and bus ducts feeding transformers shall be sized based on current ratings of transformer at the minimum voltage tap of the transformer. All other cables/bus-ducts shall be sized based on the load demand under most onerous conditions.

(l) The electrical distribution system shall be designed considering all possible factors affecting the choice of the system to be adopted such as required continuity of supply, flexibility of operation, reliability of supply from available power source, total load and concentration of individual loads.

(m) There shall be classified for the degree extent of hazard from flammable materials. Classification of hazardous areas for all areas shall be done as per guideline indicated in latest IS 5572 and equipment selection for hazardous area shall be as per IS 16724/IEC 60079-14. All electrical equipment in hazardous area shall be minimum suitable for ZONE-2, Gas group IIA/IIB/IIC, Temperature class T1. . . .T6.

(n) Interlocks & protection as per IS/IEC & CEA guidelines shall be provided.

(o) Lock out Tag out (LOTO) provision for all HT & LT feeders.

(p) Maximum interchangeability of equipment's.

3. **Supply Items (Tentative list finalized during detailed engineering)**

(a) HT panel.

(b) HT power cable and control cable

(c) Transformers (oil type)

(d) Dry type transformers for lighting

(e) LT power cable & Control cable

(f) LT switchgear/panel (PCC, IMCC/MCC, EMCC, DB's, etc.)

(g) Bus duct

(h) Cable Tray

(i) Cable Tray/ Trench formation

(j) JB's

(k) Necessary items required for existing NTPC breaker Module modifications.

(l) Numerical relays Draw out type.

(m) Energy Meters.

(n) LDB's

(o) Battery & Battery Charger (1 $\times$ 100%) 30AH

(p) Necessary items required for successfully commissioning & operation of the plant.

4. **Scope of Electrical Work**

(a) Single point 11KV Power supply shall be provided for operation of the plant. Extension of the same and distribution of the same shall be in bidder's scope. Tentative SLD provided for the electrical distribution philosophy. Final SLD shall be decided during detailed engineering.

(b) The Electrical scope shall be as described briefly in the following clauses but not limited to it. Bidder shall make all provision required according to the design and for satisfactory and safe operation of the system.

i. IIPE shall provide electric feeder as indicated in the section 'Terminal Points'. The electrical supply extension system from the identified feeder to Hydrogen Generation Plant distribution by using existing pipe gallery/trench/new pipe gallery/new trench and switchgear shall be under the bidder's scope. Any other voltage level, if required for the system, shall be arranged by the Bidder.

ii. All equipment's to be supplied shall be of type tested design. The Contractor shall submit for owner's approval the reports of all the type tests as listed in this specification and carried out not earlier than ten years prior to the date of bid opening. These reports should be for the tests conducted on the equipment like those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

iii. In case the Contractor is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost either at third party lab or in presence of client/owner's representative and submit the reports for approval.

iv. 11kV, _____ A (Current rating by Contractor), 40kA for 1 sec draw out type switchboards, with VCB type circuit breakers including spare feeders.

v. 11 kV (UE) Aluminium conductor, XLPE insulated, cables with heat shrinkable end termination kits and straight through jointing kits (where joints are required due to length of feeders being longer than standard cable drum lengths) cable glands and lugs for all cabling.

vi. 11kV / 0.415 kV distribution transformers of required ratings.

vii. 415 V, _____ A (current rating by Contractor), 3- phase TPN, 50 kA for 1 sec draw-out type Main LT switchgear and bus ducts for interconnection between distribution transformers and switchgear including spare feeders.

viii. 415V, _____ A (current rating by Contractor), 3-phase TPN, 50 kA for 1 sec draw-out type, Motor Control Centers (MCCs) for feeding motor loads and other loads up to 55 kW including spare feeders.

ix. 415V, _____ A (current rating by Contractor), 3-phase TPN, 50 kA for 1sec draw-out type Auxiliary Service Boards (ASBs) for miscellaneous power loads like welding sockets, power panels, pressurization panel etc. including spare feeders

x. 415/415 V, 3-phase dry type lighting transformers for normal lighting and emergency lighting system

xi. 415V, _____ A (current rating by Contractor), 3-phase TPN, 25 kA for 1 sec. draw-out type Lighting Distribution Boards (LDBs) including spare feeders

xii. Any kind of distribution of power supply to various drives, auxiliaries through MCCB, MCB, isolators, AC/DC fuse boards, etc. as required shall also be in the bidder's scope.

xiii. Industrial type safe area and flameproof type control stations with push buttons, selector switches, ammeters, lamps as required.

xiv. Industrial type safe area and flameproof type 415V AC welding receptacles and 240V AC, 1-phase Convenience receptacles.

xv. All electrics for electrolyser as required as per latest standards & safety requirements.

xvi. Voltage distortion limits for bus voltage V $\leq$ 1.0 KV at PCC, Individual harmonic is $\leq$ 5% & THD is $\leq$ 8% (as per IEEE519-2022).

xvii. Voltage distortion limits for bus voltage 1 kV $<$ V $\leq$ 69 KV, Individual harmonic is $\leq$ 3% & THD is $\leq$ 5% (as per IEEE519-2022).

xviii. Complete lighting and fixtures within the plant battery limit.

xix. For the purpose of electrical earthing calculations (soli electrical resistivity) and cable rating calculations (soil thermal resistivity) the data of the area shall be used.

xx. Where necessary, all electric apparatus and equipment's and conduits carrying electric wiring in a hazardous area shall be treated with suitable protective paint.

xxi. 9 Tank paint process shall be followed with min. 85 micron.

xxii. 415V incomers from transformers or ties between switchgears shall be through bus ducts wherever switchgear rating is 1600Amp and above.

xxiii. All the cables and bus ducts feeding switchboards from transformers shall be sized based on transformer ratings. All the cables and bus ducts feeding transformers shall be sized based on current ratings of transformer at the minimum voltage tap of the transformer. All other cables/bus-ducts shall be sized based on the load demand under most onerous conditions.

xxiv. VFD & UPS shall be air-conditioned to increase reliability of heat sensitive electronic components. Switchgear room shall be force ventilated.

xxv. Battery room shall be ventilated with exhaust fans. However, failure of cooling or ventilation shall not affect the equipment.

xxvi. Above ground cable joints shall not be installed in hazardous areas.

xxvii. HV, MV, LV and control cable shall be separated from each other by required spacing or running through independent pipes, trenches or cable trays as applicable.

xxviii. 240 V AC control switch station to be provided with proper enclosure & proper earthing arrangement. (explosion proof wherever required).

xxix. Electrical equipment used in hazardous areas shall be flameproof type as per area classification.

xxx. The Fire Detection and Alarm System shall be an independent, micro-processor based Analogue Addressable system comprising of individual break glass type manual call points, automatic sensors e.g. smoke/heat detectors, hooters, exit signs, Main DGFAP, battery, battery charger and other hardware. The system shall be designed to provide audio-visual indication at the main fire alarm panel to be located in the fire station and zonal panels. The fire detection system shall be interfaced with fire suppression system, HVAC system, pressurization system, plant communication system and any other systems as required.

xxxi. The Fire protection system shall be conceived to operate both in prevention and fighting mode, depending on the relevant actions selected, either manual or automatic. The firefighting system shall be designed & provided as per OISD guidelines.

xxxii. All electrical equipment for hazardous areas shall be certified by PESO, ATEX, UL for the service and the area in which it is to be used.

xxxiii. All indigenous flameproof equipment shall have BIS license.

xxxiv. PESO approval shall be obtained for equipment installed in hazardous area for both indigenous and imported equipment's.

xxxv. Interlocks & protection as per IS/IEC & CEA guidelines shall be provided.

xxxvi. The contractor shall carry out the installation, field testing and commissioning of all items of electrical equipment. Further appropriate test and commissioning reports and as-built documentation as necessary for all electrical equipment should be provided.

xxxvii. A suitable size of cable/busduct shall be provided for interconnection of electrical equipment.

xxxviii. Termination at transformer, rectifier & electrolyser end OEM guideline shall be followed.

xxxix. Bidder shall be done basic, detailed engineering and system studies including relay setting.

xl. Obtaining clearance for energizing the complete electrical facilities covered under this tender and approval of installation / drawings from central electrical inspector and any other concerned approving authority is in contractor scope.

xli. Any other power, control, instrumentation, and special cables, if required shall be under the Bidder's scope.

xlii. Cable support system and laying & termination of all cables along with necessary termination arrangements and other accessories such as, trays, conduits, pipes, JBs, etc shall be in bidder's scope

xliii. Construction power, if required by the Bidder, should be clearly indicated in the bidder's offer including its KVA rating. IIPE shall provide a suitable terminal point for it and Bidder should safely withdraw the power from the identified terminal point.

xliv. Grounding & Lightning system for Hydrogen Generation Plant and equipment are under Bidder's scope.

xlv. Motors along with canopy, couplings and coupling guards for all rotating pumps and blowers are covered under this package. All motors shall be provided with cable glands, cable box and lugs suitable for termination of the required size of power cable.

xlvi. Any kind of distribution of power supply to various drives, auxiliaries through MCCB, MCB, isolators, AC/DC fuse boards, etc. as required for Hydrogen Generation Plant and equipment shall be in the bidder's scope.

xlvii. Any components of HT and LT switchgear assembly required for Hydrogen Generation Plant or any other component/equipment etc. which shall be required for the extension of electrical supply shall be under the bidder's scope.

xlviii. All the required controls and protections as per the system requirement for individual equipment and overall Hydrogen Generation Plant electrical system shall be under the bidder's scope.

xlix. Adequate numbers/rating of rectifiers to cater to the load of each of the Electrolyzer.

l. The rectifier equipment shall be complete in all respect with rectifier transformer, thyristor converter, electronic control and annunciation, filter choke, etc. mounted in the suitable panel.

li. Relevant IS/IEC standards shall be applicable for Rectifier Assembly for Hydrogen Generation Plant

lii. The formation of cable trench/tray shall be required for cable laying shall be under bidder's scope if not available.

liii. Proper Earthing and Lightning protection shall be provided Hydrogen Generation plant.

liv. The safety of the plant and equipment shall be the Bidder's responsibility till the final handover of Hydrogen Generation plant to IIPE.

lv. The Bidder should ensure the safety of personnel working on the electrical system.

5. **Basic Design and Detailed Engineering**

(a) The following points to be kept in knowledge while preparing the design

i. Basic engineering calculations i.e. load analysis, load flow, short circuit, and voltage drop during motor start-up etc. to be done for selection of electrical equipment's.

ii. Sizing and selection of electrical equipment as per applicable hazardous area classification to be developed by Contractor.

iii. Overall single line diagram and single line diagrams for individual switchboards, UPS, DC systems, Aux power supply system.

iv. Hazardous Area classification drawings including plans at various levels, elevation drawing, list of hazardous hydrocarbon material along with their characteristics.

v. Electrical Equipment list and Motor List.

vi. Preparation of Electrical and Instrumentation interlock and interface requirements as per process/ operational requirements.

vii. Relay & metering diagrams, Control, protection and Annunciation schemes.

viii. Substation Sizing including construction of substations as applicable

ix. Preparation of substation equipment layout, providing cutouts for complete substation.

x. Sizing calculations for cables, cable trays/ cable trenches including providing cable trays and RCC trenches.

xi. Procurement engineering activities include preparation of enquiry specifications, bid evaluation, preparation of purchase specifications, expediting and approval of vendor drawings.

xii. Area-wise illumination level calculation and preparation of power supply distribution scheme for normal, emergency and critical lighting.

xiii. Calculations for plant earthing and lightning protection. Carryout soil resistivity test to ascertain the soil resistivity value for earthing system design as applicable.

xiv. Preparation of electrical layouts such as equipment layouts, lighting layouts, cabling layouts, earthing layouts, lightning protection layout, plant Communication layouts, fire alarm layouts, telephone layouts

xv. Cable termination and equipment Installation details.

xvi. Cable schedule, interface drawings, interconnection diagrams, etc. for plant communication system, fire detection & alarm system and telephone system, including all owner-supplied equipment.

xvii. Equipment specifications and data sheets.

xviii. Preparation of bill of materials for cabling, lighting, earthing, communication, fire alarm, telephone system and miscellaneous items.

xix. Cable Schedules, drum schedules.

xx. Collection of data from site/Owner as required for carrying out detailed engineering.

xxi. Preparation of Lighting/ Power panel schedules.

xxii. Interconnection drawings.

xxiii. Relay Co-ordination drawings, Protection coordination drawings, relay setting calculations; relay parameterization for complete power system.

xxiv. Shop inspection and testing procedures and QA schedule.

xxv. Field testing and commissioning procedures.

xxvi. Preparation of as-built drawings on completion of the project for final records.

xxvii. Preparation of operation and maintenance schedule/manuals.

xxviii. Type, routine and acceptance test certificates.

xxix. Vendor and sub vendor drawings.

xxx. Contractor shall also coordinate with manufacturer of equipment free issued / supplied by others, wherever required, and shall freely and readily supply all technical information for this purpose as and when called for.

xxxi. Any other work/ activity, which are not listed above, however are necessary for completeness of electrical system

(b) **Transformer**

i. The standard ratings of transformers shall be confirmed during detailed engineering.

ii. Nominal voltage ratings

- Primary voltage - 11 kV
- Secondary voltage- 415 V

iii. The windings of the transformers shall be connected to Delta on the primary side and star (Y) on the secondary side. The neutral of the LT winding shall be brought out to a separate terminal. The vector group shall be Dyn-11.

iv. Bidders are required to include these accessories along with the main equipment in their proposals.
Note:
1. Permissible Temp rise over ambient of 50 °C (irrespective of tap)
2.Termination, SC withstand time & Fault level as per system requirement.

