

EPC PACKAGE

OF

1 TPD (NOMINAL) GREEN HYDROGEN PLANT
FROM PLASMA ENHANCED GASIFICATION OF
MSW-RDF/AGRI-WASTE
AT
NETRA, NTPC LTD.



A Maharatna Company

Technical Specifications

NETRA Technology Project

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1. Project Information

1.1 General

NETRA, NTPC Ltd is setting a 1 TPD (Nominal) Green Hydrogen plant based on 'Plasma induced Radiant Energy based Gasification System' (GH2-PREGS) with Municipal Solid Waste-Refuse Derived Fuel or Agriculture Waste as feed at NTPC NETRA, Greater Noida.

This 1 TPD GH2-PREGS plant, primarily, comprises of following 5 blocks:

- (i) Block-1: 25 TPD Plasma induced Radiant Energy based Gasification Block (including storage, transportation and preparation of feed)
- (ii) Block-2: Syngas Conditioning/Cleaning Block
- (iii) Block-3: Hydrogen Separation Block
- (iv) Block-4: Hydrogen Compression & Storage Block and
- (v) Block-5: Power Block.

1.2. Location

1 TPD GH2-PREGS plant shall be set up at NETRA, which is located in the district of Gautam Budh Nagar, Uttar Pradesh. Nearest airport is Delhi at a distance of approx. 50 KMs. The nearest railway station is Ghaziabad, which is at distance of about 25 km. Also, site is approachable by road from National Highway 24 (NH 24).

1.3 Plant Capacity & Design Considerations:

S.No.	Description	Value
1	Input	25 TPD MSW-RDF/Agri-Waste (NCV greater than 2800 kcal/kg) (Design margin: > 25%)
2	Output	1 TPD (nominal) Hydrogen with Purity $\geq 99.99\%$
3	Power	33 kV, 3 phase
Design Considerations		
4	Gasification Technology	Plasma induced Radiant Energy based Gasification
5	Hydrogen Separation Technology	Membrane separation/VPSA/PSA or combination of above
6	Hydrogen Compression	200 bar
7	Hydrogen Storage	2 tonnes

2. Framework and Scope:

2.1 Framework

1. 'Technology Licensor' for 'Plasma induced Radiant Energy based Gasification' of MSW-RDF/Agri-Waste: Bidder shall appropriately liaison with the 'Technology Licensor' and shall construct, commission and operate the '1 TPD GH2-PREGS Plant' under his supervision / guidance. Among other things, scope of liaisoning between bidder and 'Technology Licensor' shall also include process design, equipment sizing / selection, material selection, controls, staged / final inspection of all fabricated items (if any), auxiliaries etc - in a manner which ensures safe and automated normal / emergency operation, startup and shutdown of plant.

2. 'Proveness Criteria' for 'Technology Licensor' of 'Plasma induced Radiant Energy based Gasification': The 'Technology Provider' for 'Plasma induced Radiant Energy based Gasification' should be the owner of patent (i.e applicant /assignee in case of organization), wherein gasification of MSW-RDF/Agri-Waste, is carried out / enhanced with the use of "Plasma induced Radiant Energy'.
3. The bidder shall execute the project on a Lump sum basis.

2.1. Scope of Supply & Services

1. The scope of this project includes following:
 - a. Setup of 1 TPD GH2-PREGS plant based on the design provided by the Technology provider,
 - b. O&M of 1 TPD GH2-PREGS plant for 2 Year (including spares, consumables etc),
 - c. Supply of Feed Stock (MSW-RDF / Agri Waste) for 2 Year.
2. The bidder shall include Design, Engineering, Fabrication, Packing, Forwarding, Supply, Transportation and handling, Custom duty (and any other duties), Freight, Insurance, Loading & Unloading, Storage, Construction, Erection, Commissioning, Testing, PG Test, Training and O&M of this plant - in line with the specifications provided in this document. All supporting packages and utilities other than those mentioned under the heading 'Terminal Points' required for the project shall be provided by the bidder.
3. The design philosophy of this plant shall be such that process start/stop should be from the control room & hence all designs, controls, interlock, instrument selection, HMI etc. should be developed accordingly.
4. All PLCs (including standalone equipment, chillers, Nitrogen System etc.), instruments, solenoid valves etc. shall be of minimum SIL 2 Type, however any upward revision of SIL No. shall be decided as per HAZOP study. Deviation, if any, shall be with explicit approval of NTPC.
5. Bidder shall carry out detailed HAZOP study and any other study required for project.
6. All electrical equipment shall confirm to 'Electrical Area Classification Zone 2, Group IIC'.
7. In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India, NTPC rules/codes of practices as well as of the locality where they will be installed.
8. Bidder shall carry out, civil, mechanical, electrical, and C&I erection - including interconnection with existing plant and conduct of all quality tests (field & lab).
9. The Project shall be executed through a dedicated, well qualified and experienced team in consultation with Owner/Licensor. The bidder shall also implement proper MIS (management information system) for effective monitoring & management of the project.
10. The Bidder shall obtain approval of manufacturer/ sub vendors for all equipment required in the package from NTPC.
11. Bidder shall submit all engineering drawing and documents including (i) Operation & Control Philosophy, (ii) Drawings pertaining to civil, mechanical, electrical and C&I including PFD, P&ID , MDL, L2 Network, etc. (iii) Detailed engineering drawing, (iv) All calculations for civil & structural analysis, mechanical, electrical and C&I system, (v) Datasheets, (vi) Manufacturing & Field Quality Plan and its compliance, Calibration & Test certificates (vii) Submission of list of BOQ/BBU, Startup & Commissioning spares &

- consumables.(Minimum 2 set of Hard copy & 1 set of Soft copy of final drawings & documents). All documents provided by the bidder, depending on its category indicated in the MDL (master drawing / document list), shall be approved by NTPC.
12. First fill of all chemicals, solvents, consumable etc. up to the maximum level in respective storage tanks and subsequent topping till the successful completion of commissioning of the plant.
 13. Laboratory Testing facility for testing composition / quality of feedstock, chemicals, gas composition, Hydrogen as per requirement shall be provided.
 14. The guarantee/ warranty of all equipment shall be provided to NTPC as per manufacturer provisions or as per contract, whichever is more.
 15. Performance Guarantee tests after completion of initial continuous trial operation - details of which shall be finalized along with technology licensor. Bidder shall supply and ensure calibration of PG Test instruments, T&P, manpower etc.
 16. The bidder shall be responsible for insurance of the facilities until the handing over of the facilities to the owner. Bidder shall also be responsible for insurance of his personnel working at the Site, equipment, and materials. The security and watch and word of Bidder's Stores shall be the responsibility of the bidder.
 17. System / process for safe handling of solvent after its end of useful life and spilled/contaminated solvent in compliance with statutory requirements.
 18. Bidder shall arrange for the 'labor permit' till the completion of the project.
 19. Separate Safety officer and personal protective equipment for all working personnel, as per the requirement of NTPC, shall be finalized prior to the commencement of field work.
 20. Compliance with OISD, PESO, CPCB, SPCB guidelines and all other statutory regulations shall be in the scope of bidder. 'Consent to Establish' and 'Consent to Operate' shall also be obtained by the bidder.
 21. Training (Minimum 7 days) for control room & field operation of plant and its related packages.
 22. O&M of plant shall start after the successful commissioning of plant. It shall include supply of manpower, machineries, T&P, chemicals, solvents, consumables, spares etc. and all topping in the interim period. Plan for manpower deployment and plan for O&M shall be submitted by the successful bidder at least 3 months prior to plant commissioning for approval of NTPC. Detailed scope of O&M is mentioned in Annex-O&M.
 23. 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 outsourced items shall be finalized in consultation with NTPC.

2.2. General Guidelines

- a) Site Survey: Before submitting bid, 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 NTPC.

- b) 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.
- c) All material constructed or otherwise, shall be considered as the property of supplier till the handover after successful commissioning of Plant.

2.3. Facilities Provided by NTPC

- a) **Land:** Outdoor land, as marked in the plot plan, shall be provided in the NETRA premise.
- b) **Construction Power:** 415 VAC, 3Ph AC supply shall be available at the nearest NETRA feeder.
- c) **Construction Water:** Raw water will be provided by NTPC at about 300m from the identified land.

3. Performance Guarantee Test

3.1. PERFORMANCE GUARANTEE (PG) TEST

- i. PG Test shall be carried out to demonstrate the 1 TPD H₂ production. Measurement point shall be after removal of particulate matter and water wash (pl refer 'Process Flow Drawing - Figure 2').
- ii. PG Test shall be carried out after completion of 'Trial Operation' and 'Functional Tests'
- iii. Liquidated damage for deviation in performance shall be computed as per following formula:
 - a) $\text{Deviation in performance} = \frac{(\text{Tested capacity of Hydrogen Production} - \text{Guaranteed capacity of Hydrogen Production})}{\text{Guaranteed capacity of Hydrogen Production}}$
 - b) $\text{Liquidated damage} = (\text{Contract Value}) \times (\text{Deviation in performance})$
- iv. PG Test duration shall be at least 24 hours. Computation of all parameters shall be considered on average basis.
- v. The bidder shall provide the PG Test procedure for approval of NTPC.
- vi. PG test shall be carried out as per the approved PG Test procedure. PG test procedure shall be submitted and finalized within 60 days and 120 days respectively from the date of Notification of Award.
- vii. The Bidder shall be responsible for providing all material, equipment, and manpower, specified or otherwise, which are required to carry out PG Test.
- viii. There shall be no incentive / reward in case of positive performance deviation i.e., when tested parameters are better than the guaranteed capacity.
- ix. The contractor's aggregate liability to pay Liquidated Damages (LD) for failure to attain the performance guarantee shall not exceed five percent (5%) of the Contract Price.
- x. 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.

3.2. FUNCTIONAL TEST

S.No.		Description	Value
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1a	Gasification Block	Quality of syngas (after wet scrubber – pl refer 'Process Flow Drawing - Figure 2)	H ₂ > 27.6 mol% CO > 26.0 mol %
1b		Native carbon in syngas (after wet scrubber – pl refer 'Process Flow Drawing - Figure 2)	≤ 1 ppm (w)
1c		Syngas Impurities at Gasifier Block Battery Limit (ppm)	H ₂ O < 1.2 ×10 ⁵ CH ₄ < 2 N ₂ < 7×10 ⁴ NH ₃ < 5 HCN < 0.07 SO ₂ < 0.015 H ₂ S < 4500 COS < 200 HCL < 3 HF < 0.45
1d		Power consumption	< 500kw
2a	Syngas Conditioning Block	Syngas Impurities at Syngas Conditioning Block Battery Limit (ppm)	N ₂ < 7×10 ⁴ NH ₃ < 1 HCN < 0.01 SO ₂ < 0.01ppm H ₂ S < 1ppm COS < 1ppm HCL < 0.1 ppm HF < 0.1 ppm
3a	Hydrogen Separation Block	Recovery of Hydrogen	≥ 90%
3b		Quality of Hydrogen	≥ 99.99 (Vol % - wet basis)

- i. Functional Tests shall be carried out after successful completion of 'Trial Operation'.
- ii. Functional Tests duration shall be at least 24 continuous hours.
- iii. The bidder shall provide the Functional Test procedure for approval of NTPC.
- iv. Functional Tests shall be carried out as per the approved Functional Test procedure. The Functional Test procedure shall be submitted and finalized within 60 days and 120 days respectively from the date of Notification of Award.
- v. The Bidder shall be responsible for providing all material, equipment, and manpower, specified or otherwise, which are required to carry out Functional Tests.
- vi. There shall be no monetary penalty in case Functional Test parameters are not met. However, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the Functional Test parameters at no extra cost to the Employer and re-conduct Functional Tests with Employer's consent.
- vii. In case the specified Functional Tests parameters are still not met, PG Test can be carried out only if all Functional Test parameters are within a band on ±10%.

4. Plot Plan & Terminal Points

4.1. Plot Plan:



Figure 1: Plot Plan-1: Proposed Location of GH2-PREGS Plant (Layout drawing is for Tender Purpose only and actual will be finalized during detailed engineering)

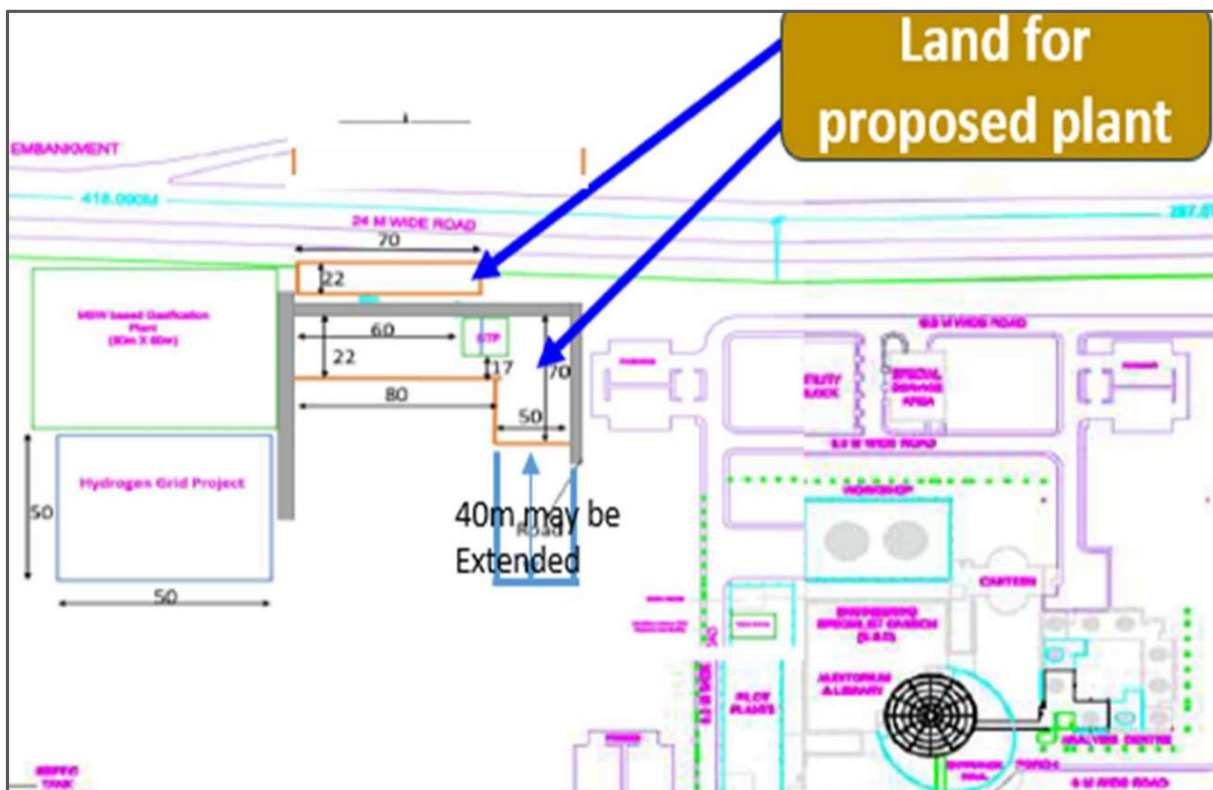


Figure 2: Plot Plant-2: Dimension of the land proposed for GH2-PREGS Plant (Layout drawing is for Tender Purpose only and actual will be finalized during detailed engineering)

4.2. Terminal Points

Electrical: NTPC shall provide one feeder at nearest MCC room. Bidder shall do all the arrangements to extend this power supply during construction/startup/operation as per their requirement. Total construction and startup/auxiliary power requirement at plant boundary shall be indicated in bid. It will be in the scope of the work of the bidder to lay a permanent line required for the O&M i.e. for power evacuation and running of auxiliary system of the plant during start up/shutdown from the given terminal point.

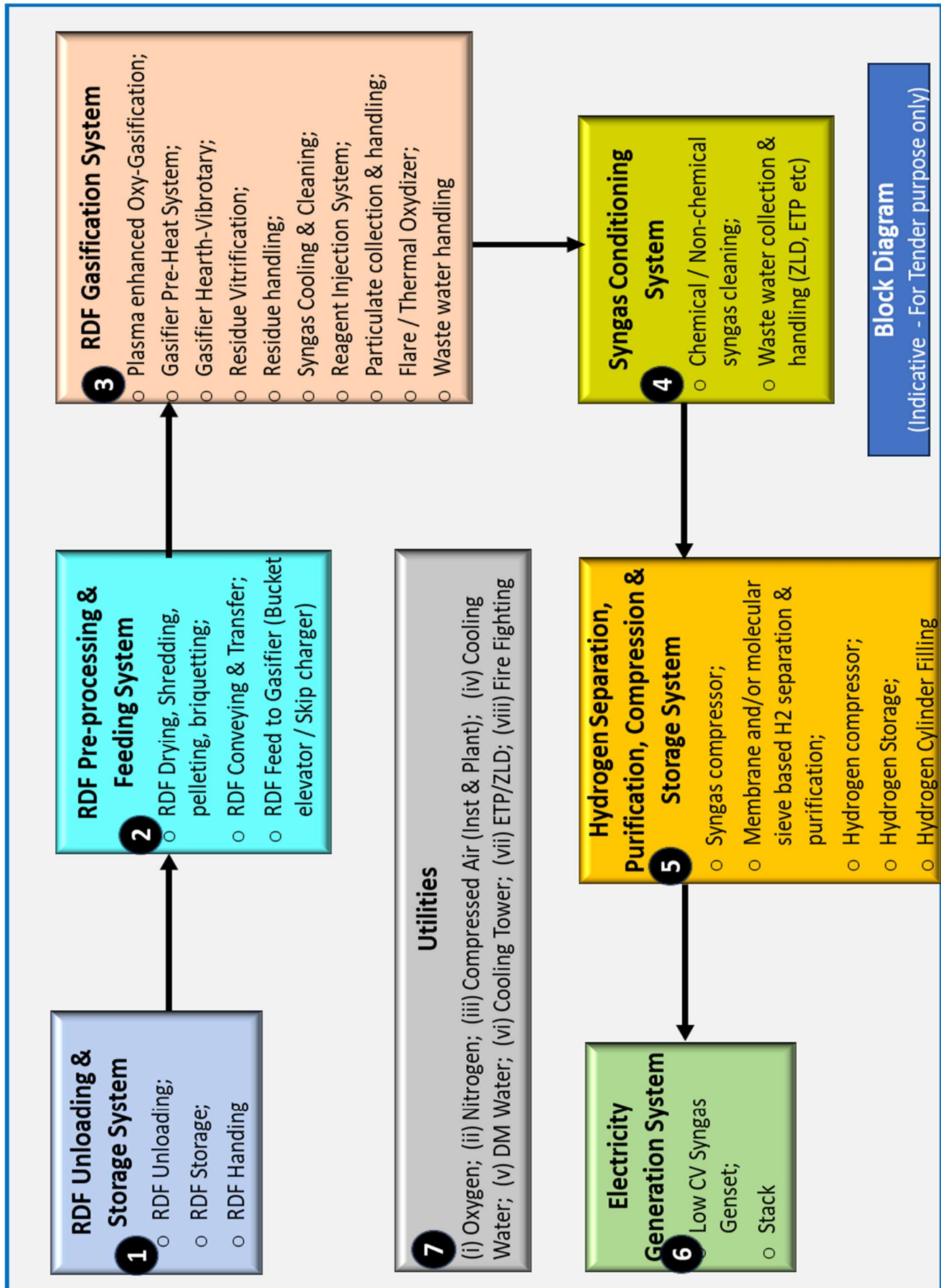
Water Supply: NTPC shall provide a tap off point with isolation valve with an approx. distance of 300m from the project site. The bidder shall lay pipelines and connections/valve as per their requirement. Bidder has to use this water supply for all plant/process requirements except for drinking. All necessary/required treatment processes as required by the plant or process of the bidder and associated process/storage/pipelines/instrumentation for water quality monitoring shall be in the scope of bidder.

Fire Fighting: Fire hydrants are available in the vicinity. It will be in the scope of the agency to extent the hydrant line to project site for firefighting system. All necessary equipment/system after the hydrant tap off point shall be in the scope of bidder.

Drinking Water: NTPC shall provide a tap off point. The bidder shall lay the pipelines and install water tank/valves as per requirement and shall use this supply strictly for drinking purpose.

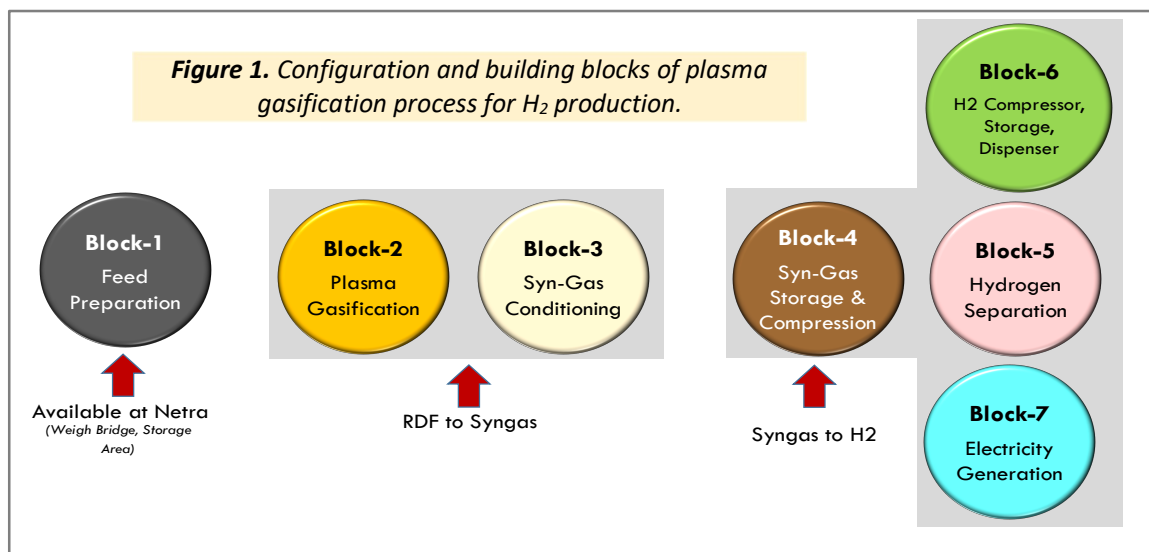
PNG (Piped Natural Gas): NTPC shall identify a tap off point. The bidder shall lay the pipelines for pre-heating of Gasifier, as required, along with metering, control and safety system. Augmentation of existing PNG supply line, if required, shall be in bidder's scope.

5. Block Diagram



5. Process Description

1 TPD GH2-PREGS shall gasify MSW-RDF/Agri-Waste to produce 'Syngas'. Thereafter, hydrogen is separated from 'Syngas' using suitable a process. 1 TPD GH2-PREGS comprises of following blocks, brief of which is mentioned below.



5.1. Block-1: Feed Preparation

In Block 1 of GH2-PREGS, MSW-RDF/Agri-Waste is prepared as per the specification (Table 1). In order to produce MSW-RDF/Agri-Waste, waste may first be screened and shredded and then carefully sorted to remove all non-combustible materials such as glass, metal and stone via a series of mechanical operations i.e. vibrating screen, magnetic separator, shredder etc. Size of shredded MSW-RDF/Agri-Waste along with need of briquetting is to be finalized together with 'Technology Licensor'.

Parameters	Units	MSW-RDF/Agri-Waste (Grade III)	Design Basis (Avg)	Design Basis (Max)
Moisture	Wt % (ar)	< 20%	20%	25%
Ash	Wt % (d)	< 15%	15%	20%
Chlorine	Wt % (d)	< 1.0%	0.5% Cl	1.0% Cl 1.2% Cl+F+Br
Sulfur	Wt % (d)	< 1.5 %	1.0%	1.5%
Net Calorific Value (NCV)	Kcal/kg (ar)	>3000	3200	>3000
Size	mm	< 50 or < 20		50
PVC		None	Allowed	Allowed
Mercury	mg/kg (d)	-	0.25	0.5
Arsenic	mg/kg (d)	-	-	10
Cadmium	mg/kg (d)	-	-	10
Cobalt	mg/kg (d)	-	-	25
Chromium	mg/kg (d)	-	-	100
Copper	mg/kg (d)	-	-	200
Nickel	mg/kg (d)	-	-	50

Lead	mg/kg (d)	-	-	50
Antimony	mg/kg (d)	-	-	50
Vanadium	mg/kg (d)	-	-	50

5.2. Block-2: Gasifier Block

The main process equipment may include gasifier chamber, plasma torch, product gas cleaning system, slag vitrification subsystem, in-process analyser and control system.