(c) **Codes and Standards**

i. Transformers IS:2026, IS:6600, IEC:60076, IS 1180

ii. Bushings IS:2099, IEC:60137
iii. Insulating oil IEC:60296
iv. Bushing CTs IS:2705, IEC 60185
v. Indian Electricity Act 2003, BEE Guideline & CEA notification

(d) **Transformer Cooling requirements**
The radiators shall be detachable type, mounted on the tank. Each radiator shall be provided with a drain plug/valve at the bottom, an air release plug at the top, shut off valve at each point of connection to the tank. The radiators shall be made of Hot Dipped Galvanized Steel conforming to ISO 12944-5, system no. A7.13 of paint and coating of the Table A.7. LT Auxiliary outdoor transformers shall have maximum losses of energy efficiency level 3 rating or better as per latest BEE guideline. The outdoor transformer shall also comply with latest IS:1180. Transformer type test to be submitted for TRAFO approval.
Safety: Mulsifire system shall be provided as per CEA norms.

(e) **Design and Constructional Features**
Tank shall be of welded construction & fabricated from tested quality low carbon steel of adequate thickness. The main tank body including tap changer, radiators and coolers shall be capable of withstanding full vacuum. Tank shall be provided with suitable lifting lugs, minimum 4 jacking pads & haulage holes for wheeling in all four directions. Transformers shall be mounted on detachable type bi-directional rollers for rail gauge of 1676 mm. Suitable locking arrangement shall be provided to prevent accidental movement of transformer. At least two adequately sized inspection openings, one at each end of the tank for easy access to bushings and earth connections & suitable manhole shall be provided.

(f) **Core**
Core shall be high grade, non-ageing, cold-rolled, super grain oriented silicon steel laminations known as Hi B grade steels or equivalent. The insulation of core to tank, tank to clamp and clamp to core shall be able to withstand a voltage of 2 KVrms for 1 min in air. To facilitate testing of above during pre-commissioning stage, the core/clamp earthing has to be done outside the tank with suitable bushings.

(g) **Insulating oil**
No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters as shown below

i. a. Kinematic Viscosity, $mm^2/s > 12$ at 40 $^\circ$ C & < 1800.0 at (-)30 $^\circ$ C
ii. Flash Point, deg C > 140 $^\circ$ C
iii. Pour point, deg C $<$ (-)40 $^\circ$ C
iv. Appearance Clear, free from sediment and suspended matter.
v. Density kg/dm^3 at 20 $^\circ$ C < 0.895
vi. Interfacial Tension N/m at 25 $^\circ$ C > 0.04
vii. Neutralisation value, mgKOH/g < 0.01
viii. Corrosive Sulphur Non-Corrosive
ix. Water content mg/kg < 30 in bulk supply & > 40 in drum 95 supply
x. Antioxidants additives Not detectable
xi. Oxidation stability -Neutralization value, mgKOH/g -Sludge, % by mass $< 1.2 < 0.8$
xii. Breakdown voltage as delivered, kV After treatment, kV ¿30 ¿70

xiii. Dissipation factor, at 900 ° C & 40 Hz to 60 Hz ¡0.005

xiv. PCA Content < 1 %

xv. Impulse withstand Level, kVp > 145

xvi. Gassing tendency at 50 Hz after 120 min,
Prior to energization at site for following properties and acceptance norms:

xvii. BDV > 60 KV

xviii. Moisture content < 10 ppm

xix. Tan delta at 900 °C 0.05 (max.)

xx. Interfacial tension: 0.035 N/m (min)

(h) **Windings**

The conductors shall be of Electrolytic grade copper. All Windings of 66kV and below shall have uniform insulation. The contractor shall ensure that the windings are made in dust proof & conditioned atmosphere. All windings of HT transformers shall have Thermally upgraded paper covering insulation. Transformer winding paper moisture shall be less than 0.5%. Oil preservation

Main tank and OLTC (if applicable) shall be provided with conservator tanks of adequate capacity for expansion of oil from minimum ambient to 100 °C . Conventional type conservator with indicating type cobalt free breather (transparent enclosure) shall be offered for transformer below 7.5 MVA.

(i) **Bushings**

i. The electrical & mechanical characteristics of bushings shall be in accordance with IS: 2099, IS: 3347 & IS: 96 12676.

ii. Bushings below 52 kV shall with porcelain insulator and shall be of oil communicating / OIP (non-oil communicating type)/epoxy RIP type. All condenser bushings shall be non-communicating type.

iii. The oil side shall be provided with tank which can be filled with oil. Tank shall have necessary provision for oil filling, level gauge etc. Suitable covering to be provided on air side to protect from any damage. The arrangement shall be suitable for storage in horizontal/ vertical direction in outdoor location.

iv. The oil end dimension of RIP bushing shall be same for all bushings of similar voltage rating.

v. All condenser bushings shall be non-communicating type.

vi. Clamps & fittings shall be of hot dip galvanized steel.

vii. Bushing & fittings shall be provided with vent pipes that shall be connected to route any gas collection through the Buchholz relay.

viii. No arcing horns shall be provided on the bushings.

ix. LV Bushing palm shall be Silver/Tin plated.

(j) **Bushing CTs**

Shall be of adequate rating for protection as required, WTI etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted. All CT terminals shall be provided as fixed type terminals on the M. Box/CCC/CMB to avoid any hazard due to loose connection leading to CT opening or any other loose connection in power circuit. In no circumstances Plug In type connectors shall be used for CT & Power connection.

(k) **Marshalling box**

i. M. Box shall be of stainless steel (SS-316 or better), at least 2.5 mm thick, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. The gasket used shall be of neoprene rubber. Also Marshalling Box gland plate shall be at least 450 mm above ground level.

ii. For auxiliary transformer, wiring scheme shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.

iii. TB shall be stud type for all CT & Power connections with ring type lugs.

(l) **Valves**

i. All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings.

ii. Sampling & drain valves should have zero leakage rate.

(m) **Gaskets**

i. HT transformers all the gaskets shall be weatherproof & hot oil resistant of 'O' ring of Nitrile rubber for all valves, flanges, HV, LV & Neutral Turrets, Bushings, Tank rim, etc. For this, all the flanges shall be machined.

ii. If gasket is compressible, metallic stops shall be provided to prevent over compression.

iii. The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, the contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

(n) **Fittings**

Following fittings shall be provided with Transformers, Shunt Reactor & Neutral Grounding Reactor covered under this specification.

i. Conservator for main tank with MOG (with low oil level alarm contact), drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above rail level) etc.

ii. Buccholz relay (magnetic type), double float type with alarm and trip contacts, along with suitable gas collecting device. Oil surge relay to be provided for OLTC.

iii. For 2 MVA & above rating transformer, a minimum two numbers of spring-operated PRD (with trip contacts) with suitable discharge arrangement for oil shall be provided. Armored cable be used between PRD to Marshalling box. PRD shall have DOP of IP-67. Plugin type connector shall be provided for proper sealing for terminating cables/ glands.

iv. OTI & WTI shall be 150 mm dial type with alarm and trip contacts with max. reading pointer & resetting device. (Maximum height 1500 mm above rail level) For HT transformers WTI shall be provided for all windings, also PT-RTD with 4-20 mA signals shall be provided with OTI & WTI of these transformers.

v. Top & bottom filter valves with threaded male adapters, bottom sampling valve, drain valve/sludge removal valve at the bottom most point of the tank.

vi. Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings (as applicable) & surge arrestor (as applicable).

vii. Prismatic/toughened glass oil gauge for transformers and OLTC chamber.

viii. Followings items are as applicable: - Bi-directional wheel & skids, M. Box, OCTC, Bushing CTs, Insulating Oil, Fans, pumps & oil flow indicator, Cooling equipment, Valve Schedule Plate.

ix. Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs, additional 4 nos. lifting lugs for bell tank cover, inspection cover, manhole, Bilingual R&D Plate, Terminal marking plates, two earthing terminals etc.

x. Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.

xi. Rain hoods to be provided on Buchholz, MOG & PRD. Entry points of wires shall be suitably sealed. The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the FGD Tie Transformer and HT transformers are deemed to be included.

(o) **Testing Requirements**

i. The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The owner may waive conduction of any test subject to availability of test facility. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule and the same 99 shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) conducted successfully under this contract and upon certification by the employer's engineer.

ii. The type tests shall be carried out in the presence of the employer's representative, for which a minimum of 15 days' notice shall be given by the contractor. The owner may waive conduction of any test subject to test facility anywhere in the world. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

iii. In case the contractor has conducted such specified type test(s) not earlier than ten years prior to the date of techno-commercial bid opening, he may submit during detailed engineering the type test reports to the owner for waiver of conductance of such type test(s). These reports should be for the tests conducted on equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.

iv. Following components to be supplied shall be of tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed below in specification and carried out within last ten years from the date of techno-commercial bid opening. The reports should be for the tests conducted on equipment like proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However, if the contractor is not able to submit report of the type test(s) conducted within last ten years from date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence

of client/employer's representative and submit the reports for approval.

- All type test on OLTC as per IEC 60214 (wherever applicable)
- Neutral Grounding Resistors
- Tank Vacuum and Pressure test
- All type tests on transformers up to and including 2.5 MVA (upto33kV class) transformers.

v. All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be included in the equipment price.

vi. Each transformer shall be completely assembled with all fittings & accessories meant for the transformer/reactor before offering for inspection & testing by Employer.

(p) **Routine/Type Tests on Transformers**

i. All routine test in accordance with IEC 60076 shall be carried out in the transformers.

ii. Measurement of Voltage Ratio & phase displacement (as per IEC 60076-1).

iii. Measurement of winding resistance on all the taps (as per IEC 60076-1).

iv. Vector group and Polarity Check (as per IEC 60076-1).

v. Magnetic Balance and Magnetizing Current Test.

vi. Measurement of no-load current with 415V, 50Hz AC supply.

vii. Measurement of no-load losses and current at 90%, 100% & 110% of rated voltage (as per IEC 60076-1).

viii. Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps.

ix. IR measurement (As per IEC 60076-1).

x. 2KV KV core isolation (core-clamp, clamp-tank, core-tank).

xi. Measurement of capacitance & tan delta to determine capacitance between winding & earth.

xii. Dielectric tests shall be carried out as per IEC 60076-3.

xiii. Applied Voltage Withstand Test (as per IEC 60076-3).

xiv. Lightning impulse (Full & Chopped Wave) test on windings (as per IEC 60076-3).

xv. Lightning impulse test on LV Neutral.

xvi. Switching impulse test (as per IEC 60076-3).

xvii. IVPD test as per IEC 60076-3 shall be conducted (for U1 & U2 level)

xviii. LTAC test as IEC 60076-3

xix. Induced overvoltage test.

xx. Repeat no load current/loss measurement & IR after completion of all electrical test.

xxi. Oil leakage test on completely assembled transformer along with unit coolers/ radiators (as per relevant clause of this sub section).

xxii. Jacking test followed by D.P. test.

xxiii. Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.

xxiv. IR measurement on wiring of Marshalling Box.

(q) **Type Test**

i. Lightning impulse (Full & Chopped Wave) test on windings (as per IEC 60076-3)

ii. Lightning impulse test on Neutral.

iii. Short circuit test (special test) as per IEC 60076-5. 101

iv. Temperature Rise test at a tap corresponding to maximum losses. Gas Chromatography shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599).

v. Measurement of acoustic noise level as per NEMA TR-1 (special test).

(r) **Tank Type Tests**

Routine tests: Oil leakage test on assembled transformer All tank and oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature and applying pressure equal to the normal pressure plus 35 kN/m^2 measured at the base of the tank. The pressure shall be maintained for a period of not less than 6(six) hours during which time no sweating shall occur.

(s) **Motors**

i. All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

ii. The Single phase/Three phase motors shall be supplied for the Pumps and Blowers of Hydrogen Generation Plant as per the system requirement. The motors shall be finalized during detailed engineering as per the requirement Hydrogen Generation system.

iii. The Single phase/Three phase motors shall be operating in highly chemical and explosive environment. The type of such specific motors shall be decided during detailed engineering.

iv. For design of equipment/systems, an ambient temperature of 50 °C and relative humidity of 95% (at 40°C) shall be considered. The equipment shall operate in a highly polluted environment.

v. AC motors shall be suitable for rated frequency of 50 Hz with a variation of +3% & - 5%, and ± 10% combined variation of voltage and frequency unless specifically brought out in the specification.

vi. Bidder shall provide fully compatible electrical system, equipment's, accessories and services.

vii. The responsibility of coordination with other agencies and obtaining all necessary clearances shall be of the Bidder.

viii. Motors shall be selected to have a rating in accordance with the preferred rated output values of the primary series as listed in IEC 60072 and IS 325. The enclosure of motors and motor control station shall be in accordance with the hazardous area classification and equipment selection in hazardous area as per IEC 60079 and its parts.

ix. All motors shall be IE3 energy efficiency class according to IEC 60034-30-1; 2014 except reciprocating compressor motor.

x. Reciprocating compressor motor energy efficiency class finalized during detailed engineering.

xi. Motor used in hazardous areas shall be flameproof and as per IEC 60079 & its parts.

xii. Type test report, PESO, ATEX certification to be submitted for motor approval.

(t) **Cable Trench/Tray**

i. The formation of cable trench/tray/gallery shall be required for cable laying. The formation of any cable trench/tray shall be under bidder's scope. The cable laying scheme

for Hydrogen Generation plant shall be finalized during detailed engineering as per the requirement of IIPE and Hydrogen Generation Plant.

ii. The cable trench inside substation shall be filled with sand, pebbles or similar non-flammable materials or covered with incombustible slab. If a significant number of cables are taken on racks, adequate support to be provided on the side wall of trench.

iii. Cable trays, racks and trenches shall be sized to allow for 20% future cable reserve.

iv. Concrete line cable trenches should be sealed against ingress of liquid and gases wherever trenches leave a hazardous area or control room or substation.

(u) **HT Power Cable**

i. The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground (buried) installation with chances of flooding by water.

ii. Copper/aluminum conductor used in power cables shall have tensile strength as per relevant standards. Conductors shall be multi stranded.

iii. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C. For single-core armoured cables, the armouring may constitute the metallic part of insulation screening

iv. The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath.

v. All HT cables shall be of unearthed grade.

vi. The cable cores shall be laid up with non-hygroscopic fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath.

vii. All the cables, other than single core cables, shall have distinct extruded PVC inner sheath of black color as per IS: 5831.In case of single core cables where there are both metallic screening and armoring, there shall be extruded inner sheath between them.

viii. All cables and wires shall be FRLSH conforming to category AF as per IS: 10810.

ix. All the cables, other than single core cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.In case of single core cables where there are both metallic screening and armouring, there shall be extruded inner sheath between them.

x. The above-mentioned General requirements are indicative.

xi. The HT cable shall be finalized during detailed engineering as per the requirement Hydrogen Generation Plant.

(v) **LT Power Cable**

i. The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.

ii. Cables shall be armoured, flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

iii. Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.

iv. XLPE insulation shall be suitable for a continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C. PVC insulation shall be suitable for continuous conductor temperature of 70 °C and short circuit conductor temperature of 160 °C.

v. The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

vi. The above-mentioned General requirements are indicative. The power cable shall be finalized during detailed engineering as per the requirement Hydrogen Generation Plant.

vii. **Cable Selection & Sizing**

Cables shall be sized based on the following considerations:

(a) Rated current of the equipment

(b) The voltage drops in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated Voltage

(c) Short circuit withstand capability: This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let-out energy of the fuse.

Power cable size for motors should be minimized and if required double run cable can be used for motors of higher rating.

viii. **Earthing & Lightning Protection**

(a) All electrical equipment HT and LT switchgear panel shall be earthed to suitable size GI strip through suitably sized finned copper braiding/copper flexible cable suitably lugged on either end. The earthing scheme for equipment and Hydrogen Generation plant shall be finalized during detailed engineering as per the requirement of system. Earthing shall be connected from the nearest owner earth.

(b) Suitable Lightning protection of Hydrogen Generation plant shall be provided, and it shall be under bidder's scope. The Lightning protection scheme for Hydrogen Generation plant shall be finalized during detailed engineering as per the requirement of system.

(c) Grounding and lightning protection for the entire plant areas and buildings covered in the specification shall be provided in accordance with IS 3043, IS 2309, IEEE 80, IEEE 665 and IEC: 62305.

ix. **LT Switchgear**

(a) LT panel shall be (Totally Type Tested Assembly) as per IEC: 61439-1 & 2.

(b) LT Panel shall also be tested of design as per Seismic Zone Vol IEC 60068-3-3.

(c) The FORM of separation is 4B.

(d) LT panel construction shall be Indoor, Single front, Draw out type.

(e) The metal enclosed switchgear shall be designed to operate continuously with reference of ambient temperature of 50ºC without any de-ration.

(f) All ACB's shall be 50KA EDO Microprocessor with Ekip Touch LSIG release

(g) LT Switchgear for distribution of supply to the various equipment of Hydrogen Generation plant shall be supplied by successful bidder.

(h) Final scheme, components of switchgear assembly and number of feeders in LT switchgear shall be finalized at the stage of detailed engineering.

(i) Relevant IS/IEC standards shall be applicable for LT switchgear for Hydrogen Generation Plant.

(j) Bidder shall submit valid type test reports (as per relevant IEC/IS Standard) for approval. The type test reports submitted shall be of tests conducted within the last 10 years.

(k) The bidder should have conducted a type test on identical panel to those offered.

x. **Bus Duct (if required)**

(a) The Bus-duct shall be conformed to relevant Indian standards, IE rules, IE act and factory act.

(b) 415V, 3Ph+N, 50Hz, non-phase segregated Bus-duct, suitable for indoor installation with necessary degree of protection for enclosure. which includes all required bends, flexible joints, phase crossings, adapter boxes, space heaters etc.)
(c) Busbars shall be designed for continuous rating of ampere at 50 °C ambient temperature and temperature rise shall not exceed 50 °C.
(d) The short circuit withstand capacity of Busbars shall be 50KA for 1 second.
(e) Bus-duct shall be provided with all necessary accessories, hardware, earthing, connections etc. as required and shall be suitable to connect between TRAFO and LT switch board panels (PCC – MCC).
(f) There should be a minimum gap of 300mm (about 11.81 in) between the bus duct and the LT panel for maintenance purposes.
(g) The shape of the bus duct conductor shall be informed during detailed engineering. The bushing pads shall be silver/tin plated. A drain with stopcock arrangement shall be provided at flange to drain leakage of oil/water at termination. As bus duct will be pressurized stopcocks shall be airtight.
(h) Tolerance permissible for the height of the terminal connected to bus duct over rail top level is ± 10 mm. Contractor must ensure that radiator & conservator does not obstruct the path of the bus ducts in position & during movement of transformer. The contractor shall co-ordinate the final design of terminal arrangement to suit bus duct arrangement during detailed engineering.
(i) The transformer bushing enclosed in bus duct enclosure shall be designed for satisfactory operation in the high ambient temperature existing inside the bus duct enclosure. The temperature inside the bus duct enclosure may be of the order of 90 – 100 °C. The bus duct conductor temperature may be as high as 105 °C & the temperature in the bus duct enclosure will be of the order of 80 ° C.
(j) All bus-ducts shall be sized based on the load demand under most onerous conditions.
(k) The material of the bus duct termination shall be non-magnetic.
(l) Adequate Hot Dip Galvanized support structure shall be given to the bus duct to take care of mechanical integrity and arrest the vibration
(m) Where different type of material is connected tin plating material should be used.
(n)The following type tests reports to be submitted on each rating of bus ducts:

- Heat run test (the set up shall include 3 phase straight run, 90 deg. bend, set of flexible connection of each type, and necessary inspection covers).
- Short circuit withstand test (set up same as for heat run).
- Impulse withstand test (set up shall include typical X-section with flexible connections, 90-degree bend, seal off bushing and inspection cover.
- Air leakage rate and Water tightness test (set up shall include inspection cover, flanged joint and below).

xi. **HT Switchgear**

- Type test report to be submitted for HT switchgear approval.
- Surge arrester to be provided with integrated fuse.
- HT Switchgear for distribution of electrical supply to various HT equipment present in Hydrogen Generation plant shall be supplied by successful bidder.
- Final scheme, components of switchgear assembly and number of feeders in HT switchgear shall be finalized at the stage of detailed engineering.

- Relevant IS/IEC standards shall be applicable for HT switchgear for Hydrogen Generation Plant.
- HT Switchgear for Indoor installation shall be metal clad, draw-out type and fully compartmentalized having 40 kA short time current rating. All panels shall be of unitized construction providing facility for extensions on both sides.
- Circuit Breakers used shall be VCBs of specified rating for the various types. The breaker truck's design shall be such that there will be flexibility of interchanging between incomer, bus-section and feeder trucks, where similar rated breakers are offered.
- Surge arrester to be provided with integrated fuse. 4. Temperature sensor shall be mounted in bus-bar chamber
- MFM shall be with communication on Ethernet port.
- Numerical relay for all VCB feeders & takes input from TRAFO LV Side CT for REF.
- HT Switchgear for distribution of electrical supply to various HT equipment shall be supplied by successful bidder.
- Final scheme, components of switchgear assembly and number of feeders in HT switchgear shall be finalized at the stage of detailed engineering.
- Relevant IS/IEC standards shall be applicable for HT switchgear.
- Relays (IS- 3231(1987), IEC 60255) shall be front draw out type.

xii. **DC System**

A complete DC system, comprising of batteries, battery charges, relays, contactors, timers etc. shall be suitable for continuous operation at the maximum continuous float voltage including suitable temperature correction factors. The battery sizing shall be done based on different types of continuous and intermittent loads including motor starting (wherever applicable) under complete blackout condition, for the duration specified to meet the system requirement (180 minutes (about 3 hours) minimum). All intermittent loads shall be considered with minimum 1-minute duration. The battery shall be sized considering a minimum electrolyte temperature of 15° C along with temperature correction factors as per relevant standard. An ageing factor of 1.25 shall be considered. The no. of cells and end cell voltage shall be considered based on the minimum and maximum voltage window and cable drop etc. as per system requirement. Each system shall comprise of two nos. of batteries and two nos. of float-cum-boost chargers each rated for 100% capacity. DC scheme shall ensure that each critical consumer is fed from two different bus sections. DCDBs shall provide enough feeders on each section. Boost/ fast charging time shall be as per worst operating condition and would satisfy technical requirements recommended by battery manufacturer. Each battery charger must be capable of supplying all the continuous D.C. loads (fed through both sections of DCDB) plus the trickle charging current of both the batteries. In addition, each charger must have sufficient surplus capacity for running of the largest D.C auxiliary so that the battery is not drained during testing of the same. Battery charger should also be capable of boost/ fast charge the battery from completely discharged condition to fully charged condition without imposing any limitations under worse operating Conditions. Battery size shall be as per the following:
DC Voltage - 220 V
Load - Supply total DC load of the associated area at an acceptable voltage for at least 180 minutes (about 3 hours) including DC Lighting
Battery bank - 30AH for NiCd High Discharge (KPH) type batteries

xiii. **Illumination & Lighting System**

- Adequate lighting arrangement with suitable illumination level for the equipment and Hydrogen Generation plant shall be done by bidder.
- The lighting scheme and determination of illumination level shall be finalized during detailed engineering as per the requirement of system.
- LED type Tube Lighting suspended / bracket / wall mounted type luminaire.
- 2X2 LED Panel decorative type suitable for recess mounting,
- 220V DC Critical Lighting Luminaire inside CRCA housing with UV stabilized polycarbonate cover, Suitable for direct operation in Safe Area on 220V DC Supply & Wall mounting, LED,
- Integral, toughened clear well glass luminaire, suitable for Flameproof (E x d), Zone 2, Gas Group IIC, Temperature Class T3,
- Outdoor installation IP66 with 2nos of Flameproof (Ex d) double compression type cable glands & flameproof blanking plug,
- Flood light LED non integral fixtures suitable for Flameproof (E x d), Zone 2, Gas Group IIC, Temperature Class T3, Outdoor installation, IP55 with 2nos of Flameproof (Ex d) double compression type cable glands, 1no of flameproof blanking plug,
- LED type Tube Lighting fixture, Industrial type suspended / bracket / wall mounted type luminaire,
- DC Critical Lighting Luminaire, Suitable for direct operation Hazardous Areas on 220V DC Supply, Flameproof Type with Ex-d Protection suitable for operation in Zone-1/2, Gas Group IIA/IIB areas & Column mounting.

xiv. **Lighting Panel**

- Indoor Normal and Emergency LDB for plant lighting
- DC Critical Lighting panel, (Flameproof) Zone-2, IIA / IIB, T3) IP66
- Outdoor flameproof Normal/emergency LDB-Ex d, Zone 2, Gas Group IIC, Temperature Class T3.
- Outdoor WP Street light panel IP55.