MSW-RDF/Agri-Waste will be fed to a multi-stage gasification reactor by a waste feed system. Electrical heating / PNG heating is to be provided, only during start-up, to raise the gasifier chamber to operating temperature, before beginning to feed waste. Preferably, oxygen shall be used as gasification media in order to minimize nitrogen content and thereby enhance syngas quality.

Raw synthesis gas obtained from MSW-RDF/Agri-Waste gasification will pass through a series of chambers designed to provide turbulent mixing and adequate residence time for the gasification reactions. At an appropriate location, plasma torch shall be provided, which provides intense heat to ensure that tars and carbon particulates in the syngas are removed, and syngas quality is maximized.

The inorganic part of MSW-RDF/Agri-Waste, which is not gasified, is referred to as ash. The ash exiting the gasifier is transferred to a vitrification chamber – where it is to be melted using the intense heat generated by a plasma torch. Typical melting temperatures are in excess of 2,000°F(1,100°C). The molten ash is referred to as slag. Molten slag is drained from the vitrification chamber into a water-filled slag discharge dredge conveyor. The slag solidifies as it cools in the water bath. The solidified slag forms a glassy, non-leaching solid residue similar to glass or obsidian.

In the downstream of Gasifier, an 'Evaporative Cooler' (EC) is provided which rapidly lowers the syngas temperature, from approximately 1000°C to around 200°C. The rapid cooling is achieved by the injection of 'water mist' – produced thru steam / mechanical atomization to prevent side-reactions and formation of hazardous gases. The 'water mist' consists mainly of water and some dissolved sodium chloride. As syngas is both hot and flammable, use of an inert atomizing medium is required. The flowrate of 'water mist' is controlled so as to cool the syngas to 200°C - without bringing the syngas close to saturation point. The sodium chloride in the liquid stream forms solid particles which are removed by the fabric filter.

In the next step, lime (as CaO or Ca(OH)₂) and activated carbon are injected into the syngas stream before it enters a fabric-filter baghouse. This process is known as 'Dry Sorbent Injection' (DSI). The lime reacts with, and captures into the solid phase, acid gases present in the product gas stream (primarily Hydrogen Chloride (HCl) and Hydrogen Fluoride (HF)). The activated carbon particles adsorb gaseous mercury (Hg) and other volatile metals, capturing them in the solid phase also.

The 'Fabric Filter Bag House' (FFBH) removes the particulates by a filtration process. As the majority of the acid gases (e.g., HCl), and volatile/semi-volatile metals have been moved into the solid phase as a result of the sorbent injection, they are now particulates which are captured along with any residual ash or other solids on the surface of filter bags within the fabric filter housing. Typically, acid gas removal is >99.9% and solid particle removal is > 99%. The captured solids which have been shaken off from FFBH is to be appropriately handled and disposed off.

Downstream of FFBH, syngas next enters a polishing 'Wet Scrubber' (WS) where an aqueous solution removes residual acid gases (HCl and HF) with a high (typical residual HCl removal of 99%) efficiency as well as further cooling syngas. The solution that circulates and removes the acid gases is neutralized with caustic injection into the scrubber sump. The wet scrubber is operated at close to neutral pH in order to selectively remove all but traces of the acid gases (HCl and HF) from the syngas, while removing minimal, if any, Carbon Dioxide (CO₂) and Hydrogen Sulphide (H₂S). The syngas exiting the WS is saturated with water vapor and is at a temperature of approximately 50C. The gasifier, as well as the entirety of the syngas cleaning system from the inlet of the EC to the exit of WS, is maintained under a slight vacuum.

Nitrogen (99.9% purity) is primarily used for purging and inerting purposes in the gasification process to ensure safe operations. Significant usage, include inerting of the MSW-RDF/Agri-Waste Feed 'Airlock' and back-pulsing of the FFBH media. During start-up and shutdown, Plasma Torches may be operated with Nitrogen rather than Instrument Air.

5.3. Block-3: Syngas Conditioning

The syngas from the 'Wet Scrubber' (WS) may further cleaned in the multi-stage scrubber system to remove impurities - producing very clean syngas comprising primarily of H₂ and CO as shown in Figure 2. The multi-stage scrubber system may consist of another wet scrubber followed by alkali based scrubber system etc to remove the impurities of synthesis gas to the target level. Further, if needed, activated carbon based system may be integrated to achieve the targeted impurities level in the clean syngas. The wastewater generated in the gasification and syngas conditioning blocks should be treated in the ETP plant in compliance with current ZLD policy of India.

5.4. Block-4: Hydrogen Recovery System

This block shall consist of a Syngas Compressor followed by Membrane / VPSA /PSA unit to recover H₂ from syngas. However, configuration of the 'Membrane Unit' which uses additional Syngas Compressor (other than the one mentioned above) shall not be preferred. Downstream of 'Hydrogen Recovery System' shall achieve hydrogen of required purity.

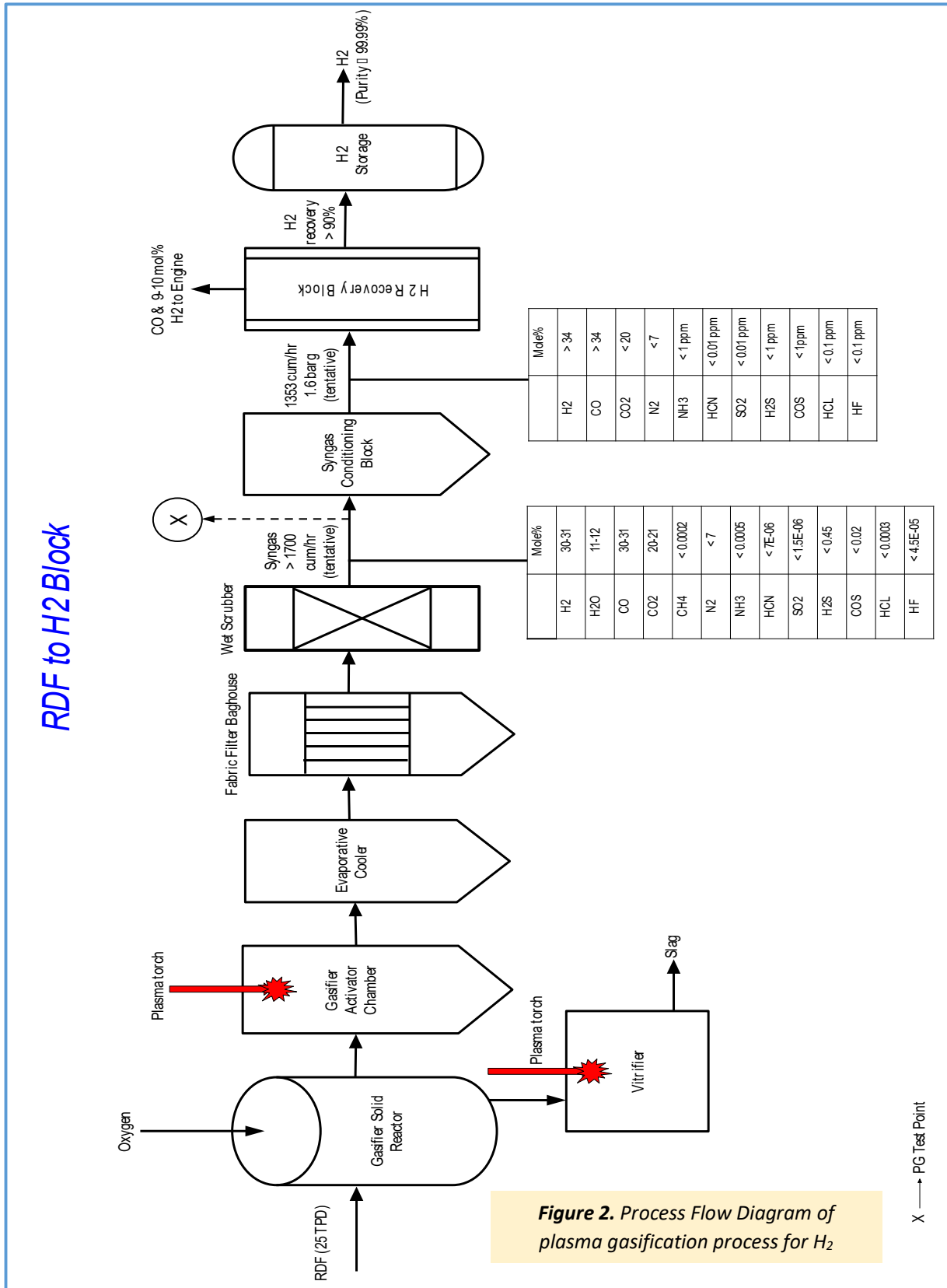
5.5. Block-5: Hydrogen Compression & Storage System

Hydrogen, of requisite purity, obtained from 'Hydrogen Recovery System' shall compressed to the required pressure (mentioned elsewhere in this doc) and stored in cascade.

5.6. Block-6: Power Block

'Carbon Mono-oxide' separated from 'Hydrogen Recovery System', along with minimum quantum of hydrogen, shall be used in 'Gas Engine' to produce electricity. 'Gas Engine' which requires minimal quantum of hydrogen for its operation, shall be preferred.

6. Process Flow Diagram



7. Technical Specifications

7.1. Technical Specifications – Mechanical:

7.1.1 RDF Unloading, Storage, Pre-processing and Feed System

S.No	Description	Parameter
7.1.1.1 RDF Unloading, Storage and Pre-processing System		
1	Intent	To have a clean, hygienic, litter-free and efficient system with minimum manual intervention.
2	Purpose	To receive, unload, store, handle, segregate, pre-process RDF
3	Capacity	25 TPD (Design margin: > 25%)
4	Functional Requirement	<ul style="list-style-type: none"> a. Clean, hygienic, litter-free, demarcated system and layout. b. Covered and ventilated industrial shed for receiving, handling and pre-processing of RDF; c. A segregation conveyor system for removing inerts/unwanted items received in RDF; d. The following pre-processing system as per requirement of bidder's offered gasification system <ul style="list-style-type: none"> i. RDF shredding ii. RDF drying iii. RDF pelleting/briquetting e. The above system needs to be interlinked with necessary conveyor /hoppers for a mechanical conveying/transfer of RDF within/out of the system; f. Tractor (preferably EV) mounted with front loader and hydraulic trolley; g. All civil, structural, mechanical, electrical, control system to enable the above process.
5	Note	Requirement of pre-processing, size of feed etc is to be decided as per the requirement of gasifier.
7.1.2.2 RDF Feed to Gasifier:		
1	Intent	Ensure Safe operation & Optimize efficiency parameters
2	Purpose	To weight feedstock and feed it to gasifier
2	Capacity	25 TPD (Design margin: > 25%)
3	Location of Load cell placement	<ul style="list-style-type: none"> a. Bidder shall provide load cell in skip charger/Bucket elevator/feeding or charging system; b. Bidder shall also provide load cell in another suitable location (such as conveying system) as standby option if the load cell as above is not operational; c. Bidder shall have additional calibrated load cell in case of outage
4	PLC feedback	<ul style="list-style-type: none"> a. The data of load shall be connected to PLC; b. It shall have 15 days back up of data storage; c. All necessary hardware and software shall be provided by bidder d. The exact locations of Load cells shall be decided during detailed engineering.

5	Calibration	Bidder shall calibrate the load cells bi-annual basis from any NABL accredited lab.
6	Other design consideration	a. Adequate design to avoid RDF spillage during the operation of RDF charger with minimum manual intervention. b. All civil, mechanical, electrical, control system to enable the above process.
7	Note	Design of Feed System is to be decided as per the requirement of gasifier

7.1.2 RDF Gasification System

S.No	Description	Parameter
7.1.2.1 General		
1	Functional Requirement	a. Plasma enhanced Oxy-Gasification; b. Gasifier Pre-Heat System; c. Gasifier Hearth-Vibrotary; d. Residue Vitrification; e. Residue collection, handling & Storage; f. Syngas Cooling & Cleaning; g. Reagent (Lime, Activated Carbon etc) Injection System; h. Particulate collection & handling (Bag house etc); i. Flare / Thermal Oxydizer; j. Waste water collection & handling (scrubber etc)
7.1.2.2 Gasifier		
1	Intent	Ensure Safe operation & Optimize efficiency parameters
2	Purpose	To gasify Feedstock to produce Raw Syngas & Vitrified Ash
3	Capacity	25 TPD MSW-RDF/Agri-Waste (Design margin: > 25%)
4	Design Consideration	a. Gasifier is to be designed for the physico chemical characteristics of the feed stock mentioned at 'Process Description, Table-1'. b. Gasifier is to be designed in a manner to ensure (i) Nil/Minimal Tar in the Syngas exiting Gasifier and (ii) Solid residue of Gasifier (including ash) is vitrified; c. Syngas composition at the outlet of battery limit of Gasifier block shall comply with the requirement mentioned at 'Functional Test 1a,1b,1c'
5	Other design consideration	d. Adequate instruments are to be provided to measure process parameters including gas composition in order to monitor gasifier performance; e. Design of Steel Structure & Civil Foundation shall be carried out as per Gasifier geometry and weight; f. Cooling water (if required) shall be provided as per Gasifier design; g. In case Syngas needs to be conditioned before Bag Filter with suitable reagent (lime, activated carbon etc) for removal of acidic gas, heavy metal etc, then complete system (including storage, conveying, injection , weighment etc) needs to be provided for each reagent; h. All mechanical, electrical, instrumentation & control, civil, steel & RCC structural items to enable the above process are in scope of bidder.

6	Note	<ul style="list-style-type: none"> i. Capacity and sizing of utilities viz oxygen, nitrogen etc is to be decided as per the requirement of gasifier. ii. High Turn down ratio of Gasifier shall be preferred. iii. Turn down ratio of downstream equipment (viz Syngas cooler etc) shall be designed based on Turn down ratio of Gasifier.
7.1.2.3 Syngas Cooler		
1	Purpose	To rapidly cool the raw syngas stream to approximately 200°C.
2	Other design considerations	<ul style="list-style-type: none"> 1. Type of cooling: <ul style="list-style-type: none"> (i) Direct contact Evaporative cooling: Water mist /Steam atomized OR (ii) Indirect Contact; 2. MOC: <ul style="list-style-type: none"> (i) Evaporative Syngas Cooler: Top Section (Inlet plenum & upper section refractory lined) and Bottom Section (Corrosion resistant alloy) (ii) Evaporative Cooling Nozzle: 310 SS or better; 3. All mechanical, electrical, instrumentation & control, civil, steel & RCC structural items to enable the above process are in scope of bidder.
7.1.2.4 Fabric Bag Filter		
1	Purpose	Removal of particulates from Syngas
2	Other design considerations	<ul style="list-style-type: none"> 1. Particulate collection efficiency: > 99.9% 2. Bag Filter Material: Suitable for continuous operation >260C 3. Cleaning arrangement: Self cleaning (Jet pulse)
3	Note	In case Syngas needs to be conditioned before Bag Filter with suitable reagent (lime, activated carbon etc) for removal of acidic gas, heavy metal etc, then complete system (including storage, conveying, injection , weighment etc) needs to be provided for each reagent.
7.1.2.5 Wet Scrubber		
1	Purpose	<ul style="list-style-type: none"> a. Removal of 'Acid Gases' from Syngas; b. Cool Syngas to 'saturation temperature' in order to condense moisture from Syngas
2	Other design considerations	<ul style="list-style-type: none"> a. Vertical vessel with 'Packed Bed' – using cooled and pH adjusted recirculating water; b. Removal of 'Acid Gases' from Syngas >99.9%; c. Removal of 'Moisture' from Syngas >90%; d. MOC: (i) Shell: SS 316L or better, (ii) Packing: Polypropylene/SS 316L, (iii) Piping: SS 316 or better.
3	Note	<ul style="list-style-type: none"> a. Wet Scrubber (WS) shall be provided with (i) WS Recirculation pump (2x100%, MOC: SS 316L or better) and (ii) WS Heat Exchanger (1X100%, MOC: SS 316 or better) b. Syngas composition at the outlet of battery limit of Gasifier block shall comply with the requirement mentioned at 'Functional Test 1a,1b,1c'

7.1.3 Syngas Conditioning System

S.No	Description	Parameter
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1	Purpose	Removal of contaminants such as H ₂ S, COS, NH ₃ , HCL, HCN, Hg etc in Syngas exiting Gasifier block
2	Design Considerations	a. Capacity: 2000 M ³ /Hr (indicative) b. Inlet Syngas composition: Refer 'Functional Test 1c) c. Outlet Syngas composition: Refer 'Functional Test 2a)
3	Other Design Considerations	a. All pumps shall be: (i) 2x100%, (ii) MOC: SS 316L or better; b. All Heat Exchanger shall be: (i) 1X100%, (ii) MOC: SS 316 or better; c. All pipes & valves shall be of SS 316 or better; d. All Tanks shall be of SS 304 or better

7.1.4 Hydrogen Separation, Purification, Compression & Storage System

S. No	Description	Parameter
7.1.4.1 General		
1	Purpose	Separation of hydrogen in Syngas after the 'Syngas Conditioning System', its purification, compression and storage
2	Design Considerations	a. Capacity: 2000 M ³ /Hr (indicative); b. Inlet Syngas composition: Refer 'Functional Test 2a; c. Output: (i) Hydrogen, (ii) Lean Syngas; d. Hydrogen: (i) H ₂ Recovery after 'Syngas Conditioning System': ≥ 90%; (ii) H ₂ Quality: ≥ 99.99 (Wet Vol%); (iii) H ₂ Storage Pressure: 200 Bar; (iv) H ₂ Storage Capacity: 2 Tons; e. Lean Syngas: Refer 'Process Flow Diagram'
7.1.4.2 Syngas Compressor		
a. Type: Reciprocating; b. Capacity: 2x100%; c. Process fluid: (i) Composition: Syngas (Refer 'Functional Test 2a), (ii) Flowrate: 2,000 M ³ /Hr (indicative), (iii) Suction / Discharge Parameters: As per process requirement; d. Standard: API-618; e. Compressor should be non-lubricated; f. Turndown capacity should be 50% (min); g. Intercooler, aftercoolers and PSV is to be provided; h. Any special arrangement for startup / shutdown / emergency (viz nitrogen purging etc) is to be provided, as required; i. Number of stages should depend on vendor depending on discharge conditions; j. Knock out drum should be included to entrap any liquid present in the gasses; k. Mandatory Spares to be provided with compressors.		
7.1.4.3 Hydrogen Compressor		
a. Type: Reciprocating / Diaphragm; b. Capacity: 2x100%; c. Process fluid: (i) Composition: Hydrogen, (ii) Flowrate: 500 NM ³ /Hr (indicative), (iii) Suction Parameters: As per process requirement, (iv) Discharge Pressure: 200 Bar(g); d. Standard: API-618; e. Compressor should be non-lubricated; f. Turndown capacity should be 50% (min);		

- g. Intercooler, aftercoolers and PSV will be in the scope of bidder;
- h. Any special arrangement for startup / shutdown / emergency (viz nitrogen purging etc) is to be provided, as required;
- i. Number of stages should depend on vendor depending on discharge conditions;
- j. Mandatory Spares to be provided with compressors.

7.1.4.4 Hydrogen Separation & Purification System

- a. Technology: Membrane separation/VPSC/PSA or combination of above;
- b. Hydrogen Product Purity: Refer 'Functional Test 3b';
- c. Configuration of 'Membrane separation/VPSC/PSA Unit' which uses additional Syngas Compressor (other than the one mentioned above) shall not be preferred. However, in such case, all compressor shall be of 2x100% duty and confirm to API-618.

7.1.4.5 Hydrogen Storage Cascade

1	Capacity	2 tonnes
2	Pressure	200 Bar (g) (Minimum)
3	MOC	Type: II, III & IV
4	Hydrogen Storage Type	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 Chief Controller of Explosives, Govt. of India, Nagpur
5	Other design considerations	<ul style="list-style-type: none"> 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 in Fuel cell the Hydrogen needs to meet the purity level of 99.99% b. The Normal working pressure of the Quads/Cascade/cylinder is minimum 200 bar c. 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) and emptied (to fuel cell) simultaneously in a safe and reliable manner. d. The Hydrogen storage area shall be equipped with leak/fire detector and control system. e. 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. f. Ownership certificate for all gas cylinders in the name of NTPC NETRA g. The supplier should provide one copy of inspection / test certificate duly signed by BIS authority and approval letter from Chief Controller of Explosives, Nagpur, permitting filling of gas in these cylinders along with the cylinders. h. Manufacture's test certificates and approval from Chief Controller of Explosives, Nagpur. i. Hydraulic test certificates of all the cylinders. j. PESO and any other statutory certificates, if required are in the scope of

		vendor.
7.1.4.6 Hydrogen Cylinder Filling System (Fixed Rack, Mobile Rack, 20 Single Cylinder Station)		
a. Fully automatic, SCADA controlled filling of hydrogen cylinder (minimum 20 single cylinder station, fixed rack, mobile rack); b. Filling techniques: Both Pressure Temperature compensated & Mass Flow; c. Manifold, instruments, filters, check valves, particle traps, isolation valves, proportional valves etc has to be of 'hydrogen service' grade; d. System has to be designed and hydro-tested at 200% and 150% of operating pressure respectively; e. Hydrogen leak detection system to be provided; f. Fire detection and fighting system to be provided; g. Vacuum pump together with peripherals to be provided for evacuating hydrogen cylinder / rack.		

7.1.5 Power Block

S.No	Description	Parameter
7.1.5.1 Tail Gas Buffer Storage		
1	Purpose	a. To have a buffer storage at the inlet of gas engine take care the variation in producer gas quality/quantity; b. Safe shutdown of Gasifier
2	Capacity	30 minutes (at full load operation)
3	Other design considerations	a. A gas buffer storage (balloon) with adequate safety provision for against pressurization or vacuum needs to be incorporated; b. All pipes, valves, gates, air locks, instruments, accessories, interlocks, protections etc which are required for safe and efficient operation is to be provided
7.1.5.2 Gas Engine		
1	Purpose	Produce electricity using 'Tail Gas' obtained after separating hydrogen from Syngas
3	Capacity	Corresponding to 100% use of 'Tail Gas' at full load + 10% as design margin
4	Other design considerations	a. Governing System: Should be EMC type and communicable that means should be able to send and receive controlling commands from the plant PLC/SCADA system; b. Acoustic enclosure for gas engine (including generator) to reduce noise to acceptable level; c. Stack: (i) Of suitable height with insulation, heat resistance paint and cladding, (ii) Height of the stack to satisfy statutory norms of CPCB/ UPSCB/ MoEF&CC, (iii) Provision for exhaust gas sampling;

		<p>d. Gas engine auxiliaries: Suction filter system, cooling system, lubrication system, vibration sensor, controls, interlocks & protection etc to be provided;</p> <p>e. Foundation & Mounting: Appropriate foundation for the gas engine considering various types of loads</p> <p>i) Gas engine and the Generator shall be mounted on a single steel base frame fabricated from angle iron or channel, which shall be set into or fixed to the floor (separate fixing shall be avoided in order to avoid tension stresses occurring in the concrete floor). If the Gas engine and the Generator are closely coupled (i.e. their own frames are rigidly connected to each other), then the base frame may be omitted.</p> <p>ii) The Gas Engine and the Generator shall be fixed securely to the base frame in a workshop before installation so that correct positioning may be achieved.</p> <p>f. Measurement & Control</p> <p>i) The plant operation shall be PLC based.</p> <p>ii) Digital temperature & pressure sensor at the inlet of Gas engine.</p> <p>iii) Other instruments of standard make as needed shall be provided as per requirement at appropriate locations.</p> <p>g. Safety</p> <p>i) All moving parts shall be shielded by a protective cover.</p> <p>ii) Standard set of tools as per manufacturer's standard/requirement. Suitable lifting hoists shall be provided as required.</p> <p>iii) Provision for flaring the producer gas with the help of a burner/flare system with automatic ignition during start-up/shut down and when engine is not available.</p>
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Note: All foundation, civil, mechanical, electrical, control, structural steelwork, platforms, stairs, piping, valves, supports, equipment/system not mentioned above but required for effective and complete system shall be in the scope of bidder.