(w) **Design Philosophy**

i. A comprehensive illumination system shall be provided in the entire area.

ii. All outdoor lighting systems shall be automatically controlled by a synchronous timer. Provision to bypass the timer shall be provided in the panel.

iii. The system shall include distribution boards, normal/ emergency lighting panels, lighting fixtures, junction boxes, receptacles, switch boards, lighting pole/masts, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting etc. Outgoing circuits in LPs shall be provided with MCBs of adequate ratings.

iv. The illumination system shall be designed based on best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare-free illumination. The lighting fixtures shall be designed for minimum glare. The design shall prevent glare/luminous patch seen on VDU/ Large video screens, when viewed from an angle. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection. The diffusers/ louvers used in fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period. The Lux levels to be adopted for various areas as per IS/IEC, CEA guideline.

(x) **Fault Level**

- Equipment through fault withstand capabilities under worst operating conditions duly considering negative tolerances on transformer and maximum fault levels of source etc. shall be as follows:
  1. All transformers - 2 seconds 73
  2. 11 kV Bus duct - 1 second
  3. All Switchgears - 1 second
  4. Cables to the feeders protected by breakers - Main protection fault clearing time with 0.12 seconds minimum.
  5. Cables of all other feeders - As per fuse operating time
  6. 11KV cable screen - 2 seconds for the adopted ground fault current

(y) **Alarm Annunciations**
All electrical faults, tripped, alarm and equipment malfunction signals from the communicable relays should be accessible via a computer connected to the communication port in each switchgear/PCC/MCC. In addition, certain signals shall bring up alarms/indication in central control room (CCR) or in the PLC/DCS.

(z) **Hazardous area**

- Electrical equipment shall meet the selection requirements of the Indian standards IS: 16724/IEC: 60079 and its part.
- All electrical equipment for hazardous areas shall be certified by PESO, ATEX, UL for the service and the area in which it is to be used.
- All indigenous flameproof equipment shall have BIS license.
- All electrical equipment used in hazardous areas shall be flameproof & as per IEC 60079.
- PESO approval shall be obtained for equipment installed in hazardous area for both indigenous and imported equipment's.

4.3.12 Control & Instrumentation

1. **Control and Monitoring Philosophy**
All closed loop controls, interlocks, protections, alarms and indications are described in the 'Operation and Control Philosophy' chapter of this Technical Specification. However, the same shall be finalized in discussion with IIPE.

2. **Programmable Logic Control System**

(a) **General**

i. Bidder shall supply, erect and commission a PLC based Control & Instrumentation system with all accessories, auxiliaries and associated equipment and cables for the safe, efficient and reliable operation of the plant.

ii. It shall be possible to remove/replace online various modules (like any I/O module, interface module, etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. System design shall ensure that while doing so, undefined signaling and releases do not occur and controller operation in any way is not affected (including controller trip to manual, etc) except that information related to removed module is not available to controller. The online I/O modules shall in no way jeopardize safety of plant and personnel.

iii. The Control system shall include on-line self-surveillance, monitoring and diagnostic facility giving the details of the fault on the Human Machine Interface System (HMIS) viz. main & standby power supplies, sensor fault, Input/ Output card failure, Memory Status, Controller fault, failure of Communication/ Network links to PLCs, LAN. These faults shall be reported as colour change on system status display and as messages on HMIS as well as through local indication on the faulty module and on respective rack/ cubicle. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place.

iv. The Control system shall operate in air-conditioned area.

v. Obsolescence: The equipment/system shall ensure provision of latest proven state-of-the-art technology to guard against obsolescence.

(b) **PLC processor**

The processor unit shall be capable of executing the following functions

i. Receiving Digital and analog signals from the field and providing command output to MCC/Drive etc. through Input / Output modules and operator-initiated commands from HMIS/ control panel.

ii. Implementing all logic functions for control, protection and annunciation of the equipment and systems. It shall be user friendly & site programmable.

iii. Implementing modulating control function for certain application as specified elsewhere in the specification.

iv. Providing supervisory information for alarm, various types of displays, status information, trending historical storage of data etc.

v. Performing self-monitoring and diagnostic functions.

vi. PLC configuration shall be minimum SIL-2 certified for process units and its associated package units, utilities, and off sites as per IEC 61508. SIL validation/ evaluation for critical loops shall be considered as per process requirement.

vii. Dual processor-based PLC system shall be provided with two processors (including main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete plant operation automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor should be updated in line with the changes made in working processor automatically.

viii. The memory shall be field expandable. The memory used for the system shall not exceed its capacity more than 70% and have extra capability for at least 20% expansion in future. Programmed operating sequences and criteria shall be stored in nonvolatile semiconductor memories like EPROM / Flash memory. All dynamic memories shall be provided with buffer battery backup which shall be for at least 360 hours.

ix. Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands. A forcing facility for changing the state of input/outputs to facilitate the fault finding and other testing requirements shall be provided. It shall be possible to display the signal flow during operation of the program.

x. Maximum CPU loading shall be limited to 50% after commissioning.

xi. All the electronic modules PCB should have conformal coatings that can provide protection against extreme moisture, corrosive gases and aggressive dust, or combinations thereof.

(c) **Human Machine Interface System (HMIS)**

i. A PC based Operating Work Station (OWS) shall perform control, monitoring and operation of all remote and local IO's, auxiliaries/ drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC and the Human Machine Interface System. 1 no. of EWS shall also be supplied for doing rectification or changes in PLC when the plant is in operation. PLC based control system shall perform control, monitoring and operation of all remote and local IO's, auxiliaries/ drives via interacting HMI. (Repetition)

ii. All frequently called important functions including major displays shall be assigned to dedicated function keys on a soft keyboard for the convenience of the operator for quick access to displays & other operator functions. Display selection should be possible with minimum no. of operation.

iii. The operator functions shall as a minimum Control System operation (A/M selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local-remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.; printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering.

iv. UPS for at least 180 Min. for all the instruments, PLC and HMIS.

(d) **Programming Functionalities**

Programming of the PLC Processor / controller as well as programming of HMIS (like development and modification of data base, mimics, logs / reports, HSR functionalities etc.) shall be user friendly with graphical user interface and shall not require knowledge of any specialized language. For example, the programming of PLC shall use either of the following:

- Flow-chart or block logic representing the instructions graphically or Ladder diagrams.
- All programming functionalities shall be password protected to avoid unauthorized modification.

(e) **Software Requirement**

i. All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The system shall be OPC compliance. The programs shall include high level languages as far as possible. The bidder shall provide sufficient documentation and program listing so that it is possible for the owner to carry out modification at a later date. Site modification in program, historian & graphics should be possible.

ii. The Bidder shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.

iii. Industry standard operating system like WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry standard protocols (OLE -OPC on TCP-IP) shall be provided and should implement OPCUA/DA server as per OPC Foundation. The system shall have user friendly programming language & graphic user interface.

iv. All system related software including Real Time Operating System, File management software, screen editor, database management software, on line diagnostics/debug software,

peripheral drivers software and latest versions of standard PC-based software(with life time license) and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.

v. All application software for PLC system (with life time license) functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.

vi. The Bidder shall provide software locks and passwords to owner's engineers at site for all operating & application software for operation, maintenance, backup, modifications, installations etc. Three (3) days for four (4) minimum training to owners engineer at site shall be included in package.

vii. The Bidder shall provide software license for all software being used in Bidder's System. The software licenses shall be provided for the project (Owner/employer) and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for IIPE to seek a new license/renew license due to up gradation/change of hardware/machine in Bidder's System at site.

viii. As a customer support, the Bidder shall periodically inform the designated officer of the IIPE about the software upgrades/new releases that would be taking place after the system is commissioned so that if required, same can be procured & implemented at site.

(f) **Parametric Requirements**

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

On/Off Command	The response time for screen update after the execution of the control command from the time the command is issued (for example command to start a motor to the time the screen is updated) shall be two 2 seconds (excluding drive actuation time).
On screen Updating	1 second
All Control related displays	1 second
Bar Chart, MIMIC, GROUP displays	2 to 3 seconds
X-T Plot Displays	3 - 4 seconds
Plant Summary Displays	3 - 4 seconds

(g) **Input/output Modules**

i. Input Output modules, as required in the Control System for all type of field input signals (4- 20 mA, RTD, Thermocouple, non-changeover/change over type of contact inputs etc.) and outputs from the control system (non-changeover/change over type of contact, 24/48 VDC output signals for energizing interface relays, 4-20 mA output etc.) are to be

provided by the Bidder. The individual input/output cards shall incorporate indications on the module front panels for displaying.

ii. Electrical isolation of 1.5 kV with optical couplers between the plant input/output and controller shall be provided on the I/O cards and ensure that any inadvertent voltage or voltage spikes shall not damage or mal-operate the internal processing equipment.

iii. The Input/output system shall facilitate modular expansion in fixed stages.

iv. Individually fused output circuits with the blower fuse indicator shall be provided.

v. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses such that for any fault, fuse failure shall affect the particular drive system only without affecting other systems.

vi. All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.

vii. The Bidder shall provide the following monitoring features: a Power supply monitoring.

viii. Contact bounces filtering.

ix. Optical isolation between input and output signals with the internal circuits

x. In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated to the successful Bidder during detailed engineering.

xi. Digital Output modules shall be rated to switch ON/OFF coupling relays of approx. 3 VA at 24 VDC. Analog output modules shall be able to drive a load impedance of 500 Ohms minimum. Coupling relays will be installed in PLC cabinets only close to I/O cards.

xii. All input field interrogation voltage shall be 24V DC or 48 V DC.

xiii. In case of loss of I/O communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be decided during detailed engineering) with proper alarm/message.

xiv. Binary & analog outputs shall be non-redundant only. Failure of any single module shall not affect operation of more than one single drive.

xv. The signal conditioning functions like multiple measurement schemes, square root extraction for flow signals, pressure and temperature compensation, limit value computation can be performed either in the controllers or in signal conditioning and processing hardware outside controllers.

xvi. The maximum number of inputs/outputs to be connected to each type of module shall be as follows:
Analog input module: 16
Binary input module: 32
Analog input & output (combined): 16
Binary input and output (combined): 32
Note: For binary inputs, one changeover contact is counted as 2 inputs.

xvii. Any sensor/transducer/transmitter failure alarm shall be provided on HMI.

(h) **System Spare Capacity**

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

ii. Bidder shall provide 15% spare channels in total input/outputs with fully wired up to cabinets TB.

iii. Wired-in "usable" space for 20% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in system cabinets. Empty slots between individual modules/group of modules, kept for ease in maintenance or for heat dissipation requirement as per standard practice of Bidder shall not be considered as wired-in "usable" space for I/O modules. Terminal assemblies (if any in the offered system), corresponding to the I/O modules shall be provided for above mentioned 20% blank space.

iv. Processor / controller shall have 30% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops. Further, processor / controller shall have spare capacity to handle minimum 30% additional inputs/ outputs of each type including above specified spare requirements, over and above implemented capacity. The corresponding communication controllers shall also have same spare capacity as that of processor/controller.

v. Twenty (20) percent spare relays of each type and rating mounted and wired in cabinets TB with termination in terminal blocks should be provided.

(i) **System Reaction Time**

The reaction time of the programmable control system from input signals at the input cards to output of the associated signals or commands of the output card inclusive of programmed logic processing, comprising a mixture of logic gates, arithmetic operations and other internal operations shall be less than 50 milli seconds under the most arduous control system operating conditions.

(j) **Operator Interface Displays/Logs/Reports/Remote Communication**

i. Suitable Operator Interface Displays/Logs/Reports like P&ID, live displays or mimic, bar chart displays, X- Y & X-T plot (trend) displays, operator guidance message displays, group displays, plant start- up/shutdown message displays, system status display for control operation & monitoring shall be provided.

ii. Historical storage and retrieval system (HSRS): The HSRS shall collect store and process system data from HMI data base. The data shall be saved online on hard disk. Provision shall be made to notify the operator when hard disk is certain percentage full. The disk capacity shall be sufficient to store at least 15 days data.

iii. The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs/reports. The data/information to be stored & frequency of storage and retrieval shall be as finalized during detailed engineering. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on HMI or printer in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least last 15 days shall be available on the disk.

iv. In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable long-term storage media). These data will include any data from the database as well as processed/computed data based on various calculations/transformation. The retrieved data from long term storage media should be possible to be presented in form of X-T display, X- Y display, logs, reports, etc.

v. All data should be accessible through OPC server for remote location so that data, trends and reports can be generated remotely.

vi. Bidder shall demonstrate and provide the necessary tools (application software etc) required for real time monitoring, data export and generation of trends & reports from remote location wherever notified by IIPE post award. Necessary spare ports and networking hardware for remote communication through cloud or other means should be provided apart from local monitoring.

vii. PLC system shall be connected to network and both inbound and outbound access for remote location is to be controlled and monitored by the firewall.

(k) **Control and Power Supply Scheme**

All PLC along with OWS (Operator Workstation) & EWS (Engineers Workstation) shall be powered by 230V single phase with minimum 6 output terminals of 230V UPS power supply along with battery backup of minimum 3 hours shall be in the scope of bidder. The Bidder shall also furnish all required hardware/ equipment/ cubicles / JBs for conversion, distribution and/or stabilization of UPS power source.

(l) **Control Cabinets/Panels/Desks**

i. The cabinets shall be IP-22 protection class of reputed make. The Bidder shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet. The cabinets shall be designed for front access to system modules and wiring and shall be designed for bottom entry of the cables. The cabinets shall be totally enclosed, free standing type.

ii. 2 no. of PC based OWS (Operator Work Station) shall be mounted on table type control desk to house PC/ keyboards/ mouse etc. Control desk shall be free standing table top type. four nos industrial grade chairs shall be provided with control desk.

(m) **Annunciation System**

i. HMI based alarm system shall be provided with audio alarm facility (beep/tone generator).

ii. The system shall display history of alarms in chronological order on any of the OWS. The HMIS shall have the capability to store a minimum of 100 alarms each with paging features allowing the operator to view any page. The system shall have all alarm functions and related function keys like alarm acknowledge, reset, paging, summaries etc. the detail such be finalized during detailed engineering. The alarm display/report format shall be as approved by the IIPE.

iii. Alarm boxes shall be provided in each display to alert the operator about an alarm when he is viewing some other picture. No of alarm boxes shall be for each process area & each priority therein.

(n) **Software: Documentation, Licences and Upgrades**

i. All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the PLC System shall be furnished.

ii. All the software listings including Source code for application software, all special-to-project data files etc shall be submitted by the Bidder.

iii. Factory Acceptance Test of the system shall be done as per the methodology approved by IIPE during detail engineering.

iv. Software License: The Bidder shall provide software license for all software being used in Bidder's System and it shall not be hardware/machine-specific. All licenses shall be valid for the continuous service life of the plant.

v. Software Upgrades: Bidder shall periodically inform the plant owner about the software upgrades/new.releases.

CPU	Latest generation CPU
Main drive (RAM)	8 GB expandable to 16 GB
Drives	48x CD/DVD R/W drive or better
Hard disk/SDD	1 TB SSB preferable
Removable bulk storage drive	1 TB (minimum)
Monitor	24" minimum LED Flat screen
Graphic memory	1 GB
Communication port	2 serial, 4 USB port, Dual 100 M bps Ethernet
Expansion slots	3
Peripheral	Keyboard, Optical mouse, 5000 VA smart UPS
Software Application software	Licensed MS Windows based latest version, latest version MS office licensed copy, Adobe Acrobat, anti-virus McAfee or equivalent subscription for two years, etc to suit project specific requirement
Interfacing requirements	Interface with PLC and separate PC/systems with OPC compliant interfacing
Functional requirements	Ability to operate drives locally using function keys Ability to do programming Graphics display including alarms and operator guidance messages

(o) **Grounding System**

i. Panel shall be provided with a continuous bare copper ground bus of suitable size. The ground bus shall be bolted to the panel structure on bottom on both sides. The bolts shall face inside of panels.

ii. The system ground shall be isolated from the panel ground with suitable isolators. All internal component grounds or common shall be connected to the system ground, which shall be fabricated of copper flat (size 25mm x 6mm min., length as applicable).

iii. Shield on instrumentation cables shall be grounded on panel side. System and shield ground shall be connected to separate earthing pit using separate strip and suitable size of cable which shall be in the scope of bidder only

iv. The panel shall be grounded at two points with separate electronic earth pit, which shall be connected to the nearest NTPC earth pit if required. Separate electronic earthing of PLC and instrumentation if any, shall be in the bidder's scope at mutually agreed location during detailed engineering.

3. **Measuring Instruments-Technical Requirements**

(a) All instruments shall be of reputed make, proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to IIPE's approval.

(b) Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

(c) All transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided. The exact value shall be provided by IIPE during detailed engineering.

(d) The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, all instruments would be suitably mounted as per Requirement on local racks with weather protection canopy, even if not specifically asked for, on as required basis. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose.

(e) All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments. Housing of instruments should be IP 65or better.

(f) All instruments shall be of reputed make, proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to IIPE's approval.

(g) Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

(h) All transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided. The exact value shall be provided by IIPE during detailed engineering.

(i) Hazardous area protection for instruments:

(j) Intrinsically safe type shall be used in general.

(k) Canopy shall be provided by Contractor for all Analyzers panels/ racks, PRDS.

(l) Barriers (Wherever Applicable): Intrinsically safe barriers: 3-port galvanically isolating type, as applicable.

(m) All instruments for hazardous areas shall be certified by PESO/ATEX for the service and the area in which it is to be used.

(n) All instrument devices shall be provided with an explosion proof enclosure as described in NEC (USA) Article 500, Class – I, Div. I or EN60079-14 or to provide suitable type Zener barriers of standard approved make meeting the requirements as approved by the governing statutory body in India and other statutory authorities.

Electronic Transmitter: Pressure, Flow, Level

Features	**Essential/Minimum Requirements**
Type	Microprocessor based 2 wire type with local indications
Accuracy	± 0.1% of calibrated span (minimum)
Output signal range	4-20 mA
Turn down ratio	10:1 for vacuum/very low-pressure applications, 30:1 for other applications.
Stability	± 0.1% of calibrated span for six months
Zero and span drift	± 0.015% per deg.C at max span, ± 0.11% per deg.C at min. Span.
Load impedance	500 ohm (min.)
Housing	Weather and Explosion proof as per IP-65 with durable corrosion resistant coating.
Over Pressure	150% of max. Operating pressure
Connection (Electrical)	Plug and socket type
Process connection	1/2-inch NPT (F)
Span and Zero	Continuous, tamper proof, Remote as well as adjustability manual from instrument with zero suppression and elevation facility.
Accessories	Diaphragm seal, pulsation dampeners, siphon etc. as required, 2 valve manifold for absolute & Gauge pressure transmitters, 3-valve manifold for vacuum pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve manifold for DP/Level/Flow applicable.
Diagnostics	Self-Indicating feature
Power supply	24V DC ± 10%.

Resistance Temperature Detector

Features	**Essential/Minimum Requirements**
Type of RTD.	Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade)
No. of element	Duplex

Housing/Head	IP-55/Diecast Aluminum. Plug in connectors are to be provided for external signal cable connection.
Sheathing of RTD	Metal sheathed, ceramic packed
Calibration and accuracy	As per DIN-43760 Class-A for RTD
Characteristic	Linear with respect to temp, within $\pm$ 1/2 percent of top range value.
Accessories	Thermo well shall be spring loaded for positive contacts with the well.
Standard	DIN-43760 for RTD and ASME PTC-19.3 for Thermo-well.

Temperature Transmitter

Features	Essential/Minimum Requirements
Compatibility	Temperature Transmitter shall be fully compatible with RTDs, Dual-input Temperature Transmitter With Indicator shall be provided, These transmitters shall have bump less change over facility to second sensor in case first sensor fails. This changeover is to be alarmed. Protection class shall be IP65 minimum, Common requirements for each of the above type of temperature transmitters
Output	4-20 mA
Input	The transmitter shall be capable to handle Pt-100 RTD
Isolation	min. 500 V AC
EMC compatibility	as per EN 61326
Operating ambient temperature (°C)	0 to 70
Power supply	Compatible with input module of Control System.
Accessories	Mounting arrangements including clamps etc.
Composite Accuracy	T/C-K type $\leq$0.2% of 0-600 °C Span, RTD$\leq$0.25% of 0-250 °C span, CJC accuracy (for T/C)) shall be$\leq$ 1 °C

Notes: In case of failure (open/burn-out) of RTD, Temp Transmitter shall provide low temperature output

Gauge:Pressure and Temperature Requirement

Feature	Pr. Gauge/Dp Gauge	Temperature Gauge
Sensing Element and material	Bourdon for high pressure, Diaphragm /Bellow for low pr. Of 316 SS.	Mercury in steel for below 450 °C and inert gas actuated for above 450 °C of SS bulb and capillary.
Body material	Die-cast aluminum	Die-cast aluminum
Dial size	150mm	150 mm
End connection	1/2-inch NPT (F)	3/4 inch NPT (F)
Accuracy	$\pm$1% of span	$\pm$ 1% of span
Scale	Linear, 270° arc graduated in metric Units	Linear, 270° arc graduated in ° C
Range selection	Cover 125% of max. of scale	Cover 125% of max. of scale

Over range Test	Test pressure for the assembly shall be 1.5 to the max. design pr. at 38 °C	
Housing	Weather and dust proof as per IP-55	Weather and dust proof as per IP-55
Zero/span adjustment	Provided	Provided
Identification	Engraved with service legend or laminated phenolic name plate	
Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS 316L Thermowell
Material of Bourdon/ movement	316 SS / 304 SS	316 SS / 304 SS

Magnetic Level Transmitter With Local Indicator

Features	**Essential/Minimum Requirements**
Type of Transmitter	Magnetic level Transmitter , 2 wire type
Output signal	4-20Ma
Sensor Accuracy	± 0.5% of span or better
Sensor linearity	±0.5% of span or better.
Power supply	24 V DC ± 10%
Ambient Temperature limits	-10 °C to 65 °C
Housing	Weather proof as per IP-65 or better
Local Indication	Stainless steel scale with graduations in mm / cm
Wetted parts	Suitable for Pressure rating: 0-1 Kg/sq.cm (Abs) Temperature rating: Upto 120 °C, Fluid: Water & Steam

Range	Probe length of transmitter (to be finalized at the time of detailed engineering) shall be capable of covering the complete level span of flash chamber and is to be mounted on standpipe connected to the main vessel via flanged connection with isolating valves at top and bottom
Electrical Connection	Plug and socket

Electrical Metering Instruments

Features	**Essential/Minimum Requirements**
Type	Flush Mounted
Applicable Standard	IS: 1248-1968 (Revised)
Size	To be decided during detailed Engineering
Transmitter output	7 4 to 20 mA

Miniaturized digital indicators shall be provided for the indication and electrical parameters etc. These shall meet the following general specifications.

- Input signal: 4-20 mA
- Size: 48 mm (w) x 24 mm (h)/50 mm x 25 mm
- Display Accuracy: 2.5% of final value
- Temp. coefficient: 0.15% /°C of measured value
- Mounting: Flush panel
- Type $3\frac{1}{2}$ digit 7 segment LED display Float decimal

Conductivity Meter

Feature	**Essential/Minimum Requirements**
Range of measurement	As per requirement
Accuracy of Measurement	$\pm$ 2 percent of the measured value or better
Sample temp range	-20 °C to 200 °C

Ambient operating temperature	-10 °C to 55 °C
Sensor	Flow through type
Transmitter output	4 to 20 mA

pH Analyser

Features	**Essential/Minimum requirements**
Measuring Range	0-14
Repeatability of Measurement	± 0.02 pH or better
Sample temp range	-20 °C to 200 °C
Ambient operating temperature	-10 °C to 55 °C
Transmitter output	4 to 20 mA

General Requirements for Conductivity, pH-analytical meters

- All consumables / reagents / calibration solutions required for successful operation for one year to be supplied
- Operating voltage 240 AC, 50 Hz
- Analytical Meters to be of standard make like ABB, Forbes Marshal / Polymetron, Yokogawa, Siemens, Emerson / Rosemount, Hach and Honeywell .
- All above meters may be mounted in the panel/ as per site condition with proper arrangement for sample entering / drainage
- All samples to be brought to the panel/ instrument from the tapping via SS 316 pipe with proper support.
- Sample conditioning if required, arrangements to be done suitably
- SS316 $\frac{1}{2}$ inch tubing shall be used for connection.

4. **Technical Requirements: Instrumentation and Power Supply Cables**

(a) **General Requirements**

i. All cables, internal wiring and electrical field construction material shall conform to this specification, IIPE approved detail engineering drawings & documents and the latest edition of the relevant standards & guidelines. The Bidder shall furnish all material and

services required for the completeness of the work identified in his scope as per this specification.

ii. Furnish all construction tools, material & equipment required to perform the work included under this specification.
iii. Furnish & install all cable sub trays, rigid and flexible conduits, conduit fittings, cable glands, junction boxes, and accessories.
iv. Supply, unload, handle, store at site, install, check for continuity, terminate and test all analog, binary & pulse signal instrumentation cables, control cables, power cables, signal cables:
v. Interconnect instruments/devices/local panels/PLCs etc. from field either through field JB etc. or directly from field devices/instruments to PLC marshalling/Terminal cabinets/System cabinet TBs furnished under this specification by the Bidder.
vi. Furnish, install, terminate and test all signal and prefabricated cables, which interconnect between various equipments supplied by the Bidder under this specification.
vii. Furnish, install, test, terminate and check for continuity all cables required for grounding of control systems, cabinets, equipments etc. furnished under this specification. All cables/isolated flats etc. used for grounding shall be of copper or aluminum of proper size to avoid any increase in ground potential.
viii. All control & instrumentation cables shall be direct & cross ferruled on single sleeve through ferrule printing machine. Scheme of ferruling shall be finalized in consultation with site IIPE.
ix. PVC, grouted, colored long life route markers are to be provided for buried cables at every 10 meter interval at bends, at terminals, either end of road/culvert crossings etc.
x. Specification of Instrumentation cable

Common Requirements

Property	**Requirement**
Voltage grade	225 V (peak value), armored, FRLS
Codes and standard	All instrumentation cables shall comply with VDE0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472
Others	Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground-buried installation Repaired cables shall not be acceptable.