7.1.5.3 Gas Engine Generator

1	Design Considerations	<p>a. Electricity generation and synchronization: With NETRA LT System;</p> <p>b. Mode of Operation: Grid, microgrid and islanding mode</p> <p>c. Capacity: Corresponding to the Gas Engine;</p> <p>d. Nominal Parameters: (i) Phase: 3, (ii) Voltage: 415+10%, (iii) Frequency: 50Hz \pm 3%, (iv) Power factor: 0.8, (v) Voltage regulation required: \pm 10%;</p> <p>e. Insulation: Thermal Class 155 (F) for Stator and Rotor winding insulation conforming to IEC-60034;</p> <p>f. Grounding: The neutral of the generator shall be effectively earthed along with all the metal casings of the electrical equipment etc.</p>
2	Generator Excitation System	<p>Generator excitation and voltage regulating system having capability for:</p> <p>a. Meet the declared maximum continuous rated output of Gas Engine;</p> <p>b. Continuous stable operation without any excessive temperature rise at the peak output of Gas Engine and temperature rise shall be lower than those permissible for Thermal Class 155 (F) insulation (IEC-60034).</p>
3	Protection System	<p>a. Protections for complete electrical system shall be provided as per prevailing practices. Protection coordination with the existing system is also in the scope of the bidder.</p> <p>b. Air circuit breaker shall be provided at generator terminals in case rating of one generator is more than or equal to 110kW</p>

		c. 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.
<p>Note:</p> <p>a. All auxiliaries, cable trays, electrical cables, metering module interlocks and protection systems. All the necessary electrical equipment like earthing, switching, circuit breaker, PT, CT, voltage control, speed control, step up / step down transformer, synchronization, protection, overload, reverse power protection, Metering, remote and local display, interfacing with the C&I system is in the bidder's scope.</p> <p>b. All foundation, civil, mechanical, electrical, control, structural steelwork, platforms, stairs, piping, valves, supports, equipment/system not mentioned above but required for effective and complete system shall be in the scope of bidder.</p>		

7.1.6 Utilities, Auxiliaries & General Items:

S. No	Description	Parameter
7.1.6.1	Oxygen System	<p>a. Purpose: Provide Oxygen for Plasma enhanced Oxy-gasification;</p> <p>b. Plant Parameters: (i) Capacity: 800 Kg/Hr (Indicative), (ii) Purity: >93 %, (iii) Delivery Pressure (in Buffer Vessel): > 4 Bar(g);</p> <p>c. Type: Vacuum Pressure Swing Adsorption/ Pressure Swing Adsorption;</p> <p>d. Buffer Vessel: (i) Capacity: Minimum 10 minute of full load gasifier operation, (ii) Design Code: ASME Section VIII Div I (Latest);</p> <p>e. Rotating Equipment: 2x100% (1 Operation + 1 Standby);</p> <p>f. Process Control: (i) Start/Stop in Auto, from Remote and from Main PLC, (ii) Provision of data communication with Main PLC;</p> <p>g. Installation: Outdoor;</p> <p>h. First charge of Molecular Sieve to be provided;</p> <p>i. All necessary static and rotating equipment, instruments, piping, valves, cabling, spares, civil works viz steel structure, approach, platform, foundation, RCC, PCC etc – shall be in the scope of bidder.</p>
7.1.6.2	Nitrogen System	<p>a. Purpose: Provide Nitrogen for (i) Plasma enhanced Oxy-gasification, (ii) Hydrogen Separation, Purification, Compression & Storage System;</p> <p>b. Plant Parameters: (i) Capacity: 50 Kg/Hr (Indicative), (ii) Purity: >99.99 %, (iii) Delivery Pressure (in Buffer Vessel): > 11 Bar(g);</p> <p>c. Type: Pressure Swing Adsorption;</p> <p>a) Buffer Vessel: (i) Capacity: Minimum 10 minute of full load operation of plant, (ii) Design Code: ASME Section VIII Div I (Latest);</p> <p>d. Rotating Equipment: 2x100% (1 Operation + 1 Standby);</p> <p>e. Process Control: (i) Start/Stop in Auto, from Remote and from Main PLC, (ii) Provision of data communication with Main PLC;</p> <p>f. Installation: Outdoor;</p> <p>g. First charge of Molecular Sieve to be provided;</p> <p>h. All necessary static and rotating equipment, instruments, piping, valves, cabling, spares, civil works viz steel structure, approach, platform, foundation, RCC, PCC etc – shall be in the scope of bidder.</p>
7.1.6.3	Compressed Instrument Air System	<p>a. Capacity: 200 NM3/Hr (Min)</p> <p>b. Air Compressor: (i) 2x100% (1 Operation + 1 Standby), (ii) Type: Oil Free, (iii) Installation: Outdoor;</p>

		<ul style="list-style-type: none"> c. Air Compressor Inlet Condition: Pressure: Ambient, Temperature: 50C (Max), RH: 95% d. Air Compressor Outlet Condition after 'After Cooler' (Guaranteed) : Pressure: 12 Bar(g), Temperature: 41C; e. Air Dryer: (i) 2x100% (1 Operation + 1 Regeneration), (ii) Type: Pressure Swing (preferably), (iii) Installation: Outdoor, (iv) Outlet Condition (Guaranteed) : DP: 0.5 Bar, Dew Point: (-)40C, Oil free, Dust free; f. Dryer capacity to be specified by vendor considering regeneration air flow (not exceeding 15% of outlet air flow) g. Buffer Vessel: (i) Capacity: 50 M3 (minimum liquid volume), (ii) Design Code: ASME Section VIII Div I (Latest); h. Dryer capacity to be specified by vendor considering regeneration air flow (not exceeding 15% of outlet air flow); i. Process Control: (i) AUTO Start / Stop, (ii) Control from PLC; j. All necessary equipment, inter/after cooler, pre-filter, silencer, instruments, piping, valves, accessories etc required shall be in the scope of bidder
7.1.6.4	LP Steam System	<ul style="list-style-type: none"> a. Steam Generator: (i) Type: Electric; (ii) Discharge Pressure: >6 Bar(g), (iii) Capacity: 40 Kg/Kr; b. Steam Pressure Regulating Station: (i) Automatic (based on user set point provided in PLC/OWS); (ii) SV/PRV, silencer, instruments, piping, valves, vent, drain etc to be provided by the bidder; c. DM Water System: (i) DM Water Transfer Pump: 2x100% (1 Operation + 1 Standby), (ii) DM Water Storage Tank: 5M3 (Min), (iii) Pipework including Valves, Relief Valves, Strainers, Instruments, etc to be provided by the bidder
7.1.6.5	Cooling Water System	<ul style="list-style-type: none"> a. Heat Duty: 2,500 kW (Min); b. Design Conditions: (i) Cold Water: 33 C, (ii) Hot Water: 43 C, (iii) WBT: 28 C, (iv) RH: 95% at 40C, (v) Approach: 5C; c. CW System shall comprise of: (i) Cooling Tower: 1x100%, (ii) CW Pumps: 2x100%, (iii) Cooling Tower Blowdown (including pumps and peripherals) (iv) Piping & Valves, (v) Instruments, (vi) Acid Dosing System, (vii) Inhibitor Dosing System; d. Basin and sump shall be designed as per HIS (Hydraulic Institute Standard) and shall have retention time of minimum 10 minutes.
7.1.6.6	Effluent Treatment Plant	<ul style="list-style-type: none"> a. A common facility is envisaged to treat all liquid effluents. (Details to be confirmed during detailed engineering). b. ETP Details: (i) Capacity: 1M3/hr (indicative), (ii) Configuration: 1X100%, (iii) Turn down ratio: 50%, (iv) Duty: Continuous, (v) Dedicated PLC with interfacing with Main PLC; c. Scheme and P&ID of ETP shall be finalized at the stage of detailed engineering with the approval of NTPC. d. Outlet effluent water quality shall comply with latest Central & State Pollution Control Board requirements; e. Any vent/purge gas (Toxic & /combustible/hazardous) generated during the effluent processing shall be treated to meet the specification as per statutory requirements. These streams may be routed to a gas disposal system. f. Environmental clearances, EIA and other applicable local / statutory requirements, as required, shall be in the scope of bidder;

		g. Scope of supply shall include all civil, structural, piping, electrical, instrumentation items. Necessary spares to be provided.
7.1.6.7	Flare System / Thermal Oxidizer	<p>a. Design Feed Flow & Composition: 100% Syngas with Gasifier operation at full load + Design margin;</p> <p>b. Configuration: All Syngas PRV to be routed through a 'Flare Header' and 'Water Seal';</p> <p>c. Stack & KO Drum: (i) MOC: Carbon Steel (Corrosion Allowance; Min 3 mm), (ii) Design Condition: Pr: 3.5 BarG, Temp: 280 C;</p> <p>d. Pilot Burner: (i) Ignition System: Manual Flame Front Generator, (ii) MOC Heat Corrosion Resistant;</p> <p>e. Gas Seal: (i) Type: Molecular seal below flare tip, (ii) MOC: Carbon Steel;</p> <p>f. Utility; (i) Purge Gas: N2 (Pr: 5-7 Bar, Purity: 99.9%; (ii) Pilot Gas: LPG Cylinder & Cylinder Rack (By Vendor);</p> <p>g. Vendor to provide: (i) Fuel consumption for pilot burner (guaranteed), (ii) Purge gas consumption.</p>
7.1.6.7	Fire Detection & Protection	<p>a. Bidder shall provide both fire detection and fire protection system including fire extinguishers, as required, for main and auxiliary plant as per TAC/NFPA/IS 3034/OISD with the approval of NTPC.</p> <p>b. Fire alarm cum control panel shall be extended to main security and interfaced with main plant PLC for information exchange. The scheme shall be approved by NTPC.</p> <p>c. Bidder shall also provide Personal Protective Equipment to all its personal, as appropriate, with approval / acceptance of NTPC.</p>
7.1.6.7	Pipework	<p>a. Final Pipe and Valve schedule along with its quality plan (if any) shall be finalized at the time of detail engineering with the approval / acceptance of NTPC.</p> <p>b. 10% of the quantity for each type of valve and pipes based on material of construction, size, type etc shall be supplied as spares. In case the main population of any item is 1 or less, the spare quantity shall be 1 number.</p> <p>c. Provision and operation of valve shall be in such a way that plant shall run safely and controlled automatically and in accordance with approved P&ID.</p> <p>d. Design Code: All material under this sub-section shall conform to the latest editions of American National Standard Code for Pressure Piping, Power Piping, ANSI B 31.1, ANSI B16.11, and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and state standards.</p> <p>e. Other Design Considerations:</p> <ol style="list-style-type: none"> Pipes shall run over a pipe rack and it shall be suitably clamed with support structure. Pipe rack shall be in the scope of bidder. Piping shall cross the road over an MS structure/ rack (cross over bridge) so that movement shall not be affected. The same shall be in the scope of bidder. Concrete pedestals for pipe on the earth surface shall be in the scope of bidder. Hot Insulation & Cladding (wherever required): Mineral/glass wool insulation with Aluminum cladding. Removal & re-installation of thermal insulation & cladding provided on/ around the new tap-off /connection points on existing feed water discharge line, in consultation with NTPC. Hydrostatic Test: All piping systems shall be hydro tested at 1.5 times the design pressure subject to regulation of 374 IBR. However, for such systems where it is practically not possible to do hydro tests, the tests as

		<p>called for in ANSI B31.1& IBR in lieu of hydro test shall also be acceptable. Hydro testing, steam blowing & chemical cleaning of piping systems, after complete erection is to be carried out, which also includes supply, erection, making temporary closures, dismantling and removal of all temporary material/piping, equipment and materials from site, disposal of water/waste water/effluent, clean up and reinstatement of the cleaned piping system.</p> <p>iv. It is the responsibility of the Bidder to identify and obtain all necessary approvals from various Government agencies/board/statutory authorities/ IBR (CBB, Delhi / CIB of the state in which the plant is being installed) etc., as applicable.</p>
7.1.6.8	Pumps	<p>a. Capacity: (i) Design Flow: Flow of pumps to be based on 15% margin over maximum flow envisaged during operation. ii. Design Head: Design head of pumps shall have 10% margin over the maximum head required during operation, (ii) Capacity: All pumps shall be 2 x 100% capacity;</p> <p>b. MOC: (i) Process / DM / Condensate Pumps: SS304 / SS316L or better for Impeller, Casing, Shaft, (ii) Cooling Water Pumps: (i) SS410 or better for Impeller & Shaft, (ii) CS or better for Casing;</p> <p>c. Design Code: (i) All centrifugal pumps shall be designed as per ISO 5199/ ISO 13709/API 610 or equivalent, (ii) All positive displacement pumps shall be designed as per ISO 16330/ ISO 13710/API 674 or equivalent;</p> <p>d. NPSH Margin: (i) 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, (ii) Further, NPSH (R) at 3% head break shall be well below NPSH (A) under all conditions;</p> <p>e. Other design considerations:</p> <ol style="list-style-type: none"> i. 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. ii. Maximum efficiency of pumps shall be preferably within 10% of the rated design flow. iii. First critical speed shall be at 130% of the rated speed or higher. iv. 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. v. Minimum recirculation circuit and minimum flow protection in accordance with the pump design vi. 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. vii. 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. viii. 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.

		<ul style="list-style-type: none"> ix. Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment. x. 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. xi. Reciprocating pump shall have pressure relief valve at discharge. xii. Aluminum canopy cover for all outdoor pumps . xiii. Motor rating at 50°C ambient shall not be less than the maximum load demand of pump in entire frequency variation range. xiv. Motor shall be complete with gland, mounting hardware etc.
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7.2. Technical Specifications – Electrical:

7.2.1 Introduction:

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 'Plasma induced Radiant Energy based Gasification System' (GH2-PREGS).

7.2.2 Design Philosophy:

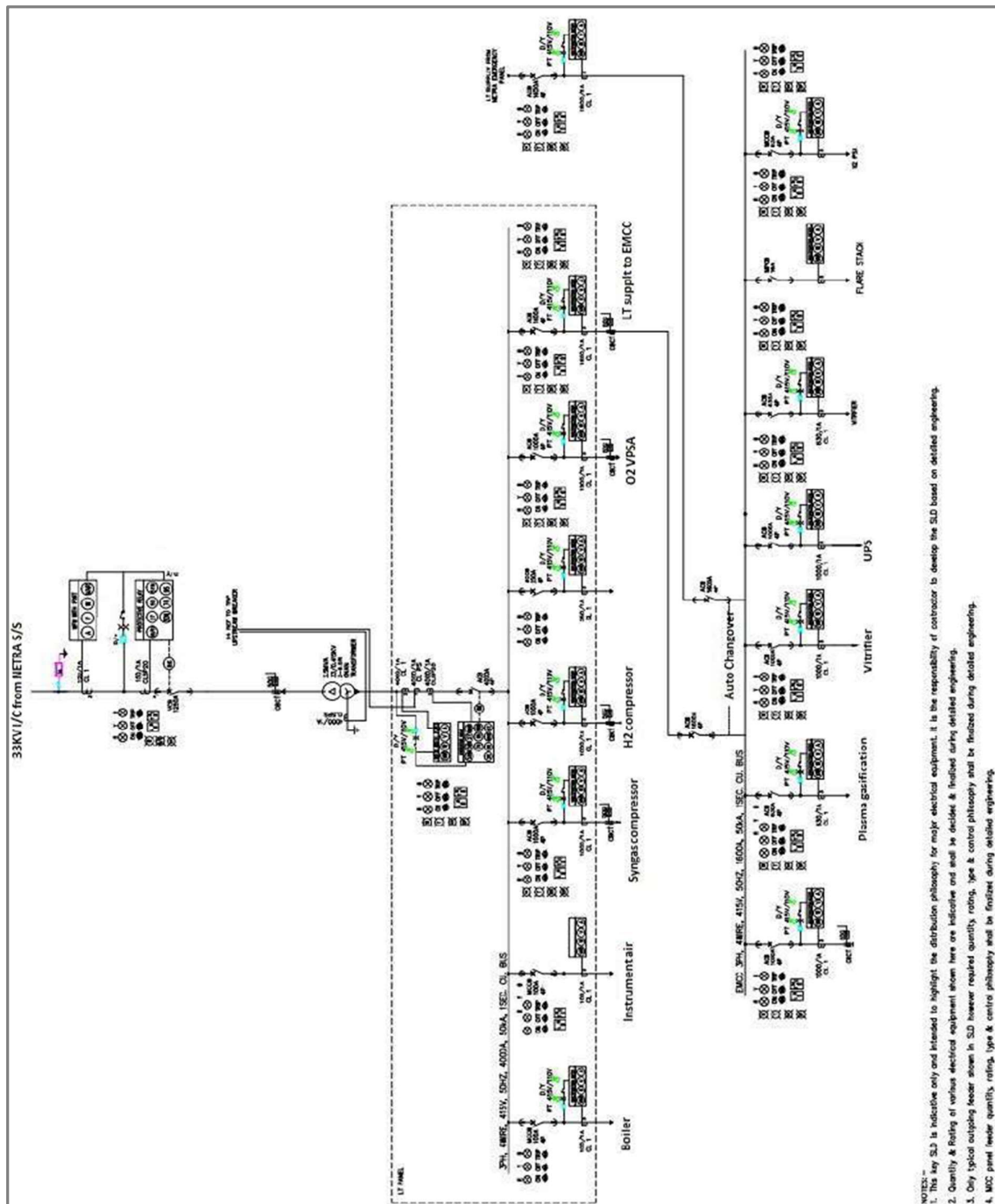
- i. The design and engineering of the electrical installation shall be in accordance with established codes & specification, sound engineering practices and shall meet the statutory requirements & local regulations.
- ii. Electrical equipment and material shall comply with their relevant specification, Data sheet & Project specification & latest edition of the codes & standards (Including any amendments) applicable shall be followed.
- iii. All electrical equipment, system and their installation shall be designed for operation under site condition as required.
- iv. All equipment & material shall be suitable for operation in service conditions typical of gas processing plants.
- v. VFD & UPS shall be air-conditioned to increase reliability of heat sensitive electronic component. Switchgear room shall be force ventilated.
- vi. Battery room shall be ventilated with exhaust fans. However, failure of cooling or ventilation shall not affect the equipment.
- vii. For the purpose of electrical earthing calculations (soil electrical resistivity) and cable rating calculations (soil thermal resistivity) the data of the area shall be used.
- viii. 415V incomers from transformers or ties between switchgears shall be through bus ducts wherever switchgear rating is 1600Amp and above.
- ix. 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.
- x. 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.
- xi. There shall be classified for the degree extend of hazard from flammable materials.
- xii. Classification of hazardous areas for all area 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.
- xiii. Interlocks & protection as per IS/IEC & CEA guidelines shall be provided.
- xiv. Lock out Tag out (LOTO) provision for all HT & LT feeders.
- xv. Maximum interchangeability of equipment.

7.2.3 Scope of work

The Electrical scope shall be as described briefly in following clauses, but are not limited to it. The scope shall include design, 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 'Plasma induced Radiant Energy based Gasification System' (GH2-PREGS).

7.2.3.1 Part-A General:

- i. NTPC shall provide electric feeder as indicated in the section 'Terminal Points'. The electrical supply extension system from the identified feeder to 'Plasma Gasification Plant' switchgear shall be under the bidder's scope. Any other voltage level, if required, shall be arranged by the Bidder. Indicative SLD of the project is placed below.



- ii. Electrical load list shall be primarily governed by the configuration of plasma gasification, syngas cleaning, hydrogen separation and their utilities – and it shall be the responsibility of bidder to finalize it and obtain approve of NTPC.

Electrical Load List (MCC Panel) (Tentative)				
415V 4000A, I/C ACB and following O/G's, Panel BUS Rating 4000A				
S. No.	Feeder description	Power (KW)	Voltage	Quantity
1	Hydrogen Separation & Purification Sys	~ 550	415V AC	1
2	Hydrogen Compressor	~ 350	415V AC	1
3	Oxygen Package	~ 500	415V AC	1
4	Feed Preparation Package	~ 100	415V AC	1
5	Instrument Air Package	~ 40	415V AC	1
6	Syngas Cleaning Package	~ 40	415V AC	1
7	Electric Steam Generator	~ 20	415V AC	1
8	Cooling Water Package	~ 30	415V AC	1
9	Raw Water Package	~ 10	415V AC	1
10	Fire Water Package	~ 10	415V AC	1
11	ETP Package	~ 10	415V AC	1
12	Lighting feeder to MLDB	~ 20	415V AC	1
13	Single phase supply feeder	~ 10	230V AC	5
14	EMCC (800A ACB I/C for EMCC)	-	415V AC	1
15	Spare feeder	-	415V AC	5
Electrical Load List (Emergency MCC Panel) (Tentative)				
415V 1000A I/C ACB from MCC & 1000A I/C ACB from NETRA Panel and following O/G'S				
1	Gasification Package	~160	415V AC	1
2	Vitrification Package	~150	415V AC	1
3	Nitrogen Package	~25	415V AC	1
4	Flare Stack / Thermal Oxidizer	~10	415V AC	1
5	Control Room Air Conditioning	~10	415V AC	1
6	Critical Fans / Rotating Eqp	~10	415V AC	3
7	Lighting feeder to MLDB	~10	415V AC	1
8	UPS Feeder for PLC	~25	415V AC	1
9	Spare feeder	-	-	3
Note:				
a. All above Feeder quantity & rating (current & voltage) are tentative only and may get changed during detail engineering,				
b. Motor feeder drive shall be finalized during detailed engineering.				

- iii. 33kV aluminium conductor, XLPE insulated, armoured 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.
- iv. 33kV / 0.415 kV distribution transformers of required rating.
- v. 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.

- vi. 415V, ___A (current rating by Contractor), 3-phase TPN, 50 kA for 1 sec draw-out type, Motor Control Centre (MCCs) for feeding motor loads and other loads up to 55 kW including spare feeders.
- vii. 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.
- viii. 415V, ___A (current rating by Contractor), 3-phase TPN, 25 kA for 1 sec. draw-out type Lighting Distribution Boards (LDBs) including spare feeders.
- ix. 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 bidder's scope.
- x. Any components of LT switchgear assembly required for modification / extension of existing switchgears for feeding power supplies to Plasma gasification plant or any other component/equipment etc. which shall be required for the extension of electrical supply shall be under the bidder's scope.
- xi. All power, control, instrumentation, and special cables shall be under the Bidder's scope.
- xii. Cable support system and laying & termination of all cables along with necessary termination arrangements and other accessories such as, trays, conduits, pipes, JB's, etc. shall be in bidder's scope The formation of cable trench/tray shall be required for cable laying shall be under bidder's scope.
- xiii. Motors along with canopy, couplings and coupling guards for all rotating pumps, compressors and blowers etc. covered under this package. All motors shall be provided with cable glands, cable box and lugs suitable for termination of required size of power cable.
- xiv. Variable frequency drives systems complete with chock, switchboard/panels of required voltage rating with bypass as required for variable speed motors.
- xv. 240V AC dual redundant with bypass UPS system (2 nos. 1X100%) with Nickel cadmium battery, ACDB, cell booster for DCS/PLC/Instrumentation loads including spare feeders. Battery backup time of 3 hours.
- xvi. Industrial type safe area and flameproof type control stations with push buttons, selector switches, ammeters, lamps as required.
- xvii. Industrial type safe area and flameproof type 415V AC welding receptacles and 240V AC, 1-phase Convenience receptacles.
- xviii. Voltage distortion limits for bus voltage $V \leq 1.0$ KV at PCC, Individual harmonic is $\leq 5\%$ & THD is $\leq 8\%$.
- xix. Voltage distortion limits for bus voltage $1 \text{ kV} < V \leq 69 \text{ KV}$, Individual harmonic is $\leq 3\%$ & THD is $\leq 5\%$.
- xx. Current distortion limit shall be $\leq 3\%$.
- xxi. Suitable size of AHF panel shall be provided to maintain harmonic in limit.
- xxii. CBCT shall be provided for feeders for earth fault protection.
- xxiii. Complete lighting within the plant battery limit.
- xxiv. Construction power if required by the Bidder that should be clearly indicated in the bidder's offer including its KVA rating. OWNER shall provide a suitable terminal point for it and Bidder should safely withdraw the power from the identified terminal point.
- xxv. Grounding system for complete plant and equipment are under Bidder's scope.
- xxvi. All the required controls and protections as per the system requirement for individual.
- xxvii. equipment and overall Plasma Gasification Plant electrical system shall be under the bidder's scope.