Specific Requirements

Specification	**Requirements**
Type F	G cable
Conductors	

Cross section area	0.5 sq. mm
Conductor material	High conductivity Annealed bare copper
Colour code	As per VDE-815
Conductor Grade	Electrolytic copper
Reference Standard	VDE 0815
Insulation	
Material	PVC type YM1 with FRLS Properties
Reference Standard	VDE 0207 Part 4
Core diameter above insulation	Suitable for cage clamp connector
Pairing & Twisting	
Max. lay of pairs (mm)	50
Conductor /pair identification as per VDE0815	To be provided (color coding attached).
Shielding	
Type of shielding	Al-Mylar tape
Individual pair shielding	To be provided for F-type cable
Minimum thickness of Individual pair shielding	28 micron
Overall cable assembly shielding	To be provided
Minimum thickness of Overall cable assembly shielding	55 micron
Shielding coverage	100% with at least 20% overlap
Fillers	
Non-hygroscopic, flame retardant	To be provided
Outer Sheath	
Material	Extruded PVC compound YM1 with FRLS Properties
Oxygen index as per ASTMD- 2863	not less than 29%
Temperature index as per ASTMD-2863	not less than 250 °C
Acid gas generation by weight as per IEC-60754-1	Maximum 20%
Smoke Density Rating as per ASTMD-2843	Maximum 60% as per ASTMD-2843

Reference standard	VDE207 Part 5
Electrical Parameters	
Mutual Capacitance Between Conductors At 0.8 KHz (Max.)	120 nF/km for F type 100 nF/km for G-type
Insulation Resistance(Min.)	100 M Ohm/km
Cross Talk Figure (Min.) At 0.8 KHz	60 dB
Characteristic Impedance (Max) At 1KHz	320 ohm for F-type 340 ohm for G-type
Attenuation Figure At 1 KHz (Max)	1.2 db/km
Complete Cable	
Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.
Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification
Accessories	
Cable accessories of flame retardant quality	Yes. (Accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc.)

(b) **Instrumentation Cable Interconnection and Termination Philosophy**

i. The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used.

ii. Note: Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs.

Terminal Blocks

iii. All terminal blocks shall be Din rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, etc., shall be suitable for cage clamp connections. The exact type of terminal blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to IIPE's approval.

iv. All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug transparent covers, support brackets, distance sleeves, warning label, marking, etc. Ffor ensuring proper connections,

v. Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory.

vi. Shall be finalized as per application during detail engineering stage subject to IIPE's approval without any cost repercussions.

vii. All control terminal block for cable size 2.5 sq mm or more shall be spring loaded.

viii. Output terminal block for driving motors shall be disconnectable from drive so that the motor can be isolated without disconnecting cable.

ix. PLC termination shall not use multilayered terminal block. All terminal block shall be of reputed make approved by IIPE.

(c) **Internal Panels/System Cabinets Wiring**

i. Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.

ii. Wiring to door mounted devices shall be done by 19 strand copper wire provided with adequate loop lengths of hinge wire so that multiple door opening shall not cause fatigue breaking of the conductor.

iii. All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.

(d) **Instrumentation Cable Installation and Routing**

i. All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of IIPE.

ii. Cables shall be segregated as per IEEE Std.-422. The distance between instrumentation cables and those of other system shall be as follows:
From 11 kV/6.6 kV/3.3 kV tray system - 914 mm
From 415V tray system - 610 mm
From control cable tray system - 305 mm

iii. Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance.

iv. All cables shall be identified by tag. Nos. provided in IIPE's approved format at both the ends as well as at an interval of 5 meters.

(e) **Cable Laying and Accessories**
Cable Laying

i. Cables shall be laid in line with cable schedule. Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 10 m in cable trench/tray.

ii. Cable tray numbering and marking: To be provided at every 10m and at each end of cable way & branch connection.

iii. Joints for less than 250 Meters run of cable shall not be permitted.

iv. Buried cable protection: Bricks; Route markers at every 20 Meters along the route & at every bend. Spacing between cables of same voltage grade shall be in accordance with the derating criteria adopted for cable sizing.

v. Cable clamping: All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray.

vi. No splices shall be made in conductors for instrument and control circuits except where required at connections to devices equipped with factory installed pigtails. Such splices shall be made only in approved splicing boxes of fitting with removable cover.

vii. The Bidder shall be responsible for proper grounding of all equipment. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests. All the cables etc. required for grounding of all equipments supplied under this package are to be supplied by the Bidder.

viii. The Contractor shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged during installation shall be replaced at the Contractor's expense.

Field mounted local junction boxes

Parameter	**Specification**
No. of ways	12/24 with 20% spares terminals.
Material and Thickness	4mm thick Fiberglass Reinforced Polyester (FRP)
Type	Self locking Screw at all four corners for door. Door gasket shall be of synthetic rubber or silicone RTV in-situ formed.
Mounting clamps and Accessories	Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in Bidders scope of supply.
Type of terminal blocks	Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm^2.
Protection Class	IP-55 minimum for indoor & IP-65 minimum for outdoor applications.
JB marking	To be provided.
Colour	To be decided during detailed engineering & subject to IIPE's approval.

- Conduits, Cable sub-tray & support able sub-tray & support
- All cable tray and conduits with their fittings shall be of FRP / GRP of relevant standards suitable for corrosive atmosphere at coastal region.

(f) **Technical Requirements: Process Connection and Piping**

i. The Contractor shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this Sub-section, enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipment (provided by the Contractor) to the process / IIPE's main equipment / systems. The Contractor shall furnish during detailed Engg. All relevant drawings, material and tech. specifications of various items service wise for IIPE's approval.

ii. All materials, furnished under this sub-section and the installation thereof shall conform to the latest editions of American National Standard Code for Pressure Piping, Power Piping (ANSI B 31.1,31.3,31.12) and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and state standards.

iii. Contractor to note that any reducers, nipple etc. for proper connection of the impulse piping system to IIPE's root valves / isolation valves / stubs etc. Shall be in Contractor's scope only, unless otherwise clearly excluded.

(g) **Impulse Piping, Tubing, Fittings, Valves and Valve Manifolds**

i. All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The material of the impulse pipe shall be same as that of main process pipe. The impulse pipe material and associated fittings and valves shall be as given in table PCP.

ii. Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. Material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard. The bending radius of the tube shall be greater than 6D.

iii. All fittings shall be forged steel and shall conform to ANSI B16.11. The material of forged tube fittings for shaped application (e.g. Tee, elbow etc.) shall be ASTMA 182 Gr. 316L. The material for bar stock tube fitting (for straight application) shall be 316 SS. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with which they are to be used.

iv. The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air services wherein no source shut-off valves are to be provided. The valve body material, stem material and pressure class shall be as given in table PCP. The end connections of valves shall be of socket welded type unless otherwise specified in the instrument installation diagrams The disc and seat ring materials of carbon steel and alloy steel valves be ASTM A-105 and ASTM A-182, Gr. F22, hard faced with stellite (minimum hardness - 350 BHN.) The surface finish of 16 RMS or greater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.

v. The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2- valve manifold and 3-valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and differential pressure transmitter/ switches respectively. 5-valve manifold shall be used for remaining applications like flow and level measurements.

vi. For Pr./DP gauges in fluid application two-way globe valve on each impulse line to the instrument and in air application two-way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the pr./DP gauges.

vii. All pneumatic piping if any, fittings, valves, air filter cum regulator, purge Rotameter and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided.

viii. For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used. The thickness of cu-tubing shall not be less than 0.065 inch and shall be PVC coated. The fittings to be used

with copper tubes shall be of cast brass, screwed type.

ix. All other air supply lines of 1/2 inch to 2 inch shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. The threads shall be as per ASA B.2.1. Fittings material shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs.

x. For pneumatically operated devices if any, IIPE may provide instrument air and service at one point near the system (depends on availability). For air supply to various devices mentioned above, the contractor shall provide required size GI pipe header with isolation valve from the instrument air and service air terminal points.

xi. All instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply. The filter regulators shall be suitable for 10-kg/ sq.cm max. Inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blow down valve. The end connection shall be 1/4 inch / 1/2 inch / 3/4 inch NPT as per the requirement to be finalised during detailed engineering.

xii. All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be $\frac{1}{2}$ inch to 2 inch.

xiii. The continuous purging with instrument air shall be done for all air-based measurements, at the process source connection end.

xiv. For intermittent purging with service air, the SS four ways valve provided in the SS tubing shall be used for isolating the transmitter & connecting the service air quick disconnect line.

xv. Purge air lines shall be of mild steel hot dipped galvanized inside and outside as per IS1239, heavy duty with threaded ends.

xvi. All instrument piping, tubing and its accessories shall be supported in a safe manner to prevent excessive vibrations and anchored sufficiently to prevent undue strain on connected equipment. Instrument piping & tubing shall not be routed across equipment removal areas, above or below monorails, cranes, removable gratings, cable trays.

xvii. For liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instrument shall be installed above source point and impulse pipe should slope upwards.

xviii. Impulse piping for air shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent & drain lines along- with isolation valves and other accessories including drainpipes. This drain is to be connected to plant drain through open funnel also. Horizontal runs must have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope and to prevent sag in piping.

xix. All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.

xx. Special accessories such as condensing pots/ reservoirs shall be provided and installed

wherever required. In any case condensing pots shall be provided for all level measurements in water services, all flow measurement in flow measurements water services above 120 Deg C

xxi. Colour coding of all impulse pipes shall be done by the Contractor in line with the colour coding being followed for the parent pipes.

xxii. The air supply headers, sub-headers and branch pipes shall be supported properly by clamps or supports to be provided and fabricated by the Contractor. Air supply piping shall be installed with a slope of over 1/100 to prevent accumulation of condensed water within the pipe. Signal/control air tubing shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy link up and checking of proper connections.

xxiii. Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminum supports.

xxiv. Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.

(h) **CCTV System**

i. **General Requirements**

- To gather video information from the various areas of the various areas of the plant. The Contractor shall be responsible for selection, design, engineering, manufacture, testing at manufacturer's works/site, installation of all the equipment's supplied as covered in this specification and commissioning of the system meeting the intent & functional requirements of the specification. All the cables, cable trays, power packs, erection hardware (viz. junction boxes, brackets glands, nut-bolts, conducts etc.) are also included in Contractor's scope.
- All necessary hardware and software, the number of camera units, servers, network video recorder, network switches, module and software, any other hardware/ software required for the safe and satisfactory operation, control, protection, monitoring, testing and maintenance of the system shall also be included by the Bidder.
- All camera shall have CE/FCC/UL certification.
- The system shall be able to accept potential free contacts from other system and use the same for predefined actions (like zoom/pan/tilt of cameras, bringing out pre-defined views on predefined monitors etc.) This feature shall be extensively used for linking fire related signals.
- The camera & Video Management Software shall be ONVIF compliant.
- The system shall support video analytics in respect of the following
  1. Video motion detection
  2. Object tracking
  3. Object classification & Tracking

  The feature can be an integral part of camera or a part of camera server.
- Camera moiniotrinng shall be extended to the remote location if required.

ii. **Power Supply Arrangement**

- The CCTV System along with all its components i.e. network switches, storage devices, servers, LAN switches, media converters, cameras etc. shall be powered from UPS system.
- It should be backed up with UPS supply (min one hour back up)

iii. **Location**

- The exact locations shall be decided during detailed engineering. The Bidder shall refer to the General Layout Plan and Equipment Location Plans for the various operational areas of the Hydrogen plant.

iv. **Application Software for video monitoring, recording and management**

- It shall be possible to control all cameras i.e. PTZ, auto/manual focus, selection of presets, video tour selection etc. The software shall support flexible 1/2/4 windows split screen display mode or scroll mode on the display monitors for live video.
- Software shall be provided by the bidder. The unit level system shall be connected to at least one monitor, keyboard and the requisite number of servers and cameras. The system shall also have the following provisions.
- The software shall support video loss and network loss alarm feature.

v. **Other Requirements**

- All the cameras and accessories are to be housed in Weather Proof IP 65 environmental Housing. The housing, with heater and blower installed, shall provide protection for camera/lens assemblies in the ambient temperature range of – 0 deg. C to 50 deg. C. The camera mount should be of the same make as that of camera and suitable for the model no. offered as specified by the manufacturer and should be an integrated unit
- Work Station and Camera/Database Server- To be provided as per system requirement, shall be industrial grade, RAM and hard disk/storage memory shall be sized to meet functional requirement. Camera server shall be provided with sufficient storage space to store recordings of all cameras at 25 FPS,4CIF for a period of fifteen (15) days or more using necessary compression techniques.
- All recordings shall have camera ID, Location, Date and time stamp of recording.
- Network Switches shall be of high quality, industrial grade. The common switch to which all networks are connected shall be Layer-III switch/router.
- All cables (CAT 6 STP, OFC), other FRLS PVC sheathed cables required, PoE switches etc which are required for the completeness of the system shall be provided by bidder.
- Four (04) core Optical fibre cable shall be used for CCTV system network Architecture.