- xxviii. Proper Earthing and Lightning protection including earth pits, earthing grid, grounding cables, strips, wires associated connectors and accessories shall be provided for Plasma Gasification Plant.
- xxix. The plant safety and equipment safety shall be the responsibility of the Bidder till the final handover of plant to Owner.
- xxx. The Bidder should ensure safety of personnel working on the electrical system.
- xxxi. Tools and tackles for maintenance of all electrical equipment and systems.
- xxxii. All Commissioning Spares.
- xxxiii. Mandatory spares as listed in this specification.
- xxxiv. Safety equipment such as, shock hazard charts, first aid boxes, caution boards, apron, eye shields, discharge rods, DCP portable CO2 fire extinguishers, insulating mats, sand buckets, 33kV grade hand gloves and other equipment for safety of all electrical equipment and personnel as per statutory regulations.

7.2.3.2 Part-B Basic Design & Detailed Engineering:

- i. Basic engineering calculations i.e., load analysis, load flow, short circuit, and voltage drop during motor start-up etc. 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 cut-outs for complete substation.
- x. Sizing calculations for cables, cable trays/ cable trenches including providing cable trays and RCC trenches.
- xi. Procurement engineering activities including 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.
- xxxii. Contractor, while performing design and engineering activities shall adhere to following guidelines:
 - a. Contractor, if not covered but required shall prepare any additional specifications for equipment or bulk material. Contractor shall follow current national & international standards/specifications for the equipment that are not covered by Owner's specifications.
 - b. The drawings supplied by Owner define the basic system design and distribution philosophy for the package. This is based on preliminary electric load data and for guidance purpose only. Contractor shall develop detailed drawings and submit for review.
 - c. Contractor to note that equipment ratings and quantity, wherever specified in the bid package shall be considered as minimum rating & quantity. Contractor shall be responsible to verify the same and provide equipment with higher rating & quantity subject to minimum rating as per bid package requirements. Compliance shall be without any extra cost and time implications to owner.
 - d. The substation shall have located in safe area and outside the risk zone. Consideration shall give to vehicular traffic or any other factor that might affect the operation of substation.
 - e. The switchgear room should be pressurized to prevent ingress of dust & to prevent or to make more reliable heat sensitive electrical equipment and panel. Substation have three entries one for normal entry, second for equipment entry & third for emergency exit.
 - f. Flooring to the battery room & walls up to 1 mtr. Height shall have acid/alkaline resistant protective material coating.
 - g. The substation switchgear floor shall have a minimum clear height of 4.5m. from any lowest beam bottom.
 - h. The formation of cable trench/tray shall be required for cable laying shall be under bidder's scope.
 - i. The Bidder should ensure safety of personnel working on the electrical system.

7.2.3.3 Part-C Supply Items (Tentative list finalized during detailed engineering):

- i. Oil type transformer
- ii. Control cable.
- iii. HT power cable.
- iv. LT power cable & Control cable.
- v. Bus duct.
- vi. LT switchgear/panel (PCC, IMCC/MCC, EMCC, DB's, etc.)
- vii. Cable Tray.
- viii. Cable Tray/ Trench formation.
- ix. JB's
- x. Necessary items required for existing NTPC breaker 33KV Module modifications (CT, CBCT, MFM & Numerical relay).
- xi. Relays, Energy Meters.
- xii. Inline fan.
- xiii. Items associated with building, Earthing System and Lightning Protection System.
- xiv. Lighting Supply & Plant area lighting as per requirement.
- xv. AC system for control room.
- xvi. Modification in existing LT switchgear (ACB, CT, PT, MFM and required accessories)
- xvii. Lighting mast.
- xviii. Earthing & Lightning protection.
- xix. Danger board sign for all equipment.
- xx. Termination material (Lug, Gland, Cable jointing material, HT/LT Sleeves, Insulation tap) etc.
- xxi. Firefighting system, equipment, First aid kit, Insulation mats & Gloves as per voltage level.

7.2.4. Electrical Standards

The Electrical system shall be complying below mentioned standards 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 'GH2-PREGS Plant shall be equally applicable.

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

The work shall also conform to the requirements of the following:

- i. The Indian Electricity Act/ CEA guidelines and rules framed there under.
- ii. The fire insurance Regulations.
- iii. The regulations laid down by Electrical Inspectorate (CEA).
- iv. The regulations laid down by the Factory Inspectorate.
- v. The regulations laid down by the Chief Controller of Explosives.
- vi. Any other regulations laid down by the Central, State or Local Authorities.

7.2.5 Technical Requirements:

7.2.5.1 Neutral Grounding:

- i. 11KV/3.3KV/6.6KV system earthing shall be low resistance earthed type to limit earth fault current to 300A. The resistor shall be rated to carry this current at least for 10 seconds. All Earth fault relay and overcurrent relays are to be designed accordingly.
- ii. Neutrals of all LT Transformers (415V) shall be solidly earthed through bolted links.
- iii. Material to be used for earthing should be GS/Cu/Al of Sufficient cross section. Separate Copper Earth bus for Electronic Earthing of IMCs.
- iv. The sizes of earthing conductors for various electrical equipment's shall be as below:

S.No	Equipment	Earth conductor above ground level and in-built trenches
a)	415V MCC/Distribution Boards / Transformer	50x6mm GS flat
b)	LT Motors 25 KW to 125 KW	25 x 6mm GS flat
c)	LT Motors 1KW to 25 KW	25 x 3mm GS flat
d)	Fractional Horsepower motor	8 SWG GS wire
e)	Control panel & control desk	25 x 3 mm GS flat
f)	Push button station / JB	8 SWG GI wire
g)	Columns, structures, cable trays	50 x 6mm GS flat
h)	Other non-current carrying metal parts	25 x 6mm GS flat

- v. Earthing strip-75 x 10MM HDGS. Strip ,50 x 6MM HDGS Strip,
- vi. Earthing Cable/Rope-10 mm diameter HDGS rope,8 SWG solid HDGS wire, insulated flexible copper cables.
- vii. Earthing bus
- viii. Earth Electrode
- ix. Gen set shall be kept ungrounded (earthing through PT).

7.2.5.2 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:

- i. All transformers - 2 seconds
- ii. All Switchgears - 1 second
- iii. Cables to the feeders protected by breakers - Main protection fault clearing time with 0.12 seconds minimum.
- iv. Cables of all other feeders - As per fuse operating time.
- v. 33KV cable screen – As per IS 7098 Part 2.

7.2.5.3 Motors:

- i. Motors shall be selected to have 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.

- ii. All motors shall be IE3 energy efficiency class according to IEC 60034-30-1; 2014 except reciprocating compressor motor. Reciprocating compressor motor energy efficiency class finalized during detailed engineering.
- iii. Codes and Standards:
 - a. Three phase induction motors: IS/IEC:60034
 - b. Single phase AC motors: IS/ IEC:60034
 - c. Crane duty motors: IS:3177, IS/IEC:60034
 - d. DC motors/generators: IS:4722, IS/IEC:60034
 - e. Energy Efficient motors: IS 12615, IEC:60034-30
 - f. Reciprocating compressor motor design follow API 618, IEC 60034/NEMA MG1.
- iv. MOV's and Electrical cranes shall be fully equipped with integral motor control gear.
- v. 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.
- vi. Relevant/Suitable IEC/IS standards shall be applicable for various type and size of motor.
- vii. The Single phase/Three phase /DC motors shall be supplied for the Pumps and Blowers of 'Plasma Gasification Plant' as per the system requirement. The motors shall be finalized during detailed engineering as per the requirement 'Plasma Gasification Plant'.
- viii. The Single phase/Three phase /DC motors shall be operating in highly chemical and explosive environment. Type of motors shall be decided during detailed engineering.
- ix. For design of equipment/systems, an ambient temperature of 50 deg. C and relative humidity of 95% (at 40 deg. C) shall be considered. The equipment shall operate in a highly polluted environment.
- x. Motor operating through variable frequency drives shall be suitable for inverter duty with VPI insulation. Also, these motors shall comply the requirements stipulated in IEC: 60034-18- 41 and IEC: 60034-18-42 as applicable.
- xi. AC motors shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and $\pm 10\%$ combined variation of voltage and frequency.
- xii. Bidder shall provide fully compatible electrical system, equipment, and accessories.
- xiii. The responsibility of coordination with other agencies and obtaining all necessary clearances shall be of the Bidder scope.
- xiv. Bearing RTD's to be provided for alarm & tripping of motors above 150KW.
- xv. For VFD driven motor I/P & O/P side chock shall be provided in VFD feeder.
- xvi. Motor starter "VFD, Soft-Starter, DOL" finalized during detailed engineering.
- xvii. All motor feeders shall be AC3 type contactor.
- xviii. MPCB shall be used for motor feeders.
- xix. Type test report & PESO, ATEX certification to be submitted for motor approval.

7.2.5.4 Cable Trench/Tray:

The formation of cable trench/tray shall be required for cable laying. The formation of any cable trench/tray shall be under bidder's scope. The cable laying scheme for GH2-PREGS Plant shall be finalized during detailed engineering as per the requirement of NTPC.

- i. All cable trenches shall be sized depending upon the number of cables, and their voltage grade.
- ii. 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.

- iii. Cable trench inside substation shall be filled with sand, pebbles or similar non-flammable materials or covered with incombustible slab. If the significant number of cables are taken on racks, adequate support to be provided on the side wall of trench.
- iv. RCC covers of cable trenches should be sealed to avoid ingress of chemicals and oils.
- v. Concrete line cable trenches should be sealed against ingress of liquid and gases wherever trenches leave a hazardous area or control room or substation.
- vi. Above ground cable tray shall be well supported suitably at every 3meters interval and protected against mechanical damage. Routing shall be decided to avoid proximity to high temperature source.
- vii. Cable trays, racks and trenches shall be sized to allow for 10 to 20% future cable reserve.
- viii. Instrument and communication cable shall not be laid in the same trench/tray along with electrical power cables.
- ix. For LT switchgear/MCC room at EL 0.0M, minimum 1400 wide x 1400 deep cable trench shall be provided to route the cables. Horizontal cable trays shall be routed in cable trenches.
- x. Cable cellars shall be provided with fire detection and monitoring device.
- xi. Cable trenches in hazardous area should be filled with sand and covered with RCC slab to prevent accumulation of flammable gases/vapour inside the trench.

7.2.5.5 HT Power Cable:

- i. HT cables 33KV (E) grade shall be XLPE insulated, screened, Armoured FRLS PVC sheathed Aluminium conductor cable. The cable shall be laid underground through Hume pipe and a cable tray.
- ii. Cables shall conform to IS 7098 Part-II. These cables shall be multi-stranded, compacted circular aluminium conductor, XLPE-insulated, metallic screened PVC outer sheathed. The conductor screen and insulation screen shall both be of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for 19/33 KV Cables shall be “dry curing / gas curing “. The metallic screen for each core shall be capable of carrying the system earth fault current and shall consist of copper wires or tape with minimum overlap of 20%. However, for single core armoured cables, the armouring shall constitute the metallic part of the screening.
- iii. The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground (buried) installation with chances of flooding by water.
- iv. Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.
- v. XLPE insulation shall be suitable for continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg. C. For single-core armoured cables, the armouring may constitute the metallic part of insulation screening.
- 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. In plant repairs to the cables shall not be accepted. Pimples, fisheye, blow holes etc. are not acceptable.
- viii. Cable lengths shall be considered in such a way that straight through cable joints is avoided.
- ix. All Cables shall be of armoured type.
- x. 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.

- xi. Cores of three core cables shall be identified by colouring of insulation or by providing coloured tapes helically over the cores, with Red, Yellow & Blue colours.
- xii. All cables shall meet the fire resistance requirement as per Category-B of IEC-60332 Part-3.
- xiii. All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions conforming to category AF as per IS: 10810.
- xiv. The control cables shall be twisted pair type with overall shielding in case of longer length.
- xv. All cable glands for equipment located in hazardous area shall be flameproof type.
- xvi. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails to eliminate ingress of water during transportation, storage and erection.
- xvii. Cables shall be supplied in non-returnable steel drums of heavy construction. The drum shall be designed on the basis of weight, diameter, bending radius and length of cable.
- xviii. Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stencilled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

- a. IS:7098 (Part -II) Specification for Cross linked polyethylene insulated PVC sheathed cables. Part-II: For working voltages from 3.3 KV up to and including 33 KV.
- b. IS: 3975 Low Carbon Galvanized steel wires, formed wires and tapes for armouring of cables.
- c. IS: 4905 Methods for random sampling.
- d. IS: 5831 PVC insulation and sheath of electrical cables.
- e. IS: 8130 Conductors for insulated electrical cables and flexible cords.
- f. IS: 10418 Specification for drums for electric cables.
- g. IS: 10810 Methods of tests for cables.
- h. ASTM-D -2843 Standard test method for density of smoke from the burning or decomposition of plastics.
- i. IEC-754 (Part-I) Tests on gases evolved during combustion of electric cables.
- j. IEC-332 Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

7.2.5.6 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. L.T. cables shall be 1.1KV grade XLPE insulated.
- iii. Cables shall be armoured, flame retardant, low smoke (FRLSH) type designed to withstand all mechanical, electrical, and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.
- iv. Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.

- v. XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg. C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg. C and short circuit conductor temperature of 160 deg. C.
- vi. 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.
- vii. All cables and wires shall be FRLS conforming to category AF as per IS: 10810.
- viii. The Armour used shall be galvanized round steel wire and shall conform latest IS-3975.
- ix. The above-mentioned General requirements are indicative. The power cable shall be finalized during detailed engineering as per the requirement 'Plasma Gasification Plant'.

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

- a. IS:1554 - I PVC insulated (heavy duty) electric cables for working voltages up to 1100V.
- b. IS: 3961 Recommended current ratings for cables
- c. IS: 3975 Low carbon galvanized steel wires, formed wires, tapes for armouring of cables.
- d. IS: 5831 PVC insulation and sheath of electrical cables.
- e. IS:7098 (Part -I) Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
- f. IS: 8130 Conductors for insulated electrical cables and flexible cords.
- g. IS: 10418 Specification for drums for electric cables.
- h. IS: 10810 Methods of tests for cables.
- i. ASTM-D -2843 Standard test method for density of smoke from the burning of plastics.
- j. IEC-754 (Part-I) Tests on gases evolved during combustion of electric cables.
- k. IEC-332 Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

7.2.5.7 Cable Selection & Sizing:

- i. Rated current of the equipment.
- ii. 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.
- iii. 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.
- iv. Power cable size for motors should be minimized and if required double run cable can be used for motors of higher rating.
- v. Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:
 - a) Variation in ambient temperature for cables laid in air
 - b) Grouping of cables
 - c) Variation in ground temperature and soil resistivity for buried cables.
- vi. Above ground cable joints shall not be installed in hazardous area.
- vii. Selection and sizing of cables for hazardous area as per relevant IS/IEC standards.

7.2.5.8 Bus Duct:

- i. The Bus-duct shall be conformed to relevant Indian standards, IE rules, IE act, Factory act.

- ii. 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.)
- iii. Busbars shall be designed for continuous rating at 50°C ambient temperature and temperature rise shall not exceed 50°C.
- iv. The short circuit withstand capacity of Busbars shall be 50KA for 1 second.
- v. 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).
- vi. 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.
- vii. Tolerance permissible for the height of the terminal connected to bus duct over rail top level is ± 10 mm. Contractor has to ensure that radiator & conservator does not obstruct the path of the bus ducts in position & during movement of transformer. The contractor shall co-ordinate final design of terminal arrangement to suit bus duct arrangement during detailed engineering.
- viii. 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 deg. C. The bus duct conductor temperature may be as high as 105 deg. C & temperature in the bus duct enclosure will be of the order of 80 deg. C.
- ix. All bus-ducts shall be sized based on the load demand under most onerous conditions.
- x. Where different type of material is connected tin plating material should be used.
- xi. The material of the bus duct termination shall be non-magnetic.
- xii. Adequate Hot Dip Galvanized support structure shall be given to the bus duct to take care of mechanical integrity and arrest the vibration.
- xiii. The following type tests reports to be submitted on each rating of bus ducts:
 - a. 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).
 - b. Short circuit withstand test (set up same as for heat run).
 - c. Impulse withstand test (set up shall include typical X-section with flexible connections, 90-degree bend, seal off bushing and inspection cover).
 - d. Air leakage rate and Water tightness test (set up shall include inspection cover, flanged joint and below).

S.No	Bus Duct Rating	As per requirement / Sizing Calculation
1	Type	Non-Segregated
2	One minute power frequency withstand voltage	2.5 kV
3	One second short ckt withstand current	50 kA(RMS)
4	Momentary dynamic current withstand	105 kA(PEAK)
5	Enclosure	3mm Al Alloy, Rectangular(IP:55), Al sheet flange protection hood for outdoor
6	Gasket	Steel Reinforced EPDM /PU Foam gaskets

7	Conductor	Material: Aluminium, Clearance: 25mm (Min)
8	Steel Structure	Hot Dipped Galvanised
9	Earthing	GI of Adequate Size along full length

7.2.5.9 Earthing & Lightning Protection:

- i. Earthing design shall be carried out in accordance with the requirements of CEA regulation 2010 and code of practice for earthing IS: 3043.
- ii. The earthing system for plant shall be designed for a life expectancy of at least forty (40) years, for a system fault current of 50 kA for 1.0 sec. The minimum rate of corrosion of steel for selection of earthing conductor shall be 0.12mm per year.
- iii. 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.
- iv. All electrical equipment and 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 'Plasma Gasification Plant' shall be finalized during detailed engineering as per the requirement of system.
- v. The metallic enclosure of all equipment shall be bonded and earthed to the common earthing grid.
- vi. In hazardous area or where the equipment contains hazardous liquid, the metallic enclosure of non-electrical equipment vessels, tanks, structures, pipelines etc., shall be bonded and earthed to common plant earthing grid.
- vii. Earthing system network / earth mat shall be interconnected mesh of mild steel rods buried in ground in the plant. All areas under contractor scope of supply shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system. All the columns shall be earthed by nearby risers and earth mat grid spacing shall be minimum 10 mts. Minimum two nos. of risers shall be provided for each equipment in 'GH2-PREGS Plant' area. Separate dedicated riser shall be provided for C&I earthing purpose and for Lightning down conductor connection purpose. Sufficient nos. of risers near the equipment shall be provided as per the system requirement.
- viii. Lightning design shall be carried out in accordance with the requirements of CEA regulation 2010 and code of practice for lightning IS: 2309, IEC 62305.
- ix. Suitable Lightning protection of 'Plasma Gasification Plant' shall be provided, and it shall be under bidder's scope. The Lightning protection scheme for 'Plasma Gasification Plant' shall be finalized during detailed engineering as per the requirement of system.

7.2.5.10 LT Switchgear:

A low-voltage switchgear and control gear assembly is a combination of low-voltage switching devices together with associated equipment (for controlling, measuring, signalling, etc.) complete with all the internal mechanical and electrical interconnections and structural parts.

S. No.	System Parameter	Values
1	Rating	415V +/-10%, 50Hz+3%, -5%

2	Phases	3Phase, 4Wire
3	Fault level (KA)	50KA for 1Sec.
4	Momentary peak current (KA)	105KA
5	Bus Bar Material	Electrolytic grade copper
6	Earthing system	Solidly Earthed
7	Ambient temp (C')	50 deg. C
8	Temperature rise	As per IEC61439, over ambient 50 deg. C
9	Insulation level	1100V

- i. LT panel shall be (Totally Type Tested Assembly) as per IEC: 61439-1 & 2.
- ii. LT Panel shall also be tested of design as per Seismic Zone Vol IEC 60068-3-3.
- iii. Panel shall be rated for Impulse withstand capability equal to or greater than the switchgears inside the panel.
- iv. The metal enclosed switchgear shall be designed to operate continuously with reference of ambient temperature of 50°C without any de-ration.
- v. LT panel construction shall be Indoor, Single front, Draw out type.
- vi. The FORM of separation is 4B.
- vii. All ACB feeder in LT Panel shall be draw out type numerical relay.
- viii. LT switchgear design shall be as per provision of termination of bus duct.
- ix. LT panel flange & Bus duct flange should be matched & termination shall be as per design.
- x. The equipment shall be designed and manufactured in accordance with the best engineering practice and shall be such that has been proved to be suitable for the intended purpose.
- xi. Provision for interlocking of LV Incomer breaker with HV side breaker shall be provided such that if the HV breaker trips then the LV breaker will trip, and it shall not be possible to close the LV breaker unless the HV side breaker is closed.
- xii. The Panel shall be indoor type having incoming, sectionalisation, outgoing switchgears etc. as per requirement. The design shall be cubical type. The degree of enclosure protection shall be IP 42.
- xiii. 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 last 10 years.
- xiv. The bidder should have conducted type test on identical panel to those offered.
- xv. Final scheme, components of switchgear assembly and number of feeders in LT switchgear shall be finalized at the stage of detailed engineering.
- xvi. Relevant IS/IEC standards shall be applicable for LT switchgear.
- xvii. All ACB's, MCCB's shall be draw out type module.
- xviii. All ACB's shall be 50KA EDO Microprocessor with Ekip Touch LSIG release.
- xix. All MCCB's shall be 50KA with Microprocessor based LSIG release.
- xx. All MCCB's shall be 60-100% setting range.
- xxi. All current rating of switchgear shall be at 50 DEG C ambient.
- xxii. For all VCB's, ACB's, MCCB's, MPCB's & MCB's feeder consider ON/OFF/TRIP, SPRING CHARGE, TCH, SERVICE POS TEST indication, L/R & TNC switch, phase indication R, Y, B to be provided.
- xxiii. MFM shall be with communication on Ethernet port.
- xxiv. Digital MFM 3-PH, 4-Wire (Programmable) CT, PT (Primary & Secondary)
- xxv. Spare contact of all components (ACB, MPCB, MCCB, Relay, Aux contact) wired up to terminal.
- xxvi. MPCB shall be used for motor feeders.

- xxvii. Busbar insulation Heat shrinkable PVC sleeve with Identification.
- xxviii. Bi-metallic strip to be used for different type of material connected.
- xxix. Space heater, Thermostat circuit, Door limit switch & Illumination lamp will be
- xxx. mounted in cable chamber.
- xxxi. LT breaker has to be provided for supply to motors of 75 KW and above rating. MPR relay with single phase preventer should be provided for motor protection.
- xxxii. The switchboard shall be totally enclosed, dust and vermin proof.
- xxxiii. Panel shall be designed to ensure maximum safety during operation, inspection, connection of cables and maintenance with switchboards energized.
- xxxiv. Consider CT in TRAFO LV side for REF to trip HT breaker.
- xxxv. Interlocks and protection as per CEA guideline shall be provided.
- xxxvi. Codes & Standards: All standards, specification and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS Codes, Standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.
 - a. IS: 5 Colours for ready-mixed paints and enamels.
 - b. IS: 694 PVC insulated cables for working voltages up to and including 1100V.
 - c. IS: 722 A.C. Electricity Meters
 - d. IS: 1248 Electrical Indicating instruments
 - e. IS/IEC: 60947-1 Degree of protection provided by enclosures for low voltage Switchgear and Control gear.
 - f. IS/IEC: 60947-2 A.C. circuit Breakers
 - g. IS: 2551 Danger Notice Plates
 - h. IS: 2705 Current Transformers
 - i. IS/IEC: IEC-60947-4-1 Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 V DC
 - j. IS: 3043 Code of practice for earthing.
 - k. IS: 3072 Code of practice for installation and maintenance of Switchgear
 - l. IS: 3156 Voltage Transformers
 - m. IS: 3202 Code of practice for climate proofing of electrical equipment.
 - n. IS: 3231 Electrical relays for power system protection.
 - o. IS/IEC 60947 Air-Break Switches, air brake disconnectors, air break disconnector and fuse combination units for voltages not exceeding 1000V AC or 1200 V DC.
 - p. IS/IEC 60947-1 /IEC-60947-1 General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V.
 - q. IS: 5082 Wrought Aluminium and Aluminium alloys for electrical purposes.
 - r. IS: 6005 Code of practice of phosphating of iron and steel.
 - s. IS/IEC 60947-5-1 /IEC-60947-5-1 LV switchgear and control gear control current devices and switching element.
 - t. IS: 8623 / IEC:61439-1/2 Low Voltage Switchgear & Control gear assemblies
 - u. IS: 8686 Static Relays
 - v. IS: 13703 / IEC: 60269 HRC Cartridge fuses
 - w. IS: 10118 (4 parts) Code of practice for selection, installation and maintenance of switchgear and control gear.
 - x. IS: 11171 Specification for dry type transformers.
 - y. IEC: 60255 Electrical Relays
 - z. IEC: 61850 Communication networks and systems in substations

aa. IS: 11353 Guide for uniform system of marking and identification of conductors and apparatus terminals

bb. IS: 12021 Specification of control transformers for switchgear and Control gear for voltage not exceeding 1000V AC.

1 set of each type & each rating all CB's, Contactors, Connectors should be supplied as spares with LT SWGR. Fuses 100% of each type & each rating should be supplied as spare. 1 No of each type and size of Power Supply Modules & Power Packs should be supplied as spares. Each type & rating 10% spare feeder to be provided with spare contact of all components wired up to terminal.

7.2.5.11 Control Switch Stations:

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

- i. With Start / Stop Push Buttons.
- ii. With Start / Stop Push Buttons & Local/OFF/Remote Selector Switch.
- iii. With Start / Stop Push Buttons, Local/OFF/Remote Selector Switch & Ammeter.
- iv. With Start / Stop Push Buttons & Ammeter.

7.2.5.12 Numerical Relay:

All Numerical relays shall be draw out type, proven for the application satisfying requirements specified elsewhere and shall be subject to Employer's approval. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Employer. All numerical relays shall be rated for control supply voltage as mentioned elsewhere under system parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Contacts for breaker close and trip commands shall be so rated as to be used directly in the closing and tripping circuits of breaker without the need of any interposing / master trip relays. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage. One-minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms).

All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts, the minimum quantity of which is as follows.

- a. Motor feeder – 10 BI + 8 BO
- b. Transformer feeder – 12 BI + 6 BO
- c. Incomer, Bus-coupler, Tie feeder – 14BI + 8 BO

The above quantities are only indicative and shall be finalized during detailed engineering. In case the offered IED does not have the required number of I/Os, the same can be achieved through external I/O device of same make complying with the requirement stated elsewhere in this specification.

Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker vacuum contactor operation. Disturbance Record waveforms, event records & alarms shall be

stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data. All the numerical relays shall have communications on two ports, local front port for communication to laptop and one RJ45 port on IEC 61850. All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters. Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping. Master trip (86) and non-86 trips shall be software configurable to output contacts and no separate master trip relay shall be used.

All numerical relays shall have provision of both current (CT) and voltage (VT) inputs. Relays shall be suitable for both residually connected neutral CT input as well as CBCT input. Relays shall be suitable for CT secondary current of 1A. Relays for transformer feeders without differential shall have 5 CT inputs (3 – Phase, 1 – CBCT, 1 – REF). Relays for transformer feeders with differential protection shall have 9 CT inputs (6 – Phase, 1 – CBCT, 1 – REF, 1 – Standby Earth Fault). Motor relays shall have 4 & 7 CT inputs for non-differential & differential application respectively. Relays for Incomers, Bus-couplers & Ties shall have 4 CT inputs. All relays except incomers, ties and bus-couplers shall have 3Nos of VT inputs. Relays used in incomers, ties and bus couplers shall have provision of two sets of voltage inputs (3Nos for bus voltage & 1No. for line voltage) for the purpose of synchronization. All CT terminals on the relays shall be of fixed type suitable for connection of ring-type lugs to avoid any hazard due to loose connection leading to CT open-circuit. In no circumstances Plug In type connectors shall be used for CT / VT connections. All numerical relays shall have key pad / keys to allow relay setting from relay front. Pre-programmed or programmable key for Master trip (86) reset shall be provided on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote. Relays shall have suitable output contact for circuit breaker failure protection (CBFP). Relays shall have self-diagnostic feature with continuous self-check for power failure, program routines, memory and main CPU failures and a separate output contact for indication of any failure. Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC / ANSI / user-programmable characteristics. All cards/hardware of numerical relays shall be suitable for operation in Harsh Environmental conditions with respect to high temperature, humidity & dust.

Protections for Incomers, Bus-couplers, and Tie feeders (Module Type DC/DE/DD)

The Incomer, Bus Coupler & Tie feeder protection relay shall be suitable for providing the following protections.

- i) Three Phase Over current and Earth Fault protection (50 & 50N): The over current element should have the minimum setting adjustable between 250- 2000% of CT secondary rated current. The earth fault element should be suitable for residually connected CT input. The relay shall be suitable for detection of earth fault currents in the range of 5% to 10% of the CT rated current.
- ii) Synchronizing Check (25): Synchronizing check feature as a part of manual live change over and dead bus closing feature shall be provided.
- iii) Bus No-volt: Bus no volt signal shall be configured in the relay for use in control logics.

Transformer Feeder Protections (Module Type DB/DBF): The Transformer protection relay shall be suitable for providing the following protections.

- i) Three Phase Over current and Earth Fault protection (50 & 50N): The relay shall have instantaneous as well as time delayed over current and earth fault protections. The over

current element should have the minimum setting adjustable between 250-2000% of CT secondary rated current. The short circuit protection shall also have cold load pick up (doubling) / group-changeover feature to allow higher setting during transformer charging (inrush) and lower setting during normal operating condition. With CBCT the relay shall be suitable for detection of earth fault currents in the range of 10mA secondary.

- ii) Restricted Earth Fault protection (64R): Restricted earth fault protection (64R) shall be provided with high stability circulating current principle having pick up setting range of 10 to 40 % of CT secondary. Necessary stabilizing resistors shall be provided.
- iii) Stand by earth fault protection (51N): For transformers of rating 5MVA and above, definite time delayed Stand by earth fault protection shall be provided having a pick up setting range of 10% to 40% with a timer delay of 0.3 to 3 sec.
- iv) Transformer Differential protection (87T): Differential protection for transformers (87T) of rating 5MVA and above shall be provided with stabilized biased differential relay. The differential protection shall be provided with harmonic restraint during switching and over fluxing condition. No ICT shall be provided either for ratio correction or for transformer primary and secondary correction. The necessary correction shall be programmable at offered numerical relay. Sensitive phase current and phase angle displays should be available to facilitate the commissioning and checking of the measurement circuit connection and vector group matching.
- v) Transformer trouble trips: Transformer troubles like Buchholz, Winding temperature, Oil temperature & Pressure Relief Device trips shall be wired to separate binary inputs of the relay and shall be configured to issue trip command to the breaker.
- vi) Transformer trouble Alarm: Alarm contacts of the above transformer troubles shall be wired to separate binary inputs of the relay for communication to HMI / DDCMIS / PLC.

Other Protections and Control features

Control of breakers / vacuum contactors shall be carried out from PLC/DCS through hardwired control commands in the form of 24V DC signal. Preferably, binary input of all relays shall be configurable to accept 24V DC signals directly from DDCMIS and no separate coupling relays shall be provided. Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker / contactor trip circuit both in pre-trip and post-trip conditions. Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer functions shall be as required for the application. Timer functions shall be configurable for on & off delays as per requirement. The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker status monitoring, VT and CT supervision. The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided. At least 200 time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault. Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be available on the user interface. Sequence of events shall have 1ms resolution at device level. Measurement accuracy shall be 1 % for rated RMS Current and voltage. It shall be possible to carryout open /

close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning. 4-20mA analog output (current signal) for use- in PLC/DCS shall be provided in all breakers. This may be provided as analog output from the Numerical relay or may be generated using a suitable CT & Current transducer. In case analog output is not available in the relay, the same may be achieved using external I/O device of same make complying with the requirement stated elsewhere in this specification. In addition, any other requirement of digital & analog signals for process controls shall be taken care.

Type Tests

- a. 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 similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
- b. 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.
- c. All routine tests as per the specification and relevant standards shall be carried out.
- d. The following type test reports on circuit breaker / circuit breaker panels, of each voltage class and current rating shall be submitted.
 - 1) Short circuit duty test on circuit breaker, mounted inside the panel offered along with CTs, bushing and separators.
 - 2) Short time withstand test on circuit breaker, mounted inside panel offered together with CTs, bushings and separators.
 - 3) Power frequency withstand test on breaker mounted in side panel.
 - 4) Lightning impulse withstand test on breaker mounted in side panel.
 - 5) Temperature rise test on breaker and panel together. For this test, the test set up shall include three panels with breakers, the test breaker and panel being placed in the centre. The adjacent panels shall also be loaded to their rated current capacity. Alternatively, the test panel may be suitably insulated at the sides, which will be adjoining to other panels in actual site configuration.
 - 6) Internal Arc Test as per IEC 62271-200
 - 7) Measurement of resistance of main circuit.
 - 8) Mechanical operation test.

For all important components like Surge Arrestors and Numerical relays, the contractor shall submit the reports of all the type tests as per applicable standards 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 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. 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 to the owner either at third party lab or in presence of client/owner's representative and submit the reports for approval.

Routine Tests

All acceptance and routine tests as per the specification and relevant standards IEC 62271- 200 & IEC 62271-100 shall be carried out. An indicative list of tests / checks will be mentioned later during engineering. However, the manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

10% relay of all types should be supplied as spare.

7.2.5.13 Transformers (Oil Filled):

S.No	Description	Rating
1	Rating:	2500 KVA, 3-phase, continuous duty, outdoor installation
2	Voltage Ratio (KV)	33 / 0.415 KV
3	Winding	2
4	Nos. of Phase	3
5	Vector Group	As per system requirement
6	Cooling	ONAN
7	Tap Changer	As per system requirement
8	Impedance (At 750C)	As per system requirement (at principal & Other tap)
9	Noise level	As per NEMA TR-1
10	Winding (Insulation levels)	LI, kVp 170kVp, (187kVp-Chopped LI) for HV Power freq. level (one min.) 70kV (HV) & 3kV (LV)
11	Loading Capability	At least 20% for HV winding
12	Winding Insulation	Uniform insulation for HV & LV both
13	Min. Clearance	432mm (p-p) & 381mm (p-n)
14	Bushings & Creepage	As per system requirement
15	Flux density	Flux density Not to exceed 1.9 Wb/sq.m. at any tap position with +/- 10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds.
Note: 1. Permissible Temp rise over ambient of 50 deg. C (irrespective of tap); 2.Termination, SC withstand time & Fault level as per system requirement.		

CODES AND STANDARDS

- a) Transformers IS:2026, IS:6600, IEC:60076, IS 1180
- b) Bushings IS:2099, IEC:60137
- c) Insulating oil IEC:60296
- d) Bushing CTs IS:2705, IEC 60185
- e) Indian Electricity Act 2003, BEE Guideline & CEA notification

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 up to and including 2500KVA, 11kV shall have maximum losses of STAR-2 rating or better as per latest BEE guideline. The outdoor transformer up to 2500KVA, 11kV shall also comply with latest IS:1180.

Safety: Mulsifier system if required as per CEA norms in case of Transformer has to be provided by the agency.

Design and Constructional Features

Tank

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 1676mm. 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.

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.

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.

a. Kinematic Viscosity, mm ² /s	> 12 at 40 deg C & < 1800.0 at (-)30 deg C
b. Flash Point, deg C	> 140 deg C
c. Pour point, deg C	< (-)40 deg C
d. Appearance	Clear, free from sediment and suspended matter.
e. Density kg/dm ³ at 20 deg C	< 0.895
f. Interfacial Tension N/m at 25 degC	>0.04
g. Neutralization value, mgKOH/g	<0.01
h. Corrosive sulphur	Non-Corrosive
i. Water content mg/kg	< 30 in bulk supply & > 40 in drum supply
j. Antioxidants additives	Not detectable
k. Oxidation stability	
-Neutralization value, mgKOH/g	<1.2
-Sludge, % by mass	< 0.8
l. Breakdown voltage	
As delivered, kV	>30

After treatment, kV	>70
m. Dissipation factor, at 90° C & 40 Hz to 60 Hz	<0.005
n. PCA Content	<1%
o. Impulse withstand Level, kVp	>145
p. Gassing tendency at 50 Hz after 120 min, mm3/	5

Prior to energization at site for following properties & acceptance norms:

- BDV > 60 KV
- Moisture content < 10 ppm
- Tan delta at 900 C 0.05 (max.)
- Interfacial tension 0.035 N/m (min)

Windings

The conductors shall be of Electrolytic grade copper. All Windings of 66kV and below shall have uniform insulation. The contractor shall ensure that 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 deg. C. Conventional type conservator with indicating type cobalt free breather (transparent enclosure) shall be offered for transformer below 7.5 MVA.

Bushings

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

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.

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.

Valves

All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. Sampling & drain valves should have zero leakage rate.

Gaskets

- i) HT transformers all the gasket shall be weather proof & 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, 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.

Neutral Earthing Arrangement

The neutral of Transformers shall be brought through insulated support from tank to the ground level at a convenient point with copper flat, for connection to ground network (as applicable). However neutral may be connected to NGR as per system requirement.

NGR (Neutral Grounding Resistor) (As per system requirement)

- i) Resistance at 50oC - As per system requirement
- ii) Rated current - 300A for 10 seconds
- iii) Application - Neutral Grounding of Transformers as per system requirement.
- iv) Service - Outdoor
- v) Resistor material & connection - Punched stainless steel grid element type
- vi) Max allowable temp rise over ambient 50 deg. C - 350 deg. C
- vii) Mounting - As per system requirement
- viii) Power frequency level - As per system requirement

- ix) Stacking Various sections comprising the neutral grounding resistor shall be capable of being stacked one above the other.
- x) Enclosure - NGR shall be housed in a 2.5 mm thick sheet steel enclosure & DOP IP-33. A heating circuit with Thermostat to be provided inside the enclosure to control humidity.
- xi) Mounting Structure - The Contractor shall supply and erect a galvanized structure to support the NGR enclosure so that the base of the enclosure shall be at a minimum height of 2.4M above ground level.

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) Buchholz 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, minimum two numbers of spring operated PRD (with trip contacts) with suitable discharge arrangement for oil shall be provided. Armoured 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.
 - 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.
 - Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.
 - 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.

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 shall be considered for the evaluation of

- the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
- ii) The type tests shall be carried out in presence of the employer's representative, for which minimum 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 the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. 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 test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witness 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.
 - a) All type test on OLTC as per IEC 60214 (wherever applicable)
 - b) Neutral Grounding Resistors
 - c) Tank Vacuum and Pressure test
 - d) All type tests on transformers up to and including 2.5 MVA (upto33kV class) transformer.
5. All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
6. Each transformer shall be completely assembled with all fittings & accessories meant for the particular transformer/reactor before offering for inspection & testing by Employer.

Routine / Type Tests on Transformers:

1. All routine test in accordance with IEC 60076 shall be carried out in the transformers.
2. Measurement of Voltage Ratio & phase displacement (as per IEC 60076-1).
3. Measurement of winding resistance on all the taps (as per IEC 60076-1).
4. Vector group and Polarity Check (as per IEC 60076-1).
5. Magnetic Balance and Magnetising Current Test.
6. Measurement of no-load current with 415 V, 50 hertz AC supply.

7. Measurement of no load losses and current at 90%, 100% & 110% of rated voltage (as per IEC 60076-1).
8. Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps.
9. IR measurement (As per IEC 60076-1).
10. 2KV KV core isolation (core-clamp, clamp-tank, core-tank).
11. Measurement of capacitance & tan delta to determine capacitance between winding & earth.
12. Dielectric tests shall be carried out as per IEC 60076-3.
13. Applied Voltage Withstand Test (as per IEC 60076-3).
14. Lightning impulse (Full & Chopped Wave) test on windings (as per IEC 60076-3).
15. Lightning impulse test on LV Neutral.
16. Switching impulse test (as per IEC 60076-3).
17. IVPD test as per IEC 60076-3 shall be conducted (for U1 & U2 level)
18. LTAC test as IEC 60076-3
19. Induced overvoltage test.
20. Repeat no load current/loss measurement & IR after completion of all electrical test.
21. Oil leakage test on completely assembled transformer along with unit coolers/ radiators (as per relevant clause of this sub section).
22. Jacking test followed by D.P. test.
23. Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.
24. IR measurement on wiring of Marshalling Box.

Type Test

1. Lightning impulse (Full & Chopped Wave) test on windings (as per IEC 60076-3)
2. Lightning impulse test on Neutral.
3. Short circuit test (special test) as per IEC 60076-5.
4. 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).
5. Measurement of acoustic noise level as per NEMA TR-1 (special test).

Tank Type 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/m² 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.

7.2.5.14 Illumination & Lighting System:

- i. Adequate lighting arrangement with suitable illumination level for the equipment and complete plant shall be done by bidder.
- ii. The lighting scheme and determination of illumination level shall be finalized during detailed engineering as per the requirement of system.
- iii. Lighting transformer
- iv. Type & Rating Dry type / 100 KVA, 50KVA(Minimum)
- v. Voltage Ratio 415/415V, +/- 5% taps in steps of 2.5%
- vi. Class of insulation B or better

- vii. One minute power frequency withstand voltage 2.5 KV.
- viii. Enclosure protection IP-42

Each AC Lighting Distribution Board (LDB) shall be fed from 415V / 415V, 50kVA(minimum) isolating transformer. The lighting transformer may, preferably, be located inside the LDB panel itself. Otherwise, the same shall be located by the side of respective LDB. Lighting transformer shall be dry type, natural air cooled with class B insulation or better. Impedance of lighting transformer shall be so selected that the fault level of lighting system shall be reduced to 3 to 5 KA. Lighting transformers shall be tested as per IS: 2026. Off circuit tap changer with $\pm 2.5\%$ and $\pm 5\%$ tapping shall be provided. In case the transformers are not mounted inside the LDB panels, the same shall be housed in a separate 2 mm thick CR sheet steel enclosure with IP-42 degree of protection as per IS/IEC 60947. However, the transformer terminal box shall have IP-52 degree of protection.

Design Philosophy

- a. A comprehensive illumination system shall be provided in the entire areas.
- b. All outdoor lighting system shall be automatically controlled by synchronous timer. Provision to bypass the timer shall be provided in the panel.
- c. 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.
- d. The illumination system shall be designed on the basis of 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.
- e. The Lux levels to be adopted for various area are indicated: -

Location	Lux	Type of fixture
Switchgear rooms, Charger	200	Industrial type LED luminaire
Control room, computer	350	LED luminaire equivalent to Mirror optics with anti-glare features
Offices, conference rooms	300	Decorative mirror optics type LED
Battery rooms	100	total enclosed corrosion Proof LED Luminaire
Transformer area	20	(general) LED luminaire and 50 (on equipment)
DG Room	150	LED medium bay / Industrial type LED luminaire
Cable galleries / vault	50	Industrial type LED Luminaire
Main Plant area	150	LED medium bay/Industrial type LED Luminaire

All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.

Lighting Fixtures and Accessories

- i) IS:1913 General and safety requirements for luminaries.
- ii) IS:2148 Flame proof enclosures of electrical apparatus.
- iii) IS:418 Tungsten filament general service electric lamps.
- iv) IS:1258 Bayonet lamp holders.
- v) IS:1534 Ballast for fluorescent lamps.
- vi) IS:1569 Capacitors for use in tubular fluorescent, high pressure mercury vapour and low pressure sodium vapour discharge lamp circuit.
- vii) IS:1777 Industrial luminaire with metal reflectors.
- viii) IS:2215 Starters for fluorescent lamps.
- ix) IS:2418 Tubular fluorescent lamps for general lighting services.
- x) IS:3323 Bi-pin lamp holders for tubular fluorescent lamps.
- xi) IS:3324 Holders for starters for tubular fluorescent lamps.
- xii) IS:4013 Dust-tight electric lighting fittings.
- xiii) IS:8224 Electric Lighting fittings for Division 2 areas.
- xiv) IS:10276 Edison screw lamp holders.
- xv) IS:10322 Luminaires.
- xvi) IS:13021 AC Supplied Electronic Ballasts for tubular fluorescent lamps.
- xvii) LED Luminaries
- xviii) 16101:2012 General Lighting. LEDs and LED modules Terms and definitions
- xix) 16102(Part 1):2012 Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.
- xx) 16102(Part 2):2012 Self Ballasted LED Lamps for General lighting Services. Part-2 Performance Requirements.
- xxi) 16103(Part I):2012 LED modules for General lighting Safety Requirements.
- xxii) 15885(Part 2/Sec. 13) :2012 Lamp control gear Part 2 Requirements Section 13 DC or AC Supplied Electronic control gear for LED modules
- xxiii) 16104:2012 DC or AC Supplied Electronic control gear for LED modules - Performance Requirements.
- xxiv) 16105:2012 Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources.
- xxv) 16106:2012 Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products
- xxvi) 16107:2012 Luminaires Performance 16108:2012 Photobiological safety of Lamps and Lamp Systems
- xxvii) IS 513 Cold rolled low carbon steel sheets and strips
- xxviii) IS 12063 Classification of degree of protection provided by enclosures.
- xxix) IS 14700 Electromagnetic compatibility (EMC) – Limits (Part 3/Sec. 2) for Harmonic current emission – THD < 15% (equipment, input current < 16 Amps. per phase.
- xxx) IS 9000 (Part 6) Environment testing: Test Z – AD: composite temperature/humidity cyclic test.
- xxxi) IS 15885 Lamp control gear: particular requirements for (Part 2/Sec. 13) DC or AC supplied electronic control gear
- xxxii) IS 16004 – 1 and 2) for LED modules. IS 4905 Method for random sampling
- xxxiii) LED type Tube Lighting suspended / bracket / wall mounted type luminaire.
- xxxiv) 2X2 LED Panel decorative type suitable for recess mounting,

- xxxv) 220V DC Critical Lighting Luminaire inside CRCA housing with UV stabilised polycarbonate cover, Suitable for direct operation in Safe Area on 220V DC Supply & Wall mounting, LED,
- xxxvi) Integral, toughened clear well glass luminaire, suitable for Flameproof (Ex d), Zone 2, Gas Group IIC, Temperature Class T3,
- xxxvii) Outdoor installation IP66 with 2nos of Flameproof (Ex d) double compression type cable glands & flameproof blanking plug,
- xxxviii) Flood light LED non integral fixtures suitable for Flameproof (Ex d), Zone 2, Gas Group IIC, Temperature Class T3,
- xxxix) Outdoor installation, IP55 with 2nos of Flameproof (Ex d) double compression type cable glands,
- xl) 1no of flameproof blanking plug,
- xli) LED type Tube Lighting fixture, Industrial type suspended / bracket / wall mounted type luminaire,
- xlii) DC Critical Lighting Luminaire, Suitable for direct operation Hazardous Areas on 220V DC Supply,
- xliii) Flameproof Type with Ex-d Protection suitable for operation in Zone-1/2, Gas Group IIA/IIB areas & Column mounting.
- xliv) Street lighting: -
 - 2.5mtrs platform mounted GI pole suitable for mounting well glass fixture.
 - 8meter high Lighting pole for single Street lighting fixture with junction.
 - 1.5Mtr swan neck pole for Building Periphery lighting.
 - LED, Street Light Luminaire, IP66 protection 110W.

Lighting Panel.

Indoor Normal/emergency LDB Incoming - 1 No 63A 4P C Curve MCCB+RCCB 300mA, 415V, 3 phase, 4 wire, Outgoing - 6 Nos(ways), 16A, 2P MCB+RCCB 100mA, 240 V AC (For normal lighting panel -1 no of outgoing feeder with Contactor + Photocell).

DC Critical Lighting panel, (Flameproof) Zone-2, IIA / IIB, T3) IP66 / IP55 'Incomer: 220VDC, 63A, DP MCB, DC 3 wire- 01 No. 'Outgoing feeders: 220VDC, 16A, DP MCB+ELCB, -6 Nos(ways),

Outdoor flameproof Normal/emergency LDB-Ex d, Zone 2, Gas Group IIC, Temperature Class T3, IP55 Incoming - 1 No 63A 4P C Curve MCCB+RCCB 300mA, 415V, 3 phase, 4 wire, Outgoing - 6 Nos(ways) / 12Nos (ways), 16A, 2P MCB+RCCB 100mA+Contactor+Photocell ,240 V AC.