(i) **Communication System: Internet Protocol (IP) based Public Address System**

i. Master Control Unit (MCU)- 1 number (in Control room), Indoor type calling stations, Outdoor type calling station (with amplifier and loudspeaker).

ii. Acoustic hood, Server (VOIP- voice over IP technology), PC Station, Network Switches (Layer- III Switch/Router), Software(s) for PA system on as required basis.

iii. All the other items- hardware, software, licenses, including public Address system erection hardware, all type of cables (armoured), junction boxes, racks, cables, cable trays, conduits, etc. as required, for the proper installation (conforming to IS:1881, IS:1882) to make the IP based PA system complete and functional are under Contractor's scope on as required basis.

iv. All hardware & software along with necessary licenses shall be capable of handling 30% additional call stations over and above the number of call stations specified for future use.

v. Various equipment offered in IP based public address system (like Calling stations, amplifiers, speakers, network switches and all other equipment as applicable) shall be explosion proof, flame proof /spark proof and shall meet all the latest international standards for explosive, flammable area's applications with ATEX, IECEx and other applicable certificates, wherever applicable.

vi. Calling stations: Outdoor type IP-66, Indoor type IP-32 as per IS/IEC:60947-1 minimum.

vii. UPS supply shall be provided with a minimum of 01-hour backup. The system shall be able to accept potential free contacts from other systems (like fire alarm system, security system and access control system etc.) for predefined actions (like fire or security alarm announcement on call stations (configurable etc.)

(j) **Shop and Site Tests**

i. The equipment and work performed as per this Sub-section shall be subject to shop and site test as per requirements of approved Quality Assurance & Inspection and other applicable clauses of this Sub-section and IIPE approved quality assurance plan.

ii. Hydrostatic and pneumatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.

(k) **Civil Requirements**

i. All civil works including foundation of equipment and structural as required shall be under the bidder's scope. Bidders to note that complete grouting of the equipment, fixing etc. shall be also in the scope of the bidder. (As per requirement) Bidder shall furnish all applicable civil inputs details during detailed engineering.

ii. Geotech investigation and Soil Bearing Test (SBT), shall be carried out by Bidder. Surveying, Leveling and grading of site as required. Plot plan indicating NGL/FGL/HPP and coordinates of structure/building/equipment etc. to be submitted.

iii. Supply of all materials, tools & tackles, safety equipment, personal protective equipment, appropriate and adequate manpower required for construction of this Hydrogen Generation plant.

iv. Container / Prefabricated, heat insulated, air-conditioned, waterproof. Control room cum / and switchgear room for housing PLC, MCC, VFD control panel (if any), Electrical Panel, HMI / OWS etc. It shall be provided with appropriate flooring etc.

v. RCC foundations of at least M25 grade for all stationary and rotating equipment, wherever required.

vi. Structural Steel Work: Steel structure for equipment and pipe rack in the process area, Compressor Bay, Utility area, offsite area etc. as envisaged at the time of detailed engineering with hardened concrete flooring. Steel structure shall include staircase, floor grill/plate, hand railing, toe guard etc. Standard Steel sections shall be used conforming to relevant IS codes.

vii. Boundary wall/Periphery fencing/ boundary-PVC coated barbed wire (min 2.5 mm wire dia) all along the boundary of site with concrete support pillar/ galvanized steel angle at suitable interval and a gate of suitable size along with guard cabin.

viii. Maintenance accesses platform with ladder, railing and toe guard for all main equipment, gates and valves.

ix. Plinth Protection, water drainage system in and around all structures covered under this contract.

x. Cable trenches with covers, along with associated foundations etc. wherever required.

xi. Foundation for all pipe and cable supporting arrangement/ structures, wherever required.

xii. All steel embedment, insert plates in the civil structures & for cable routing. wherever required.

xiii. Grouting of all equipment, steel/cast iron inserts, plates, bolts, nuts, sleeves, as required.

xiv. All excavation work required for erection, support structure, cable trenches and making good the same after completion of work.

xv. Disposal of surplus excavated soil outside the site boundary as directed by IIPE.

xvi. Construction of temporary office, store, etc as required.

xvii. All other structural steel & RCC work required for completion of the project.

xviii. Monorails of adequate capacity with monorail girders and fixtures etc./ hoist/hydra shall be provided for compressor and other equipment as per installation and maintenance requirement. The requirement shall be finalized during detailed layout engineering.

xix. Semi covered structural steel shed for equipment housing.

xx. Storm water basins shall be provided to prevent runoff of contaminated water into adjoining areas during rains and shall be connected to existing storm water drains.

xxi. All internal roads within the battery limit as per detailed engineering, are to be constructed using designer interlocking blocks (min 80mm thick M40 grade) over 50mm thick sand layer, min 300mm thick WBM and min 100mm thick PCC.

xxii. Plastering: External (rough) surface of walls shall be plastered with 18 mm thick cement plaster, consisting first (base) layer of 12 mm thick plaster in cement sand mortar (1:6) and second (finishing) layer of 6 mm thick plaster in cement sand mortar(1:4). All plastering work shall conform to IS: 1661.

xxiii. **Painting**

- For painting on concrete, masonry, and plastered & surface, IS: 2395 shall be followed. For painting on steel work and ferrous metals, IS: 1477 shall be followed. For painting on woodwork IS: 2338 shall be followed.
- Concrete surface shall preferably be applied by roller. If applied by brush, then same be finished off with roller. A minimum of two finishing coats of paint shall be applied over a coat of primer. Color shade shall be as per NTPC standard practices
  Surface preperation: SA 2.5
  Primer: Two component surface tolerant aluminium pigmented polyamide cured HB Epoxy mastic paint (100-125 microns)
  Second coat: Two component polyamide cured epoxy with MIO content (100-160 microns)
  Final coat: Two-pack aliphatic Isocyanite cured acrylic fiinish paint (40-50 microns)
  Overall DFT:240-335 microns

xxiv. **Materials**

- Cement: (i) Cement for foundation and other shall be Ordinary Portland Cement (OPC, Grade- 53) or as per the designer. (ii) Cement for all other applications shall be Ordinary Portland Cement (OPC, Grade-53) conforming to IS: 8112 or Fly ash-based Portland Pozzolona cement conforming to IS: 1489 (Part-I) and / or any other type of cement meeting IS: 456 requirements.

- Aggregates: (i) Coarse aggregate: Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383. (ii) Sand: Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.
- Reinforcement Steel: All reinforcement steel shall be TMT (Thermo Mechanically Treated) of grade Fe500/Fe 500D conforming to IS: 1786 unless noted otherwise. satisfying ductility requirement. Mild steel & medium tensile steel bars and hard drawn steel wire shall conform to grade - 1 of IS: 432 (Part - I). Welded wire fabric shall conform to IS: 1566.
- Bricks: Bricks shall be table moulded/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 75 kg/cm2. Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS:13757 and IS:12894 respectively. Minimum fly ash content in fly ash-based bricks shall be minimum 25%. Common burnt clay bricks shall conform to IS: 1077.
- Structural Steel: Structural steel (including embedded steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. structural steel shall be of grade E350/E250 confirming to IS 2062 as finalized during detailed engineering. Chequered plate shall conform to IS: 3502 and pipes for hand rail shall conform to medium grade IS: 1611. All gratings shall be pressure locked/ electro-forged.

xxv. **Design Standard**

- RCC Design: RCC structures as per IS: 456-2000. Reinforcement as per IS: 5525 and SP: 34, IS 13920.
- Steel Structure Design: The design of steel structures shall be done by Limit State Method. Design and fabrication shall be as per provisions of IS: 800 LATEST EDITION and other relevant IS standards.
- Architectural Design: As per National Building Code and Local building by-laws as applicable including provisions of the Factories Act of the State concerned.
- Earthquake Resistant Design: All structures and equipment shall be designed for seismic forces in accordance with IS: 1893 (Part 1 to Part 4 LATEST EDITION). The damping factor (as a percentage of critical damping) to be adopted shall not be more than following: (i) Steel structures- 2%, (ii) Reinforced Concrete structures-5
- Wind Resistant Design: All structures shall be designed for wind forces in accordance with IS:875 (Part-3 Latest edition). The damping factor (as a percentage of critical damping) to be adopted shall not be more than following: (i) Welded Steel structures-1%, (i) Bolted Steel structures-2%, (iii) Reinforced Concrete structures-1.6%.
  However, it is not the intent to specify herein all aspects of engineering and construction. The Contractor shall be responsible for providing all materials and services, specified or otherwise (unless specifically excluded) which are required to fulfil the intent of ensuring operability and maintainability of the complete system covered under this specification.

4.3.13 Quality Assurance

The contractor shall submit manufacturing and field quality plan indicating the practice and procedure along with relevant supporting documents for IIPE approval immediately on award of contract.

4.3.14 Mandatory Spares

Sl	Item Description	Quality
1	Sensors	1% of population of each type and size with minimum One (1)
2	Control Valves	1% of population of each type and size with minimum One (1)
3	Valves	1% of population of each type and size with minimum One (1)
4	Safety relief valve	1 No
5	Strainer	1% of population of each type and size with minimum One (1)
6	Filters	5 numbers of each type and size
7	Pipe Fittings	1% of each material, type and size
8	Gaskets	1 set of each material, type and size
9	Seals for all pumps	1 complete sets for each individual Pump
10	Rotary Equipment bearings, Motor bearings	1% of population of each type and size with minimum One (1)
11	Shaft sleeve	1% of population of each type and size with minimum Two (2)
12	MCB, Contactors, Connectors	1 of each type & each rating.
13	Fuses	10% of each type & each rating
14	Relays	10% of each type & each rating
15	Power Supply Modules and Power Packs	1 No of each type and size
16	I/O module	10% of each type

Note

- In case the main population of any item is 1 or less, the spare quantity shall be 1 number.
- Wherever the quantity is given only in percentage, the spare quantity shall be distributed into various ranges/size/rating/type (as the case may be) in the same proportion of the main population. For the quantities coming less than 1, shall be treated as 1 only.

- Only after the usage of Mandatory spares only O&M spares shall be used. The major system components and their specifications are given in the following table.

Sl	Description	Technical Specification
1	Land Area	77m x 50m
2	Type of Electrolyzer employed	Alkaline/PEM or better Electrolyzer
3	Design capacity of Hydrogen production of plant	1 TPD
4	Hydrogen purity produced from the plant	99.99%
5	Compressor capacity (Nm^3/hr)	500 Nm^3/hr
6	Compressor discharge pressure (bar)	Above 200 bar
7	Hydrogen Storage for 2 days (kg of hydrogen)	2000 kg
8	Storage vessel type and storage pressure (bar)	Type-1 200 bar or above
9	Pressure of Hydrogen at delivery point. (bar)	150 bar
	Details of Electrolyzer	
10	Type of Electrolyzer	Alkaline/PEM or better Electrolyzer
11	Pressure of generated hydrogen (output of Electrolyzer)	16 bar or in compactible with compressor suction pressure requirement
	Compressor & Storage details	
1	Type of compressor	Oil lubricated / Oil free type (one Working and one Standby)
2	Compressor capacity (Nm^3/hr)	500 Nm^3/hr
3	Compressor discharge pressure (Bar(g))	Above 200 bar
4	Type of storage vessel/cylinder	Type 1/Type 3/Type 4

4.4 Comprehensive O&M Requirements

1. Time Period: Operation & Maintenance (O&M) of the plant for the period of FIVE (05) years from the date of successful completion of trial run of the plant.

2. Spares, consumables and tackles: IIPE shall provide spares, consumables, chemicals, purge/calibration gases, tools and tackles during the O&M period.

3. Record Keeping: Proper O&M log, record shall be digitally maintained by the bidder during the O&M period

4. Manpower: The bidder shall provide adequate number of manpower for safe and reliable operation of the plant during the O&M Period.

5. Safety: The bidder shall provide necessary PPE to its workforce and design and follow safety system to ensure a safe workplace. A protocol for reporting unsafe incident/ /accident shall be forwarded to IIPE for approval which needs to be strictly followed during O&M period.

Annexure-A

Undertaking for No -Blacklisting & No- Banning

To

The Registar
IIPE, Visakhapatnam

Sub: Undertaking for No Blacklisting & No Banning

I / We hereby declare that presently our Company/ Sole Proprietorship is having unblemished record and is not declared ineligible for corrupt/fraudulent practices by any State/Central Government/PSU on thedate of Bid Submission.

I / We further declare that presently our Company/ Sole Proprietorship is not blacklisted and not declared ineligible for reasons other than corrupt/fraudulent practices by any State/Central Government/PSU on the date of Bid Submission.

If this declaration is found to be incorrect then without prejudice to any other action that may be taken, our security may be forfeited in full and the tender if any to the extent accepted may be cancelled.