Outdoor WP Street light panel IP55 'Incomer: 415V, 63A, TPN MCB, 16A SP MCB+DP RCBO 100mA. (1no. per phase), 50 Hz, 3 phase, 4 wire- 01 No., 'Outgoing feeders: 6 Nos Outgoing - 16A, TPN MCB, -6 Nos ways) + ELCB with contactor + timer

7.2.5.15 Fire Fighting System:

Fire Detection & Alarm System

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 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.

Fire Protection & Fire water system

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 as follows:

- Fire Water system (including Hydrants, monitors, HVLRM, automatic spray system on process equipment's)
- CO2 extinguishing system as per NFPA 12
- Automatic Water spray system in product warehouse
- HV spray system on transformers
- Portable extinguishers

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

7.2.6 Field testing, Commissioning & Guarantee:

- 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 shall be provided.
- 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 e.g., CEA, Electrical inspector etc. is in contractor scope.
- The contractor shall guarantee the installation for satisfactory operation against any defects of workmanship and materials (supplied by the contractor) for a period as specified elsewhere. Any damage or defect connected with the erection of materials, equipment or fittings supplied by the contractor that may be discovered at the time of issue of the completion certificate, or arise or come to light thereafter, shall be rectified or replaced by the contractor at his own expense as deemed necessary and as per the instruction of Owner or Engineer-in-Charge within the time limit specified.
- The above guarantee shall be applicable for the quality of the work executed as well as for all equipment panels/ cables/ fixtures/ fittings etc supplied by the contractor.

7.2.7 Mandatory spares

S. No.	Part Description	Quantity Required
1.0	LT switchgear	one set of spare for each switchboard
1.1	Closing coil	1 no. of each rating & type
1.2	Shunt trip coil	1 no. of each rating & type
1.3	Control fuses / MCB	10 nos. of each rating & type

1.4	Indicating lamps covers	5 nos. of each color
1.5	Indicating lamps	20% or 3 nos. (min.) whichever is more
2.0	Distribution Transformer	one set of spare for each transformer
2.1	Sealing / Gauge glass of conservator	2 Nos. of each rating & type
2.2	Control fuses / MCB for MB cubicles	20% for each rating OR 1 No. (min.) of each rating, whichever is more
2.3	HV & LV bushings	One set of each type and rating
3.0	MV induction motors 37 kW & above	One set of spare for each rating & type
3.1	Bearing (DE & NDE)	1 set
3.2	Terminal studs/bushing assembly	1 set each
4.0	Variable Frequency Drive (one set of spare for each VFD)	Quantity is per VFD
4.1	Transistors/ IGBT/ IGCT	1 Nos. of each rating and type
4.2	Control cards	1 Nos. of each type
4.3	Power supply cards	1 Nos. of each rating and type
4.4	Power fuses	20% for each rating OR 1 no. (min.) of each rating, whichever is more
4.5	Control fuses/ MCB	10 Nos. of each rating and type
4.6	Contactors	10% of each type OR 1 no. (min) of each type, whichever is more
4.7	Indicating lamps	20% OR 1 nos. (min.), whichever is more
4.8	Indicating lamp covers	2 Nos. of each color
4.9	Blocker diode	2 Nos. of each rating and type
4.10	Control power supply module	1 Nos. of each rating and type
4.11	Power module	3 Nos. of each rating and type
<p>Note: (i) The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable; (ii) The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer; (iii) Mandatory spares as indicated above do not cover commissioning and O&M spares.</p>		

7.3. Technical Specifications – Control & Instrumentation:

7.3.1 Introduction:

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 Control & Instrumentation equipment /system and works as required for putting into successful operation of 'Plasma induced Radiant Energy based Gasification System' (GH2-PREGS).

7.3.2 Programmable Controller (PC):

a) Purpose and general Information:

The Programmable Controller with built-in microprocessor shall be used to carry out the control & regulatory functions, sequencing, logical switching, alarm, integration of various drives system, process control, real time trending, recording, and monitoring of the system. It shall interface with MCC/control desk, field equipment, networking components, peripherals, other programmable controllers and/ or a host computer/ server through bus-based communication.

b) Design of Control system:

- i. Redundancy in CPU, Power Supply, Communication Modules and Network
- ii. Control Functions envisaged
- iii. Spare CPU memory capacity
- iv. Location of Remote I/Os, if any
- v. Average CPU loading

c) Basic C&I Design Requirement:

The C&I system shall meet operational requirements and correctly interface with the main process. The basic design requirements to achieve these factors are as below:

- i. Reliability and Availability: Each component of the system and the system shall be of established reliability such that the availability of the complete C&I system is assured for 99.7%.
- ii. Hardware Uniformity: It is preferred to have various C&I items from same make, series and family and should be procured from NTPC approved vendors.
- iii. Easy Maintainability: The system design to be done to achieve good sound maintainability.
- iv. Obsolescence: The equipment/system shall ensure provision of latest proven state of art technology to guard against obsolescence.

d) Compatibility & Integration signals:

- i. Each process (as mentioned in 1.1) with its utilities shall be connected to Central Integration PLC of GH2-PREGS through a two-way communication link.
- ii. This shall allow for the transmission of data to individual process plant and Central Integration PLC & do the necessary communication between these plants.
- iii. For integration of each process bidders shall determine the optimal hardwired and soft signals required to achieve data transfer between all the access points.
- iv. The contractor shall use for this purpose, approved and standard equipment like convertors and/or adaptor devices etc. required to achieve the above and shall provide an agreement of technical support and support availability. Contractor shall obtain necessary approval for

Licenses authorizing the use of communication equipment specified frequencies, if required.

7.3.3 Programmable Logic Controller (PLC)

1	Power supply system	<ul style="list-style-type: none"> All PLC along with OWS (Operator Workstation) & EWS (Engineering Workstation) shall be powered by 230 V single phase 25 KVA with minimum 6 output terminals of 230V UPS 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 / JB's for conversion, distribution and/or stabilization of UPS power source. Battery capacity should be adequate for the backup of Minimum 3 Hrs. One source of 230 V AC single phase, 50 Hz for auxiliary power supply e.g. fans, panel lamps, power sockets etc. For each I/O Panel Redundant 24 V DC regulated power supply unit (SMPS) shall be provided for interrogation voltage for digital input and loop power supply for transmitter. SMPS shall be selected with 25% separating The SMPS shall be separate for digital and analog inputs. Separate power supply bus shall be provided for interrogation voltage supply for all inputs and output respectively (even if the input interrogation voltage and output voltage is same) MCBs shall be provided for each rack of the PLC system. 20 % spare MCB of each rating (at least one no. of each rating) shall be provided in each panel. In case of Foundation Field Bus, Separate redundant power supply modules shall be considered.
2	Built-in power supply units	<p>Minimum features to be provided in power supply unit mentioned above are:</p> <ul style="list-style-type: none"> Protection against surge protection & short circuit Electronic over current protection with feedback feature. Over voltage protection. Fuse protection in the input and output circuit. Diode O-ring shall be envisaged for redundant SMPS.
3	Central processor unit	<ul style="list-style-type: none"> Minimum 32bit microprocessor based with on board RAM of minimum 8 MB, Battery backup RAM & NV RAM. Execution time 0.3 millisecond per 1K instruction or better. Provision to latch desired outputs. Shall be provided with hot redundant standby CPU (with appropriate communication module). PLC shall be equipped with Dual Processor, Dual redundant communication modules, dual redundant power supplies and dual I/Os with auto testing. PLC configurations shall be TMR/QMR, SIL-2 / SIL3(as per HAZOP study) 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 licensor / process requirement. The CPU system shall have facility of bump less transfer in case of failure of one. Fiber optic link shall be provided in between CPU's for continued applying of data. In case of failure of working CPU, standby CPU shall takeover and maximum data loss shall be for 50ms The processor shall have in-built provision for software timers, counters, examining input conditions, compare, compute, logical, conversion from/ to BCD (Binary coded decimal), bit manipulation, block memory

		<p>manipulation, diagnostic, shift, sequencing, conditional jumping, subroutine instructions, high speed counting function, PID functions, mathematical functions.</p> <ul style="list-style-type: none"> • Maximum CPU loading shall be limited to 50% after commissioning. • CPU shall be capable of handling at least more than 10% of the I/O (any mix) required in this project plus an additional 400 I/O of any mix. • All the electronic modules PCB should have conformal coatings that can provide protection against extreme moisture, corrosive gases and aggressive dust, or combinations thereof.
4	Input Units	<ul style="list-style-type: none"> • Modular, hot swappable and from the same family as the CPU. • Insulation level of 500V DC. • Input interrogation voltage 24 V DC.
4a	Digital Input Modules	<ul style="list-style-type: none"> • Digital input units shall have the following features: • 16 / 32 inputs per module. • Optocoupler / galvanic isolation • LED status indication for each channel. • BCD input units suitable for four-digit input • Pulse inputs (Incremental encoder / digital tacho) • Absolute / incremental encoder inputs. • High speed counter type inputs • All the cards shall be compatible of receiving digital signals from field sensors and switches directly. • All the control modules / cards shall be lacquered. • Digital inputs with fused terminal with LED indication for fuse blown. • LED status indication in the front of I/O cards. • SSI i/p shall be provided if required
4b	Analog input Modules	<p>Analog input units shall have the following features:</p> <ul style="list-style-type: none"> • Shall be 4 / 8 / 16 channels, • Suitable for 4-20 mA/4-20 mA HART / 0-10V DC / RTD/ thermocouple / weighing signal inputs / 0-20 mA / 1 - 5 volt. • Differential input shall be provided when specified. • Provided with internal temperature compensation for TC Input • With necessary A/D converter having at least 12 / 14bit resolution based on application. • Suitable for J/K/S/E/N/B/R/T type thermocouples & for PT1000/PT100, 2- wire / 3 wire /4 wire RTD. • Galvanically isolated with insulation level of 500V DC. • For 4 – 20 mA analog inputs, fused TB with LED for fuse blown. • The healthiness of every input shall be monitored & diagnostic LED indication provided. • Analog module shall have the facility to be configured in voltage or current mode and differential input mode.
5	Output units	<ul style="list-style-type: none"> • Modular. • Insulation level of 500V DC.

5a	Digital Output modules	<p>Digital output units shall have the following features:</p> <ul style="list-style-type: none"> • 16 / 32 digital outputs per module. • Rated for 24 V DC/ 110 V AC • With insulation level of 500V DC <p>The output module shall be able to drive interposing relays BCD output units shall be as follows:</p> <ul style="list-style-type: none"> • Suitable for four-digit output. • Rated to drive seven segment LED displays
5b	Analog output modules	<p>Analog outputs shall have the following features:</p> <ul style="list-style-type: none"> • Shall be of 4 / 8 analog output channels. • Suitable for 4-20 mA / 0-20 mA / +/- 20 mA / 0-10V DC / +/-10V DC, 1-5 V dc outputs as per requirement. • With necessary D/A converters having 12bit resolution. • With insulation level of 500V dc. • Each output shall be galvanically isolated & differential type. With short circuit protection.
6	Additional features	<ul style="list-style-type: none"> • Network shall be 100 MBPS/ 1GBPS. However, switch to switch connectivity shall be 1GBPS. Network switch shall be at least layer 2 managed switches. • Communication with computer in distributed hierarchical control system and operator consoles / display units. • High speed communication among Programmable Controller and operator consoles/ display units shall be provided through dual redundant TCP/IP Ethernet using Ethernet cards on HMI station. <p>The Controller system shall be immune to the following:</p> <ul style="list-style-type: none"> • Radio frequency interference • Electromagnetic interference (EMC compatible) • The methods and standards followed for these features shall be furnished by the supplier.
7	Mounted spares	<ul style="list-style-type: none"> • Min of 10 % of spare I/Os prewired and at least one spare module of each type. • Provision shall be provided with empty slots/ space for future expansion for 10% I/O modules.
8	Self-Diagnostic features	<ul style="list-style-type: none"> • Parity errors, cycle errors and under voltage. • Failure in central processor unit, memory and power supply. • Indication of type of failure. • Automatic turning OFF of all outputs or optionally holding of all outputs in their last state on failure detection. • Fault detection up to card level. • Communication failures – all type Fuse failure indication for outputs.
9	Monitoring functions	<ul style="list-style-type: none"> • Monitoring of internal voltages • CPU Status monitoring • Memory status monitoring • I/O Status monitoring • Address monitoring • Bus & communication signal monitoring • Broken sensor detection • A milli ammeter with selector switch shall be provided on panel facia.

		<ul style="list-style-type: none"> • monitor the earth leakage current.
10	Terminations	<ul style="list-style-type: none"> • All inputs and output wired up to easily accessible terminal blocks rated for 660V. • Suitable for terminating up to 2.5 sq-mm copper conductor industrial control cable. • Fuse terminals for all input & output signals (with LED indication). • For different types of terminal input different suitable terminal blocks to be used. • Color coding shall be used for different type of voltage levels.
11	Earthing	<ul style="list-style-type: none"> • Separate earthing bus for power / panel (IS/NIS) earthing and electronic earthing. • Electronic earthing bus shall be suitably insulated.
12	Enclosure	<ul style="list-style-type: none"> • Conforming to IP-42 class in Programmable Controller room/control room. • Conforming to IP-54 class for remote I/O cubicles located in Plant/field. • The case of the panel located outside control room, built –in panel AC shall be provided. • Color Code shall be RAL 7035, however, it shall be matched with existing panel. • Programmable controllers RIO Panel shall be suitable for normal industrial environment and 50°C ambient temperature. • Relative humidity daily average 80 to 90% (8 hrs.) and 65 to 90% (16 hrs.) Maximum 98%, not occurring simultaneously with maximum temperature. • PLC shall be suitably mounted to meet the hazardous area classification requirement of the location. Bidder shall confirm with catalogue / document mentioning ambient temperature rating of PLC. In case PLC ambient temperature rating is not adequate, local panel shall be provided with explosion proof air conditioning system / Vortex Cooler suitable for the certified hazardous area classification. • Vortex cooling is acceptable for package PLC in the field. Instruments air shall not be provided for vortex coolers, contractors shall consider ambient air with dual blowers for this purpose.

Note: The design philosophy of C&I system shall be such that process shall be from single control room & hence all design, controls, interlock, instrument selection, HMI etc should be developed accordingly.

7.3.4 PLC Software:

1	Software (Windows Programming)	<p>The PLC programming software shall be latest, Windows based, menu driven & shall support following minimum:</p> <ul style="list-style-type: none"> • Cyclic, Time Controlled, Interrupt controls. • Retentive /Non-Retentive Timers, Bi-directional counters, latches, etc., • Internal Flag generated by the Programmable Controller. • All Boolean Logic Functions • Data Transfer, Block Transfer • Sub Routines • Arithmetic functions & formula Calculations • Communication functions with Remote I/O as well as Workstations • Closed loop PID control functions including nested and cascaded loops. • Floating point arithmetic functions, Conversion of real to integer, integer to binary etc. • Output of PID controllers shall be 4-20 mA DC. • Control valve position (in 4 – 20 mA) shall be made available in programmable Controller. • PID Controller shall have auto tuning facility. • Totalization of flow inputs. • Linearization function blocks and other useful function libraries • Linearization function block shall be such that a table of values (X against Y) can be entered in a menu driven manner and for any particular field input X, the value of Y can be calculated using the values of table by interpolation method. Maximum 30-point linearization function block shall be considered. Below 30, point of linearization shall be user selectable. • Built-in ambient temperature compensation for thermocouple inputs from field. • Broken sensor detection etc. • Simulation facility / software shall be supplied for program testing without disturbing the working Programmable Controller. • The complete PID blocks shall be transferred to HMI workstation in place of split bits. • Software shall be suitable for PC based Programming Unit. • Shall be as per process control requirement. • Online program editing & bit forcing facility shall be available.
2	Application Program software & Licensing	<p>The Bidder shall provide a software license for all software being used in Bidder's System. The software licenses shall be provided for the project and shall not be hardware/machine specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good, and it shall not be necessary for Employer to seek a new license/renew license due to up gradation/change of hardware/machine in Bidder's System at site. All licenses shall be Valid for the continuous service life of the plant.</p>
		<ul style="list-style-type: none"> • The system shall always monitor SOE inputs with a resolution of one millisecond, for all inputs including spare inputs. Input card shall be equipped with digital filters with filter delay of minimum 4 ms (identical for all points) to eliminate contact bounce such that field contact which is changing state must remain in the new state for successive 4 ms to be reported as one event. The start of data collection

3	SOE functionality	<p>for SOE report shall be reported to OWS within 1 sec of SOE data collection initiation. Time stamping of SOE inputs/points shall be performed in the control system.</p> <ul style="list-style-type: none"> • In addition to the above, the facility for adding a field adjustable software delay on a per point basis shall be provided. • The system shall also include provision for historical storage and retrieval of SOE reports for a 3-month period. • The SOE reports shall also include a list of major equipment trips in chronological order and include the points that initiated SOE collection. The SOE report shall be available on each of OWS/LVS of process PLC. • All the SOE inputs shall also be available for interlock/protection functions. • SOE in other subsystems of PLC shall also be integrated into this system. • SOE reports shall be stored in the HSRS like other logs/reports and shall be provided "first out" indication and subsequent sequence of events.
4	GPS	<ul style="list-style-type: none"> • GPS Receiver: Timing Accuracy 15 ns with GPS Receiver (Receiver is locked on fixed position) • Positioning Accuracy: < 10 m, Tracking: 12 parallel channels • Antenna: Type: Active L1. GPS, 30 dB gain, Ingress Protection: IP67 • Interface and Configuration: Display: 2x20 Character backlit LCD Display • Display Data: Local / UTC time and date Day of the week Position latitude, longitude Status of the GPS receiver Current data format of COM2 • Programming: Keypad, Hyper Terminal (Serial RS232), Ethernet Parameters using TELNET (Ethernet RJ45 Port). • Programmable parameter: Global time zone correction, Hour settings for Display (12 or 24 Hrs.), Data format selection (NGTS or T-FORMAT), Repetitive event generation output via Potential free Contact (Per Minute or Hour), Additional Event Configuration (Total & On time of Events) • Configurable Parameters via TELNET: IP, Gateway, and Subnet, NTP / SNTP Client Software: Platform Support: Windows 98/NT/2000/XP/7 server synchronization, NTP Client Software is for easy distribution of time across the network.
5	LVS (Large Video Screen)	<ul style="list-style-type: none"> • The Bidder shall provide 80" Full HD Single Chip DLP Laser Light Source based Video Wall Cube having software license (if any required). • Minimum Brightness up to 1800 Lumens, • Minimum resolution: 1920 x 1080 pixels • Aspect Ratio: 16:9, • Dual power supply option • Rear Access Inputs: HDMI/ Analog D-Sub 15 pin/ DVI/ Display Port, • 10 Meter HDMI-HDMI cable to connect HMI to Video Wall Cube.

7.3.5 Programming Station

Type	<ul style="list-style-type: none"> • Shall be console / Tabletop type PC based/ Laptop based/ color graphic Work Station. • Configuration of all OWS and EWS shall be latest available in the market. • Minimum Five OWS shall be provided for the integrated process monitoring and
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	<p>control of Plasma gasification, Syngas Conditioning/Cleaning, Hydrogen Separation, Hydrogen Compression & Storage and Power generation.</p> <ul style="list-style-type: none"> • EPC vendor can provide either a common EWS or individual EWS for each process. • Make- HP/DELL Industrial grade suitable for rough environment and workstation category. • RAM: 16 GB (DDR4), Hard disk- 1 TB SDD (minimum), With latest Operating System and maximum of 50% loading. • Processors: Industrial grade processor latest (minimum: XEON processor /equivalent) with maximum of 50% loading. • Network port: 2 x (10/100/1GbE embedded/additional NIC) • Additional requirements: <ol style="list-style-type: none"> 1. Required appropriate Software/Hardware shall be capable of handling Graphics/HMI and other requirements. 2. Workstations Hard disk shall be minimum RAID 1 category. • Industrial grade Laptop (Min Qty. 01 number) shall also be provided. Technical details of laptop (RAM:16 GB, ROM- 1 TB SDD, With latest Operating System).
Programming Facilities	<ul style="list-style-type: none"> • Programming language shall be Ladder logic/functional Block/ Structure Text/ Instruction/ list/ SFC. • The programming terminal shall be capable of developing multiple programs offline without connecting to the programmable controller. • The engineering station shall have integrated development and configuration setup for all the drives, instruments, HMI etc. • Facility to view from any HMI terminal in intranet and internet for remote monitoring with password.
System Function	<ul style="list-style-type: none"> • Error detection and reporting. • Fail safe / broken sensor information and alarm and their reset. • Selection of highest / lowest signal from a group of accepted inputs and displaying the same. • Linearization and other arithmetic calculation. Provision shall be kept for pressure and temperature correction to be computed for flow measuring loops. • Built-in ambient temperature compensation for thermocouple inputs from field. • Trending real time and historical (Trending shall be provided for all analog inputs). • Fault logging • Report generation and periodic logging. • Printing of alarm conditions with parameter identification. • Online editing of: <ul style="list-style-type: none"> - Scan sequence - Identification number - Engineering units - High and low alarm limits, - Alarm dead bands - Addition / Deletion signals - Removal / introduction of analog and digital points in scanning.
Printer	<ul style="list-style-type: none"> • Latest appropriate model of Laser Printer (01 Qty) to get hard copy of the program dump / data logging / alarm logging / event logging / data trending etc.

7.3.6. Human Machine Interface (HMI) Workstation & Engineering Station:

Configuration	<p>Depending upon application one out of following configuration shall be adopted. It shall be console type PC based colour graphic with latest configuration available in the market.</p> <ul style="list-style-type: none"> a) Stand-alone Workstations with history system (Refer Distributed System Architecture Type:1) b) Client-Server based architecture (with hot standby server) (Refer Distributed System Architecture Type:2).
HMI Hardware	<ul style="list-style-type: none"> a) Color monitor with Antiglare with minimum 24" LED. b) Dual Ethernet interface with LAN accessories for all PC based OWS and EWS. c) Server shall be hot standby type with redundant power supply unit.
HMI Software	<ul style="list-style-type: none"> a) Window based, latest version (at the time of implementation) of HMI software. b) HMI software package shall have the facility to perform multitasking, data acquisition, supervisory control, monitoring, control development and routine software. c) HMI software shall also have the features for alarming, trending, data logging, production backup history, operator action list, creation of shift reports after every shift, online printing of events. d) Number of graphic pages shall not be a limit. e) HMI software shall have the facility of handling unlimited tags (Digital & analog). f) HMI software shall be capable of curve fitting, co-relation & regression functions. g) In the engineering workstation & servers, development version of HMI software & Foundation Field bus system software (licensed versions) shall be provided. h) In the operator workstations, runtime version of HMI software & Foundation field bus system software (licensed versions) shall be provided. i) Provision shall be made for subsequent integration with all other system i.e. Plasma Gasification, syngas conditioning/cleaning, Hydrogen Separation, Hydrogen compression & storage block and Power block. j) The process start/stop should be from single push button & hence the total design philosophy should be developed accordingly.

7.3.7 Measuring Instruments (Primary and Secondary):

S. No.	Transmitter Type	Accuracy/Repeatability
1	DP Flow Transmitter (Diaphragm)	a) Type – smart type DP Transmitter b) Sensor element type – diaphragm c) Ex approval / certification – ATEX and PESO d) Accuracy - +/- 0.075% of calibrated span
2	DP Level Transmitter (Diaphragm)	a) Type – smart type DP transmitter b) Sensor element type – diaphragm c) Ex approval / certification - ATEX and PESO d) Accuracy - +/- 0.075% of calibrated span
3	Pressure transmitter	a) Type – smart type Transmitter b) Type of pressure – gauge type c) Sensor element type – diaphragm d) Ex approval / certification – ATEX and PESO e) Accuracy - +/- 0.075% of calibrated span
4	Differential pressure transmitter	a) Type – smart type Transmitter b) Type of pressure – Differential pressure c) Sensor element type – diaphragm d) Ex approval / certification – ATEX and PESO e) Accuracy - +/- 0.075% of calibrated span
5	Temperature Transmitter	a) Element input <ul style="list-style-type: none"> ○ Element type - RTD (Pt-100) / Metal Sheathed ○ Tolerant class – IEC 751 ○ Wire configuration – 3 – wire RTD b) Transmitter <ul style="list-style-type: none"> ○ Type – smart type transmitter ○ Ex approval / certification – ATEX and PESO ○ Accuracy - +/- 0.025% of calibrated span c) Mounting type (remote / integral) – Remote
6	Loop power indicator	a) Type – LCD indicator b) Display element - 7 Segment LCD, 3-1/2 Digit c) Input signal – 4-20mA d) Enclosure class – IP 65 e) Ex Approval/Certification – ATEX and PESO f) Calibrated range – 0-100%
7	Servo level transmitter	a) Measuring body <ul style="list-style-type: none"> ○ Type – Servo operated ○ Displacer / Drum material – SS316 / SS316 ○ Measuring wire material – SS316 b) Transmitter <ul style="list-style-type: none"> ○ Type – 4 – wire transmitter ○ Output signal – comm. Protocol: 4-20 ma -HART ○ Ex Certification/Approval – ATEX and PESO ○ Accuracy - +/-3mm

8	Radar level transmitter	<p>a) Type Free Wave Non-Contact Radar.</p> <p>b) Probe/Antenna Type- Cone Antenna</p> <p>c) Probe/Antenna Mount: Top Mounted on Vessel</p> <p>d) Area classification: Zone 2 IIA, IIB T3</p> <p>e) Enclosure Class: IP65</p> <p>f) Transmitter Type – 2/4 wire transmitter</p> <p>g) Communication Protocol – 4-20 ma HART,</p> <p>h) Accuracy - +/-3mm</p>
9	Positioner	<p>Type - 4-20 mA + Smart HART type.</p> <p>Output - Actual valve stem travel, input current, actuator pressure, travel direction, accumulated travel, cycle counter etc.</p> <p>Diagnostic information - Valve signature data with seat load, bench set and valve friction, dynamic error and dynamic linearity of control valve, diagnostic graphics with adequate resolution shall be provided.</p> <p>Vibration effect - Shall have minimum vibration effect when mounted on the control valve, which shall be less than 1% of output span as per SAMA PMC 31.1</p> <p>Positioner enclosure - Metallic</p> <p>Advanced diagnostic software PLC/DCS compatibility.</p>
10	Rotameter	<p>Rotameter shall be metal tube type.</p> <p>Rotameter shall have an accuracy class of 1.6 or better as per VDI/VDE 3513/2.</p>
11	Gas Detectors	<p>Contractor shall design and provide hazardous gas detection system (sensors/transmitters) for alarm and shutdown to protect personnel and equipment from hazardous gas infiltration. The gas detectors shall be 3 wire, SMART type with 4-20 mA HART output wired to plant PLC.</p> <p>20% / 60% LEL for HC and 10 ppm / 15 ppm for H2S alarms are to be generated in PLC. Audible/visual alarms in field shall be provided by contractor.</p> <p>Gas detectors to be supplied as per P&ID & other specification. In addition to that three (3) nos. of portable calibration kit for HC gas detectors and two (2 nos.) number of portable calibration kit for each other type of gas detectors (if applicable) shall be provided.</p>
12	Gas Analyzer	<p>Process Analyser along with Shelters/Cabinets as indicated in Process pkg., along-with carrier gas, calibration gas cylinders/ reagents will be provided by bidder for minimum 6-month operation after commissioning.</p> <p>Following online gas measurements will be required for optimal operation of plant.</p> <ol style="list-style-type: none"> 1. At the inlet of Syngas cleaning section - H2, H2O, CO, CO2, CH4, N2, NH3, HCN, SO2, H2S, COS, HCL, HF. 2. At the outlet of Syngas cleaning section - H2, H2O, CO, CO2, CH4, N2, NH3, HCN, SO2, H2S, COS, HCL, HF. 3. At the outlet of Membrane/PSA/VPSA - CO2, H2 4. Tail Gas measurement from Membrane/PSA/VPSA - CO, H2 5. At the outlet of PSA/VPSA towards storage - H2 <ul style="list-style-type: none"> • Output Signal: 4-20 mA. • Repeatability/Accuracy: Minimum +/-1 % of Full scale

		<ul style="list-style-type: none"> Sampling system shall be provided along with instruments. <p>Statutory Approvals and Certificates e.g. PESO, ATEX/AREB (wherever ATEX/AREB approval is required, necessary documents for ATEX/AREB approvals shall be provided by bidder), IBR (wherever applicable) etc</p>
13	Solenoid valves	Solenoid valves shall be intrinsically safe type for 24V DC (≤ 700 M cable length) and flameproof type for 110V AC (> 700 M cable length). Field switches, wherever applicable, shall be flameproof. Limit switches shall be intrinsically safe type.
14	Limit switches (On-off / Shutdown valve)	a) Type: Proximity, intrinsically safe. b) Each limit switch shall have 2 separate cable entries, one for open and one for close positions. c) Instead of Proximity switches, Restrictive dry magnetic proximity switches can be used for high temp, for high vibration & corrosive atmosphere with hermetically sealed.
15	Fire Safe Valve	a) Fire safe valve shall be type tested as per API 607 (6th edition or later). b) Fire safe valve with fire safe actuator shall be equipped with all accessories including volume bottle. Contractor shall provide fire resistant blanket / jacket. c) The fire blanket / jacket shall enclose the valve actuator, all valve accessories, volume bottle as well as tubing between the valve actuator and volume bottle. d) In case the type of protection is not specified by licensor, contractor can consider fire resistant blanket / jacket type of protection as per API. For fire resistant blanket/ jacket specification. The fire jackets shall preferably be transported separately and installed at site to prevent damage during valve handling and storage. e) Also, all branch cables associated with these valves shall be Flame retardant and Fire-resistant type. f) Flame retardant and Fire-resistant cable required for branch cable for Fire Safe Valves with Fire safe Actuators.
16	LABORATORY INSTRUMENT	a) Lab equipment of reputed make shall be provided by the bidder. These needs to be duly certified by a Government approved testing laboratory. b) Offline analyser/analytical instrument with all associated system (such as calibration gases, cylinder attachments, softwares etc) for the above-mentioned gases Clause 3.2. with additionally CO ₂ gas. c) Sampling kit for producer gas sampling. d) Portable pH, conductivity, temperature Analyzer e) Portable CO, H ₂ and O ₂ leakage sensor (individual or multi gas analyzer). f) Weighing balance (02 Nos): Digital, touch screen, top pan balance and Lab scale weighing balance Capacity: 250 gms (approx.) g) Weighing balance (01 Nos): capacity minimum 500 kg or more, digital, h) Oven/furnace, Automatic bomb calorimeter, associated system and accessories/consumables/lab wares for Moisture, Ash and GCV analysis of RDF respectively. i) Tar measurement: Offline tar measurement system (with flow meter and totaliser). Minimum detection capability of tar in producer gas shall be finalized during detailed engineering. j) Sample collection and preparation system (for MSW, RDF and producer gas) k) All the lab instruments shall be of reputed make. l) Instruments shall be calibrated on regular basis

		<p>m) Bidder shall provide all spares/consumable for functioning of Laboratory till completion of O&M period.</p> <p>n) Lab shall be fully functional before commissioning of the plant.</p>
<p>General Notes:</p> <p>a) Tentative Number of I/Os (for PLC) – 2000 Nos. (Combination of 60/40 Digital/Analog I/O respectively). 20% spare I/O shall be provided over and above the actual number of I/Os used in the system.</p> <p>b) Measuring instruments/equipment, analyzers and sub systems offered by the Bidder shall be from reputed & experienced manufacturers/vendors and shall be subject to NTPC's approval.</p> <p>c) Contractor to note that, wherever applicable as per HAZOP study etc, wherever single transmitter is indicated in P&ID for both interlock and indication/control, it shall be replaced with two transmitters, one 4-20 mA + HART transmitter for interlock and one additional 4-20 mA + HART transmitter for indication / control.</p> <p>d) Handheld communicators/ calibrators, Universal type intrinsically safe dust-proof along with battery and battery charger shall be suitable for all make / model nos. of transmitters and positioners. Otherwise, 1 no. handheld configurators shall be provided for each different type of instrument.</p> <p>e) All transmitters shall be intrinsically safe and loop powered. Power supply shall be 24 V DC.</p> <p>f) FRP canopies for field mounted electronic/ electrical instruments e.g. transmitters, positioners, temperature element heads and junction boxes.</p> <p>g) Accessibility of instrument: Any instrument not accessible from grade / platform shall be provided with accessing platform.</p> <p>h) Hazardous area protection for instruments:</p> <ul style="list-style-type: none"> • Intrinsically safe type shall be used in general. • Canopy shall be provided by Contractor for all Analyzers panels/ racks, PRDS. • Barriers (Wherever Applicable): Intrinsically safe barriers: 3-port galvanically isolating type, as applicable. <p>i) Remote/local panel Indicator: Remote or local Indicator in field/Panel Microprocessor based, intrinsically safe, Loop powered type.</p> <p>j) Earthing:</p> <ul style="list-style-type: none"> • Complete field earthing including GI / Copper earthing strip, earth pits & earthing cables for earthing of all Instrumentation items including junction boxes, field instruments, local panel, analyzers, cabinets etc. • GI copper earthing wire, earthing lugs in bidders supplied panels / cabinets in Control Room to main earth pit system shall be in scope of vendor. • Earth pit for system earth (e.g. for PLC System, Analyzer system, CCTV system, UPS System) and general earthing for instruments, equipment etc., as required as per bidder's system supplier/OEM recommendation. <p>k) Junction Boxes:</p> <ol style="list-style-type: none"> Separate JB's for signals for Intrinsically safe & flameproof instruments, Junction boxes, cable glands and accessories required for flameproof instruments shall also be certified flameproof. Junction Boxes for Intrinsically Safe instruments shall be of SS316 and same shall be certified weatherproof. All junction boxes shall have bottom cable entry only. All junction boxes shall be with self-locking type Allen screws (SS 316 make) type fasteners and hinges. Junction boxes shall have tag numbers engraved on front cover with PESO certificate nos. All nuts & Bolts used for the mounting of Instruments & Junction Boxes shall be of SS. For instruments and junction boxes including cable glands, increased safety/ non-incentive concept not acceptable. 		

<p>ix. Field mounted local junction boxes (As per standard and proven practice of vendor)</p> <ul style="list-style-type: none"> No. of ways 12/24/36/48/64/72/96/128 with 20% spares terminals. Material and Thickness: 4mm thick Fiberglass Reinforced Polyester (FRP). Type of terminal blocks: Rail mounted cage-clamp type suitable for conductor size up to 2.5 mm². A M6 earthing stud shall be provided. Protection Class: IP-55 minimum for indoor & IP-65 minimum for outdoor applications. Grounding to be provided. <p>l) Certification for use in hazardous area shall be as follows: Certificates from statutory authorities like Baseefa, FM, PTB, UL, ATEX, CENELEC etc. for items of foreign origin, and from CMRI, ERTL PESO etc. for items of Indian origin.</p> <p>m) For all flameproof equipment manufactured locally (within India), the testing shall be carried out by any of the approved testing houses - PESO/Central Mining Research Institute (CMRI) / ERTL etc. The item shall in addition bear the valid approval certification from PESO and also the manufacturer shall hold a valid Bureau of Indian Standards (BIS) license.</p>
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7.3.8 Impulse Piping, Tubing, Fittings, Valves, Manifolds:

<p>a) 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 details of impulse pipe material and associated fittings and valves are to be submitted in table PCP at the time of detailed engineering.</p> <p>b) Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument.</p> <p>c) 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 ASTM A182 Gr. 316L. The material for bar stock tube fitting (for straight application) shall be 316SS. 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.</p> <p>d) 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.</p> <p>e) 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.</p> <p>f) All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.</p> <p>g) Special accessories such as condensing pots/ reservoirs shall be provided and installed wherever required.</p> <p>h) Color coding of all impulse pipes shall be done by the Contractor in line with the color coding being followed for the parent pipes.</p> <p>i) 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.</p>
<p>Notes:</p> <ul style="list-style-type: none"> Rating of piping/fittings/valves etc. are subject to final process design pressure & temperature and shall be decided during detail engineering.

- Material shall be compatible with that of the impulse pipe material and design parameter.

7.3.9 Instrumentation cable (Minimum Specification):

S.No	Property	Requirement
1.	Voltage Grade	225 V (peak value), armored, FRLS
2.	Codes and standard	All instrumentation cables shall comply with VDE0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472
3.	Others	Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground buried installation. Repaired cables shall not be acceptable
4.	Cross section area	0.5 sq. mm
5.	Conductor material	High conductivity Annealed bare copper
6.	Type of shielding	Al-Mylar tape
7.	Individual pair shielding	A minimum of 2 pair cables shall be supplied. To be provided for F-type cable for analog signals and G-Type for digital signal as per relevant applicable standard.
8.	Outer sheet Material	Extruded PVC compound YM1 with FRLS Properties
9.	Cable accessories of flame-retardant quality	Yes. (Accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc.)
10.	Buried cable protection	Proper bricks caging and Route markers at every 20 Meters along the route & at every bend.
11.	Jointing of cables	Joints for less than 250 Meters run of cable shall not be permitted
12.	Cable clamping	All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray.
13.	Grounding of cable	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 equipment supplied under this package are to be supplied by the Bidder
14.	Cable laying	The Contractor shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Contractor.
15.	Cable conduit	Conduits shall be generally used for interconnecting cables from field instruments to Local JB's. Flexible conduit shall be heat resistant lead coated steel, water leak, fire and rust proof. The temperature rating of flexible conduit shall be suitable for actual application. Conduit sealing, explosion proof, dust proof and other types of special fittings shall be provided as required by these specifications and shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors and in damp locations shall be sealed and gasketed. Contractor shall provide double locknuts on all conduit terminations not provided with threaded hubs and couplings. Watertight conduit unions and rain tight conduit hubs shall be utilized for all the application, which shall be

		exposed to weather. Moisture pockets shall be eliminated from conduits. Conduits shall be securely fastened to all boxes and cabinets.
16.	Cable Duct and tray	<p>Instrument cable duct, fittings and accessories shall be fabricated from GI (Galvanized Iron).</p> <p>Cable ducts shall be supported at the bottom longitudinally on both edges, throughout its length by means of MS channels (minimum 100 mm) to avoid sagging due to cable weight.</p> <p>Cable trays shall be supported at a distance of 1m to avoid sagging.</p> <p>Instrument cable trays, fittings and accessories shall be fabricated from Fiber-glass reinforced plastic (FRP) or GI (Galvanized Iron).</p> <p>The Bidder shall furnish and install the estimated quantities and sizes of perforated trays & sub trays/troughs including all required fittings and adaptors on as required basis.</p> <p>Cable ducts shall have at least 40% spare space and trays shall have at least 20% spare space.</p>
17.	Tagging	Tagging used for cables shall be sleeve type, cross ferruling shall be solid type.
18.	MCTs (Multi Cable Transit)	<p>The MCT shall be provided complete with insert blocks, spare blocks, stay plates, end packing etc. MCT blocks shall be provided with center core with adjustable OD with peeling off arrangement.</p> <p>MCTs shall be sized considering 50% spares for each cable size/ O.D. In addition to installed spares contractor shall also provide 30% spare insert blocks in each cable size/ O.D as loose supply.</p> <p>The MCT should have been tested for water tightness-4 Bar pressure, gas tightness-2.5 Bar pressure, Blast Load-3 Psi minimum as per OISD 163, 2 Hours fire tests as per UL 1479, EI-120 as per BS476 & ASTM E814, IP68 as per IEC60529, and rodents.</p> <p>Power cables for Instruments shall be suitably separated from the other cables and shall be routed through separate MCT blocks. In general the MCT frame considered for instruments shall not be used for electrical cables.</p>
19.	Armoured cables	<p>Armored cables shall be provided, wherever necessary as per the system/process requirement, and shall be in accordance with NTPC approval.</p> <p>All the latest applicable standards shall be followed for these cables.</p>
20.	Cable Gland	Stainless Steel, double compression type suitable for armored cables. Flameproof for flameproof instruments/ junction boxes.

7.3.10 Control Room:

- The Contractor shall provide an integrated design on single point responsibility covering Control room design, HVAC, Firefighting, Lighting, Architectural finishes and associated civil works, Video wall paneling, Color coordination, Acoustics, Human factor Engineering complying ISO 110064, Fire fighting for a modern state-of-the-art control room and its adjacent areas.
- For instrument cable entry to The Control Room, contractor shall provide MCT frames for cables from field/sub-station to control room with MCT blocks and accessories.
- Vendor to ensure that the control room design shall have sufficient space for accommodating all the equipment, control/operation/monitoring devices/Large video screen, seating arrangement as

required, panels/devices any other item etc. also sufficient space for the movement of personnel to be ensured inside the control room and being employed with all the relevant international standards shall be followed as applicable.

d) The details-design/layout shall be reviewed and approved by NTPC during detail engineering.

7.3.11 Close Circuit Television (CCTV) System:

1.	General Requirements	<ul style="list-style-type: none"> To gather video information from the various areas of the various areas of the Plasma gasification, Syngas conditioning/cleaning, Hydrogen Separation, Hydrogen Compression & Storage and Power block. 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 cameras 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: <ul style="list-style-type: none"> a) Video motion detection b) Object tracking c) Object classification & Tracking <p>The feature can be an integral part of camera or part of camera server.</p> <p>Vendor will provide remote Camera monitoring and should be extended to the control room and remote location (distance place other than plant premises).</p> <p>Camera monitoring location will be decided during detail engineering.</p>
2.	Power Supply arrangement	<ul style="list-style-type: none"> 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 (Min 01 hour)
3.	Quantity and Location	<ul style="list-style-type: none"> CCTV system, comprising 26 nos. fixed IP full HD cameras and 04 nos. PTZ IP full HD cameras of reputed make. The exact locations shall be decided during detailed engineering. The Bidder shall refer to General Layout Plan and Equipment Location Plans for the various operational areas of the complete plant.

4.	Application Software for Video Monitoring, Recording & Management	<ul style="list-style-type: none"> • The application software shall be used to display, store, control & manage the entire surveillance system. The software shall be capable of handling 20 % additional cameras over and required the number of cameras specified in each zone. • 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 Contractor. The unit level system shall be connected to at least one no monitor, one no. keyboard and requisite number of servers and cameras. The system shall also have the following provisions. • User friendly spreadsheet/ equivalent format providing the ability to enter camera titles, operator name, timely events, change system parameters, program camera sequences and lockouts. • The software shall support video loss and network loss alarm feature. • The system shall have alarm interface capability. When an alarm occurs in the • Camera/Database Server, the live video output of the camera associated with that alarm shall be switched directly to a predefined monitor/monitors. On screen controls shall be provided to achieve remote operation i.e. PTZ operation of cameras. • The software shall support video loss and network loss alarm feature.
5.	Cameras High Definition (HD)	<ul style="list-style-type: none"> • Digital Cameras shall be provided with NVR(Network video recorder) with all its accessories. • All the cameras shall be color, suitable for day and night surveillance and network compatible. There will be two types of cameras viz. PTZ & Fixed. PTZ cameras shall be high speed integrated dome type. • Image Device - 1/2.8-1/3" Progressive scan CMOS • Lens for PTZ cameras: 4.45-4.7 /89-94.0 mm focal length • Lens for Fixed Cameras: Varifocal Lens f=8-50 mm, CS-Mount • Optical Zoom for PTZ cameras-20x or better • Digital Zoom for PTZ cameras- 12x or better • Number of Pixels/Effective resolution - 1920X1080 (Full HD)/2 MP at 25/30 IPS • Horizontal Angle of view for PTZ cameras- 55.4 deg (wide)- 3.5 deg (Tele) minimum • Back Light Compensation- Required • White Balance- Automatic with mode selection options • S/N Ratio >50dB • Audio- Full Duplex or 2-way • SD/SDHC/SDXC in Fixed Camera (For Local alarm recording & scheduled local recording) -Yes, minimum 32 GB capability • Alarm Input/output- For PTZ cameras: Minimum 2 Alarm I/Ps & 1 alarm output • Alarm Input/output- -For Fixed Cameras: Minimum 1 Alarm I/P & 1 Alarm O/P • Pan, Tilt for PTZ cameras 360 Deg. Continuous ,90 deg.

6.	Other requirements	<ul style="list-style-type: none"> • All the cameras and accessories are to be housed in Weatherproof 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. • Workstation 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 the interconnecting cables between network switches shall be fiber optic only. All fiber optic cables shall be terminated directly to network switches through optical fiber port without using media converters. Bidder to ensure that minimum 100% cores are kept as spares in all type of optical fiber cables. • 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. • Minimum Four (04) core Optical fiber cable shall be used for CCTV system network Architecture. • The CCTV system shall be designed as a standalone IP based network architecture. Exact topology of network architecture (Star /Ring / any other topology) for CCTV system shall be decided during detail Engineering, however, failure of any single cable should not result in loss of more than 3 cameras. Joystick and mouse-keyboard controllers shall be used for Pan, Tilt, Zoom and other functions of desired camera.
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7.3.12 Internet protocol based Public Address System:

- a) Master Control Unit (MCU)- 1 number (in Control room)
- b) Indoor type calling stations- 2 number (with amplifier and loudspeaker)
- c) Outdoor type calling station-4 number (with amplifier and loudspeaker)
- d) Acoustic hood- 2 numbers, Server (VOIP- voice over IP technology), PC Station, Network witches, Layer-III Switch/Router, Software(s) for PA system- on as required basis.
- e) All the other items- hardware, software, licenses, including public Address system erection hardware, all type of cables, cables (armored), 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.
- f) 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.
- g) 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.

- h) IP based PA system and sub systems offered by the Bidder shall be from reputed & experienced manufacturers/vendors and shall be subject to NTPC's approval. The Bidder shall guarantee satisfactory performance of the equipment under stipulated variations of voltage and frequency.
- i) Calling stations: Outdoor type IP-66, Indoor type IP-32 as per IS/IEC:60947-1.
- j) Power Supply Arrangement: UPS and any other power supply requirement for the complete system to be provided by bidder. UPS shall be provided with minimum 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.)

7.3.12 Fire Detection & Protection System:

a) Scope of supply & services:

The scope includes Engineering, Supply, Construction, Erection, Testing and Commissioning of Fire Detection and Protection System. The scope of equipment to be furnished and erected under this specification shall cover all the systems and equipment's detailed hereunder.