(Signature & Seal of Authorized Signatory for which POA attached)

Name of Authorized Signatory:

Designation:

Date:

ANNEXURE – B

FORMAT OF COMPLIANCE STATEMENT OF SPECIFICATIONS

1	2	3	4	5	6
Sl.	Name of specifications/part / Accessories of tender enquiry as per technical specifications of the Tender Document.	Specifications of quoted Model/ Item	Compliance Whether "YES" or "NO"	Deviation, if any, to be indicated in unambiguous terms	Whether the compliance / deviation is clearly mentioned in technical leaflet/ literature
1					
2					
n					

Note: Bidders are required to fill this table as per the specifications given in the Tender Document.

The bidder should also submit the Brochure with technical details of the product supporting the compliance statement.

Signature of the Bidder: _____

Name:

Stamp

ANNEXURE – C

MANUFACTURER'S AUTHORIZATION FORM

(On OEM's Letter Head)

[**The Bidder shall require the Manufacturer to fill in this Form in accordance with the instructions indicated. This letter of authorization should be on the letterhead of the Manufacturer and should be signed by a person with the proper authority to sign documents that are binding on the Manufacturer**]

Date:

Tender No./GeM Bid No.:

To

The Director
Indian Institute of Petroleum and Energy
Visakhapatnam – 530003

We_____[insert complete name of Manufacturer], who are official manufacturers of _____[Insert type of goods manufactured] having factories at_____ [insert full address of Manufacturer's factories],do hereby authorize_ _____[insert complete name of Bidder] to submit a bid the purpose of which is to provide the following goods, manufactured by us_____[insert name and or brief description of the goods], and to subsequently negotiate and sign the contract.

We hereby extend our full guarantee and complete comprehensive warranty in accordance with the Terms and Conditions of Contract with respect to the Goods offered by the above firm.

Authorized representative of the Manufacturer	**Authorized Representative Bidder**
Signature:	Signature:
Name:	Name:
Address:	Address:
Mobile No:	Mobile No:
Email ID:	Email ID:

ANNEXURE – D

PREVIOUS SUPPLY ORDERS/CONTRACT FORMAT

Name of the Firm _____

Order placed by {Full address of Purchaser]	Order No. and Date	Description and quantity of ordered equipment	Value oforder	Date of completion of delivery as per contract	Date of actual completion of delivery	Remarks indicating reasons for late delivery, if any and justification for price difference of their supply order & those quoted to us.	Has the equipment been installed satisfactorily?	Contact Person along with Telephone no., Fax no. and e-mail address.

Signature and Seal of the Manufacturer/ bidder ……

ANNEXURE– E

BIDDER INFORMATION FORM

Company Name: _____

Registration Number: _____

Registration Address: _____

Name of Partners /Director: _____

City:_____ Postal Code: _____

Company's Establishment Year: _____

Company's Nature of Business: _____

Contact Details:

Contact Name:_____Designation:_____

Email Id:_____Mobile No: _____

Company's Legal Status (**tick on appropriate option**)	**1)** Group of Company	
	2) Private Limited Company	
	3) Undertaking	
	4) Joint Venture	
	5) Partnership	
	6) Others	
Company Category	1) Micro Unit as per MSME	
	2) Small Unit as per MSME	
	3) Medium Unit as per MSME	
	4) Ancillary Unit	
	5) SSI	
	6) Others	

Other Details

Vendor's PAN No. _____

Vendor's GST No/CST No/LST No/WCT No/TIN No: _____

ANNEXURE– F

CERTIFICATE BY BIDDER- DPIIT REGISTRATION

(Certificate on Company Letterhead)

I have read the clause regarding restrictions on procurement from a bidder of a country which shares a land border with India; I certify that this bidder is not from such a country or, / if from such a county, has been registered with the Competent Authority (copy of the Registration Certificate enclosed).

I hereby certify that this bidder fulfils all requirements in this regard and is eligible to be considered for this tender no._____dated_____listed by IIPE Visakhapatnam.

Signature with Date and
Stamp of the Bidder

ANNEXURE-G

DECLARATION FOR LOCAL CONTENT

(on OEM's letter Head)

(to be given on Company Letter Head – for tender value below Rs. 10 crores)
(To be given by Statutory Auditor/Cost Auditor/Cost Accountant/CA for tender value above Rs.10

Crores)Date: .....

To

The Director
Indian Institute of Petroleum and Energy
Visakhapatnam – 530003

Sub: Declaration of Local Content

Tender Reference No. _____

Name of Tender/ Work: _____

1. Country of Origin of Goods being offered: _____
2. We hereby declare that items offered has_____**% local content** (Please mention exact %).
3. Details of location at which local value addition will be made/ made: (Complete address to be mentioned) _____

"Local Content" means the amount of value added in India which shall, be the total value of the itembeing offered minus the value of the imported content in the item (including all customs duties) as a proportion of the total value, in percent.

"False declaration will be in breach of Code of Integrity under Rule 175 ((1)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for up to two years as per Rule151 (iii) of the General Financial Rules along with such other actions as may be permissible under law."

Yours Faithfully,

(Signature of the Bidder, with official seal)

ANNEUXRE-H

BILL OF MATERIALS (BoM)/BILL OF QUANTITY (BoQ)

(Bidder should provide the following details on Letter head)

Quotation Ref. No: Date:

Name of the Bidder_____ GeM Bid No._____

Sl	Item Description
Bought-out-Goods	
1	Power Cables and Piping to the Battery Limit
2	Power Grid
3	Electrolyser
	Gas Separation system
	Purification system & Nitrogen Purging Station
4	Compressor
5	Storage (200 bar) and bottling
6	Civil & Infrastructure
7	Erection, Commissioning
8	PLC Control Systems and Electricals
9	Safety Systems
10	Mandatory Spares
Others	
11	Operation and Maintenance (O&M) for 5 years after commissioning of the Plant
12	Third party consultations charges [Third Party Consultations Charges minimum of 7.0% (excluding taxes) of contract value (i.e.,Bought-out-Goods and O&M) for design & optimization through simulation of PEM/Alkaline electrolyser, to be vetted by IIPE or third party in consultation with IIPE by the bidder.]

ANNEXURE – I

ACCEPTANCE OF TENDER TERMS
(To be given on Company Letter Head)

Date: DD/MM/YYYY

To,

The Director

Indian Institute of Petroleum and Energy
Visakhapatnam – 530003

Sub: Acceptance of Terms & Conditions of Tender.

Tender Reference No: _____

Name of Tender / Work: _____

Dear Sir,

1. I/ We have downloaded / obtained the tender document(s) for the above mentioned 'Tender' from the web site(s) namely_____as per your advertisement, given in the above-mentioned website(s).

2. I/ We hereby certify that I/ we have read the entire terms and conditions of the tender documents (including all documents like annexure(s), schedule(s), etc.,), which form part of the contract agreement andI/ we shall abide hereby by the terms/ conditions/ clauses contained therein.

3. The corrigendum(s) issued from time to time by your department/ Organization too have also been taken into consideration, while submitting this acceptance letter.

4. I/ We hereby unconditionally accept the tender conditions of above-mentioned tender document(s)/ corrigendum(s) in its totality/ entirety.

5. I/ We certify that all information furnished by our Firm is true & correct and in the event that the information is found to be incorrect/ untrue or found violated, then your department/ Organization shall without giving any notice or reason therefore or summarily reject the bid or terminate the contract, without prejudice to any other rights or remedy including that we can be debarred for a period up to two years as, per Rule 151(iii) of GFR 2017, in case of false declaration.

Yours Faithfully,

(Signature of the Bidder, with Official Seal)

ANNEXURE – J

TECHNO-COMMERCIAL BID FORM

Setting up a plant for the production of 1 ton/day of Hydrogen from flue gas based desalinated water using alkaline electrolyzer / PEM technology with storage, and for extensive and detailed R&D activities at NTPC Simhadri, Andhra Pradesh along with 5 years of O&M

PROFORMA OF LETTER OF UNDERTAKING

(TO BE FURNISHED ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)

[To be executed by the Parent / Associate Company Supported by Board Resolution and submitted by the Bidder along with the Bid, in case technical and financial support is being extended by the Parent Company / Associate to the Bidder for meeting the stipulated Technical and Financial Qualifying Requirement)

Dear Sir,

1.0 We, _____declare that we are the Parent / Associate company of_____(Name of the Bidder) and have a controlling interest therein._____(Name of the Bidder) proposes to submit the bid for the package setting up a plant for the production of 1 ton / day of hydrogen from flue-gas based desalinated sea water using alkaline/PEM electrolyzer technology with storage, and for extensive and detailed R&D activities at NTPC Simhadri, Andhra Pradesh along with 5 years of O&M under bid reference no_____dated_____and _____(Name of the Bidder) have sought Technical and financial strength support from us for meeting the stipulated Technical and Financial Qualifying Requirement as per the tender.

2.0 We hereby undertake that we hereby pledge our technical and financial support for the execution of the said package to **_____(Name of the Bidder)**, for the execution of the Contract, in case **_____(Name of the Bidder)** is awarded the Contract for the said package at the end of the bidding process.

3.0 We further agree that this undertaking shall be without prejudice to the various liabilities that **_____(Name of the Bidder)** would be required to undertake in terms of the Contract including the Performance Security as well as other obligations of the Bidder/Contractor.

4.0 This undertaking shall remain in force till the successful execution and performance of the entire contract and/or till it is discharged by Employer.

5.0 We are herewith enclosing a copy of the Board Resolution in support of this undertaking.

Yours faithfully,

(Signature of Authorized Signatory on behalf of the Parent Company)

Date:

Name & Designation:

Place:

Name of the Parent / Associate Company:

Seal of the Parent / Associate Company.....

WITNESS:1. ..... 2. .....

Annexure-K

POA Format

To be submitted in appropriate stamp paper

Know all men by these presents, We, _____(Name of the bidder with complete address), do hereby constitute, appoint and authorize _____, _____ who is presently employed with us and holding the position of _____, as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our Bid for _____ **i**ncluding signing the bid that the bid is binding upon the bidder during the full period of its validity for a period of 180 days starting from _____(bid opening date)

We hereby agree to ratify all acts, deeds, and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds, and things done by our aforesaid attorney shall and shall always be deemed to have been done by us.

I Accept

Name:
Designation:
Company Name with address:
Place:
Date:

ANNEXURE – L

CHECKLIST FOR BIDDERS TO BE SUBMITTED IN DULY FILLED AND SIGNED FOR TECHNICAL EVALUATION

Sl. No.	Name of the Document	Document Particulars	Submitted (Yes/No)?
01	Copy of Contract / Purchase Order of the project submitted against the Technical qualification criteria.		
02	Certification for in-house R&D recognition for last ten years.		
03	Completion Certificate or Project completion report or Signed copy of Performance Guarantee Test Report or equivalent documents for the R&D projects completed.		
04	Completion Certificate or Signed copy of Performance Guarantee Test Report or equivalent for the completed EPC projects.		
05	Completion Certificate or Signed copy of Performance Guarantee Test Report or equivalent for the completed flue gas based seawater desalination projects.		
06	Relevant documents submitted and presented as per the criteria mentioned for experience and exposure of key personnel in R&D domain and project planning.		
07	Presentation to IIPE regarding the project execution and relevant experiences.		
**All other documents to be submitted as per the bid documents wherever is required.*			

CHECKLIST FOR BIDDERS TO BE SUBMITTED IN DULY FILLED AND SIGNED

Sl. No.	Name of the Document	Document Particulars	Submitted (Yes/No) ?
01	Copy of PAN Card		
02	Copy of Registration/ Incorporation Certificate by Ministry of Corporate Affairs (MCA), GoI.		
03	GST Registration copy		
04	**Experience Criteria**		
05	**Bidder Turn Over Criteria**		
06	**OEM Turn Over Criteria**		
07	**Non-Blacklisting (As per Annexure-A)**		
08	Technical Compliance Statement **(As per Annexure-B)**		
09	OEM Authorisation form **(As per Annexure-C)**		
10	Previous supplied orders list **(As per Annexure-D)**		
11	Bidder's Information **(As per Annexure-E)**		
12	DPIIT Registration **(As per Annexure-F)**		
13	Declaration for Local -Content **(As per Annexure-G)**		
14	Bill of Materials/BoQ **(As per Annexure-H)**		
15	Acceptance of Tender and Conditions **(As per Annexure –I)**		
16	Techno-Commercial Bid Form **(As per Annexure-J)**		
17	POA format **(As per Annexure-K)**		
18	Checklist for Bidders to be submitted in duly filled and signed for Technical evaluation (**As per Annexure-L**)		
19	EMD /RTGS Transaction details Copy		
20	Purchase Preference: (if applicable) Micro and Small Enterprises (MSEs):		
21	Data Sheet/Brochure of the product offered (if any).		
22	**Warranty:** Undertaking from OEM/Bidder for providing minimum **1 Year warranty** from the date of Installation and Commissioning.		
23	Operation and Maintenance for 5 years (1825 days) after commissioning of the Plant		
24	**Delivery & Installation of the equipment**: 365 Days		
25	**Bid Offer Validity:** 180 days (From End date)		
**All other documents to be submitted as per the bid documents wherever is required.*			

Note: Submission of bid without the above-mentioned documents may lead to rejection/disqualification of theBid.

Signature of the bidder with stamp