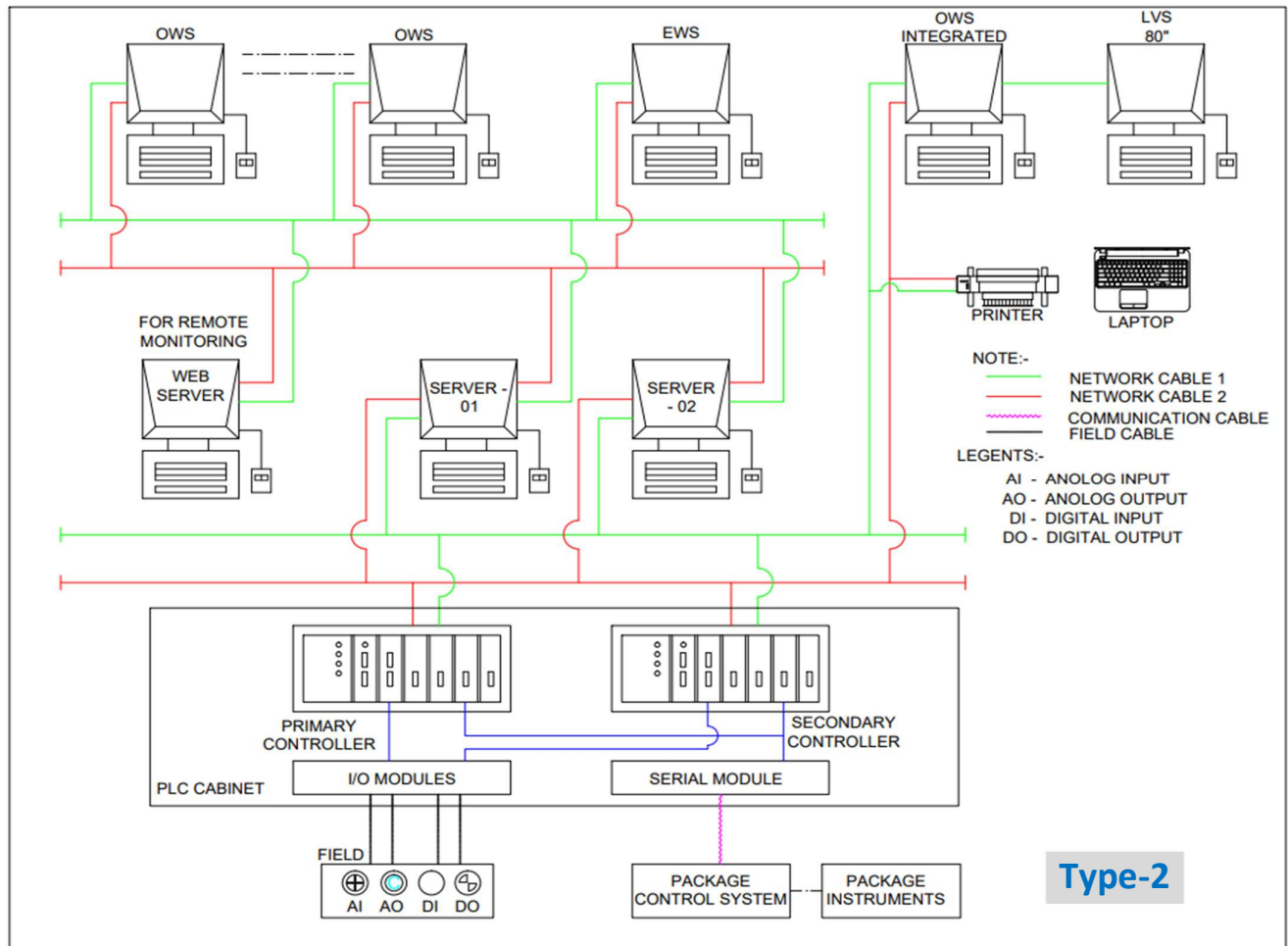
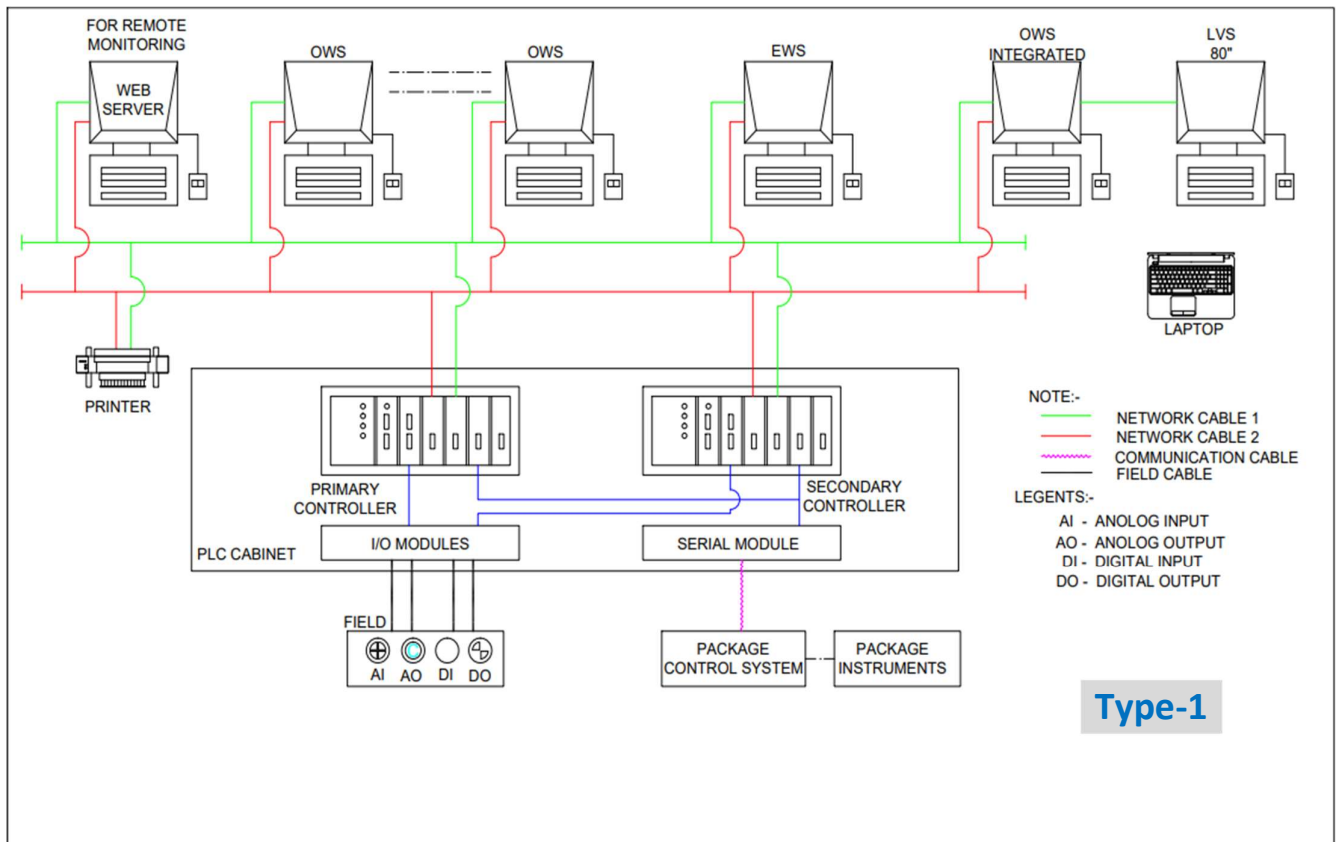
b) Fire Detection and Alarm System:

- Analogue addressable type Fire alarm system consisting of multisensory detectors, cabling, junction boxes, instrumentation, fire alarm cum control panel etc for various area/equipment shall be provide for plant area shall be provided.
- The fire alarm cum control panel shall also be interfaced with main office (NETRA) fire station for information exchange.
- Any other necessary items required for the system shall be provided by the contractor.

Note:

The above specifications are for tender and indicative purpose only. Further details shall be finalized during detail engineering of project after award of contract.

7.3.13 Distributed System Architecture:



7.4. Technical Specifications – Civil:

The scope of civil works to be furnished and constructed under the contract is detailed herein. The items, though not specifically mentioned, but are needed to make the system complete shall be treated as though included and the same shall also be furnished and erected/ constructed unless otherwise specifically excluded. Broadly, the scope of contractor shall include following:

1. Geotech investigation and Soil Bearing Test (SBT), shall be carried out by Bidder through NTPC approved Geotech agency as mentioned in Table.1
2. The bidder shall carry out detailed Topographical survey as required for the entire plant area.
3. Site clearance & disposal including cutting of shrubs and trees, including 'tree cutting permission and any related payment thereof, if any' shall be in the scope of the bidder.
4. Site Levelling and grading of site of total plant area. Ground level of complete land Plinth level of the Project shall be raised up to level 300 mm below the level of NETRA Hostel Car Portico. Supplying, filling, and compacting of good earth shall be in the scope of Bidder. The filling shall be done in layer of thickness not exceeding 300mm with watering, rolling, and ramming by manual methods/mechanical compactors to grade and level as mentioned, to obtain 95% of maximum laboratory dry density. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary, instruments, materials, access to works, etc., to the engineer for general checking of the correctness of the civil works.
5. Supply of all materials, tools & tackles, safety equipment, personal protective equipment, appropriate and adequate manpower required for construction of this plant.
6. An Air-conditioned control Room (8mX10m min) to accommodate PLC, HMI, Operation Desk, CCTV, UPS, PA system, etc. A switch gear room (9mX15m min) sufficient to accommodate all required equipment. Rest Room (9mX10m min) for workers. Laboratory and storage space (6mX12m min.) of sufficient capacity with washroom and pantry. All the room sizes mentioned above are indicative and for tendering purpose only. Final room size shall be finalized during the stage of detailed engineering. The firefighting system shall be provided as per guidelines of the statutory regulatory bodies.
7. Filled up area shall be retained properly by providing boundary wall up to HPP level with RCC columns at 3.0m c/c distance with suitable foundation, with brick infill of 345mm thick supported on the RCC beam between the RCC columns provided at founding level or stone pitching with slope.
8. Periphery fencing/ boundary-PVC coated barbed wire (min 2.5 mm wire Dia) all along the boundary of site with concrete support pillar at suitable interval and a gate of suitable size along with guard cabin.
9. RCC foundations of at least M25 grade for all modules, utilities, stationary and rotating equipment.
10. Structural Steel Work: Industrial Shed sufficient to accommodate gasifier, all critical equipment and associated Electrical and Control systems as per vendor's proven practice. Industrial shed/ Canopy required to cover critical equipment as per standard practice. 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.
11. Maintenance accesses platform with ladder, railing and toe guard for all main equipment, gates and valves.
 12. Plinth Protection, Storm water drainage system in and around all structures covered under this contract and connecting to the nearest owner's storm water drain.
 13. Storm water basins shall be provided at different locations of the complex to prevent runoff of contaminated water into adjoining areas during rains.
 14. Pits and associated civil work for Effluent Treatment Plant.
 15. Cable ducts/ slits, cable trenches with covers, along with associated foundations etc. wherever required,
 16. All pipe and cable supporting arrangement/ structures, pipe and cable trenches, duct banks, crossings etc.,
 17. All culverts associated with pipeline crossings across roads, embankments, channels, boundary wall, drains etc.,
 18. All steel embedment, insert plates in the civil structures & for cable routing.
 19. Monorails of adequate capacity with monorail girders and fixtures etc. to be provided for compressor and other equipment as per requirement.
 20. Roof rainwater to be collected and connected to nearby common drain / rain water harvest point if available - else bidder has to make arrangement for the same.
 21. Grouting of all equipment, steel/cast iron inserts, plates, bolts, nuts, and sleeves.
 22. Suitable covering / shed of all critical outdoor equipment and control panels as protection against rain.
 23. All excavation work required for erection, support structure, cable trenches and backfill the same after completion of work.
 24. Disposal of surplus excavated soil outside the site boundary as directed by NTPC.
 25. Construction of temporary office, store, workshop, laboratory etc.
 26. All other structural steel & RCC work required for completion of the project.
 27. Road Work: All roads 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.
 28. 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.
 29. Dyke / Containment Berm: to be provided for Tank Storage area. Dyke / Containment Berm shall comply with the stipulations of PESO and OISD with dyke wall height of 1M (minimum).
 30. Process area and Utility area shall be Paved RCC flooring.
 31. Plot plan indicating NGL/FGL/HPP & coordinates of building/equipment to be submitted.

32. Painting:

- a) All painting on masonry or 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. Colour shade shall be approved / accepted by NTPC.
- b) All Steel surfaces shall be provided with 2 coats of Inorganic Zinc Silicate Primer Coat (Solid by Volume Minimum 60%) of Minimum 75 Micron Dry Film Thickness (DFT) applied over blast/ wire brush cleaned surface to near white metal. Finish Coat shall be followed with the application of Final Finish Coat of Polyurethane based colour pigmented Paint (Solid by Volume Minimum 40%) of Minimum 30 Micron DFT. This Coat shall be applied within Seven (7) days (from the completion of Finish Coat) after Erection by brush and/ or spray. Paint shall be of NTPC approved colour and shade.
- c) 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.

33. Materials:

- a) Cement for all applications shall be Ordinary Portland Cement (OPC, Grade-53/43) conforming to IS: 8112 or Fly ash-based Portland Pozzolana cement conforming to IS: 1489 (Part-I) and / or any other type of cement meeting IS: 456 requirements.
- b) 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.
- c) 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.
- d) Structural Steel: Structural steel (including embedded steel) shall be straight, sound, free from twists, cracks, flaw, laminations, and all other defects. Unless otherwise specified all structural steel (including open grating and raised pattern plates, shapes, bars, hollow sections) shall be 350 MPA quality BR confirming to IS: 2062. All structural pipes shall conform to IS: 1161, GRADE YST-310. Structural pipes shall be either seamless or mild welded.
- e) 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.

34. Design Standard:

- a) RCC Design: RCC structures as per IS: 456 2000. Reinforcement as per IS: 5525 and SP: 34.
- b) Steel Structure Design: The design of steel structures shall be done by the Limit state method. Design and fabrication shall be as per provisions of IS: 800 and other relevant IS..

- c) Architectural Design: As per National Building Code and Local building by-laws as applicable including provisions of the Factories Act of the State concerned.
- d) Earthquake Resistant Design: All structures and equipment shall be designed for seismic forces in accordance with IS: 1893 (Part 1 to Part 4). 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%.
- e) Wind Resistant Design: All structures shall be designed for wind forces in accordance with IS:875 (Part-3). The damping factor (as a percentage of critical damping) to be adopted shall not be more than the following: (i) Welded Steel structures-1%, (i) Bolted Steel structures-2%, (iii) Reinforced Concrete structures-1.6%.
- f) Earthing & Lightning protection of Buildings as per relevant IS codes.
35. At the stage of detailed engineering, contractor shall provide drawings for approval of NTPC, alongside necessary calculations. All reference drawings required for completion of civil structural works shall be approved in CAT2/CAT1 by Owner.
36. Review by owner shall not relieve the contractor of his responsibility for correct design and execution of the work.
37. 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.

Table-1			
S. No	Name of enlisted Agency	Address	. Contact Details
1.	M K SOIL TESTING LABORATORY PRIVATE LIMITED	Survey No. 4-4, Bharti House, Near Chanchalbag Party Plot Opp. Jhanvi Bunglows, Bodakdev, Ahmedabad, Gujarat 380054	Mr. Parag Rajnikant Dave info@mksoil.com 9824040212 07929702174
2.	SECON PRIVATE LIMITED	Plot No. 147, 7 'B' Road, EPIP Zone, Whitefield, Bangalore, Karnataka, 560066	Mr. RAM KISHORE SURI feedback@secon.in 9591037542 080-41197778
3.	C. E. TESTING COMPANY PVT. LTD	124-A, N.S.C Bose Road, Kolkata, West Bengal, 700092	Mr. Pranab Roy marketing@cetestindia.com 8697738373 03324286221
4.	CENGRS GEOTECHNICA PRIVATE LIMITED	A-100, SECTOR-63, NOIDA, Uttar Pradesh, 201309	Mr. Sanjay Gupta contact@cengrs.com 9810138095 01204206771
5.	SOIL ENGINEERING CONSULTANTS	B-310, Ansal Chambers -1 Bhikajicama Place New Delhi ,110066	Mr. AVS RANGARAO soilengg4@gmail.com 9810096793
6.	KCT CONSULTANCY SERVICES	KCT House, Beside AUDA Water Tank, behind Silver OAK College, S G Road, GOTA, Ahmedabad, Gujarat, 382481	Mr. K C Thaker kctconser@yahoo.com 9825064378 8320633275

7.	CEG TEST HOUSE AND RESEARCH CENTRE PRIVATE LIMITED	CEG Tower, 1st Floor, B 11 (G), Malviya Industrial Area, Jaipur, Rajasthan, 302017	Mr. AMIT JAIN tenders@cegtesthouse.com 7300098660 7339745333
8.	GEOMARINE CONSULTANTS PVT LTD.	11, Kannappa Nagar, Thiruvanmiyur, Chennai, Tamil Nadu, 600041	Dr.C.V.Prasad info@geomarineindia.com 9444026189 9790850971
9.	SOILTECH INDIA PRIVATE LIMITED	Ramtekdi Industrial Area, Lane No.7 hadpasar, Pune, Maharashtra, 411013	Mr. Subodh Kulkarni info@soiltech.in 9823064490

8. List of reputed manufacturers:

S.No	Item	Supplier
1.	Control Valves	B T G Calle/CCI/Copes Valcun/Dresser Masonelian/Emerson (Fisher Controls)/Fisher Xomox/IL/Kumeh/MIL controls India/Motomaya Nippon Fisher
2.	Coupling relays	ABB (H&B)/Elesta/Jyoti/OEN/Omeron/Paramount
3.	Digital Indicators	ABB/AE/FOXBORO/Gossen / metrowatt/camille auer/ Masibus/ Meco Instruments/Weigell /Messgerate/Yokogawa
4.	E/P Converter	ABB/Eckardt/Emerson/Fairchild/IMI Norgen
5.	Electrical Actuator	AUMA/EMG/Limitorque/Nippon Gear/RotorK/ Shimadzu Corporation
6.	Electrical Indicating Instruments (Mosiatic Compatible)	GANZ Gossen / Metrowatt / Camille Bauer Weigell Messgerate
7.	Impulse Pipes/Tubes	Trouvay & Cauvin/Veluric & Manessmann/BHEL ISMT (CS only)/Maharastra seamless (CS only)/ Sumitomo / Kawasaki / Nippon/ TPS Technitube
8.	Instrumentation cables	Cords/Delton/Finolex/Fujikura Ltd/Furukawa Electric Company Ltd/Habia cables engineers/I ncab/ Nicco/ paramount cables/ Polycab/ Reliance Engrs./Universal Cable
9.	Level transmitter (DP type)	Chemtrols/ Dresser/ Masonelian/Eckdart/Yamatake/ Honeywell
10.	UPS 5KVA	D B power/Gujrat Hirel/APC/APLAB/Emerson (Tata Liebert)
11.	OVS	Compaq / HP/Dell/Lenevo (IBM)
12.	PLC System	ABB/Cegelec/ GE Intelligent Platform/ Honeywell/Rockwell Automation/ Schneider/ Siemens/ Tata Honeywell
13.	Power supply	Aplab/E M Electronics/Starvox
14.	Pressure / D P / Flow Transmitters	Fuji Electric/ABB/Emerson Process Mgt/Honeywell/Tata Honeywell/Yokogawa
15.	Pressure Gauge	A N Inst/Auxitrol/Bells Controls/Budenberg/Dresser / Ascroft/ General /nst. Consortium/Gluck/Goa Thermostatic/ Helicoid/ Manometer/ Nagano Kieki/Nievo Fima/Switzer/WIKA/Wise control/ H Guru (SI)
16.	Solenoid valve	ASCO/Avcon/Herion/Jeffarson/ Rotex
17.	Temperature Transmitter	Emerson/Yokogawa/Moore
18.	Thermocouple / RTD	ABB/Altop/BICC/Degussa/Detriv Instruments/Emerson (Rosemount)/General Inst. Consortium/Heraus/Honeywell/ISA control/Jindal Leeds & Northup/Minco/Pyro-electric/Thermo/Electric/Yamari
19.	Valve Manifolds	Anderson Greenwood/Baldota/Excel Hydro/Hamlet/ Aura/ Swagelock/ Parker/D K Tek/Hy Lock/Micro Precision/Schneider
20.	Computer furniture	Featherlite/Godraj & Boyce/OTS office Take/PAN Office system/ Pyrotech
21.	MPCB	Larsen n Toubro/Control & Switchgear/GE/Siemens
22.	MCCB	Larsen n Toubro/Control & Switchgear/GE/ Siemens
23.	MCB	Standard/Seimens/Indocop/L&T/MDS/GE
24.	Switch fuse unit	Control & switchgear/Larsen n Toubro/Siemens
25.	HRC fuse link, fuse base	Control & switchgear/Larsen n Toubro/GE/Siemens
26.	Contactora	Control & switchgear/Larsen n Toubro/GE/Siemens
27.	Overload relay	Control & switchgear/Larsen n Toubro/ Siemens
28.	Indicating instruments	MECO/AE/Rishab/IMP

29.	Current Transformer	Incoil/Precise/Pragati
30.	Control Terminal block	Wago/ Phoenix/ Elmex
31.	KwH meter	ELSTER/SEMS/Conserv
32.	Isolation transformer, Control supply transformer	Kappa/AE/Ind coil/Pragati/ Jyoti
33.	Ammeter, voltmeter	Rishab/AE/IMP/MECO
34.	Indicating lamp	Seimens/Technik/BCH/Vaishno/Concord
35.	415V ACDB	Control & switchgear/L & T/GE/ABB/Unilec/Hindustan control/ Switching circuits/Control devices
36.	Motors	ABB/CGL/Marathon/KEC/Seimens/BBL/LHP/KEC
37.	Variable Frequency Drives (VFDs)	ABB/simens/schinders/Danfoss
38.	Bus coupler, LV panel	GE/L & T/Control & switchgear/
39.	LT Power cable & control cable	Polycab/KEI/Nicco/HVPL/JEMS cab/ Havells/Torrent cables/ Cords cable /Sriram Cable/Universal/Delton/Paramount
40.	PLC control panel	Rittal/Pyrotech
41.	Centrifugal Pumps	B & C/ Kirloskar/KSB/Mather & Platt
42.	Piping -ERW	Jindal/Tisco/SAIL/Surya Roshni/Welspan/MSL/Indus Tube
43.	Valves	BDK/Forbes Marshall/Audco
44.	Inline Booster Pumps	Armstrong/Crompton Greaves/ITT
45	Floor mounted Draw out type indoor/outdoor LT Switchgear Panel.	L&T
		GE
		C&S Electric
		Schneider
		ABB
		Siemens
46	LV Air Circuit Breaker	C&S Electric
		L&T
		GE
		Siemens
		Schneider
47	Floor mounted Fixed type indoor/outdoor LT Switchgear Panel (ACDB/ DCDB/MLDB/BMK etc.)	Switching Circuits
		Maktel
		Vidyut Control
		Adlec Power
		Pyrotech
		Conquerent Control System
		Control & Schematics
		Positronics
		Anand Power Ltd.
		Voltech Manufacturing Company

48	Wall mounted fixed type indoor / outdoor LT Switchgear non-compartmentalized Panel (Lighting panels / AC/ DC Fuse boards etc.)	Control Devices
		Jasper
		Havells
		Novateur Electrical & distribution
		Avaid Technovator
49	LT CT/PT/CBCT/Control Transformer	Kappa
		Southern Electric
		Precise
		G&M (CBCT Only)
		Silkaans
		Ind Coil
		Pragati
		Prayog
		AE
50	HT Cable	Universal Cable Ltd.
		Torrent Cable Ltd
		Polycab Wires Pvt. Ltd
		KEI Industries
		Havells India Ltd.
		Apar Industries
		Finolex
		KEC International
		Gupta Power
		Paramount
		Gemscab
		Sterlite
51	HT Cable Termination Kit & Straight Through Jointing Kit (Heat shrinkable type)	3M Electro & Communication
		Raychem
52	1.1KV LT Power Cable	Universal Cable Ltd.
		NICCO
		Torrent Cable Ltd
		Incab
		Polycab Wires Pvt. Ltd
		KEI Industries
		Havells India Ltd.
		Sri ram Cables
		Krishna Electrical Industries
		Apar Industries
		Finolex
		KEC International

		Tirupati Plastomatics
		Gupta Power
		Paramount
		Gemscab
		Sterlite
53	1.1 KV Control Cable	Universal Cable Ltd.
		NICCO
		Torrent Cable Ltd
		Incab
		Polycab WiresPvt. Ltd
		Hindustan Vidyut Products Ltd
		KEI Industries
		Delton Cable Ltd
		Paramount Cable
		Gemscabs Industries
		Cords Cables
		SPM Cables
		Elkay Telelink
		Havells India Ltd.
		R.R. Kabel
		Ravin Cables
		Gupta Power cable
		Thermocables
		Finolex
		Sbee Cables
		Suyog Cables
		Scot Innovation wires and
		Cables
54	EHV Cable	Diamer Kabel
		KEC
		Iljin Electric
		KEI Industries
		Phelps Dodge
		Universal Cable Ltd.
55	Lighting fixtures with accessories including lamp (Filament type & LED type)	Crompton
		Bajaj Electricals
		Philips
		Wipro
		Surya Roshni
		Goldwyn
56	MCB Boxes/Junction boxes / Link Boxes/ Test Link Box/ Adopter box, Switch Boxes, Pull Boxes (Hot Dip Galvanized)	I. Main Contractor approved sources including galvanization II. BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.

57	Industrial /welding receptacles & boxes	Schneider
		BCH
		Ajmera
		Sakthi & Crown
58	MV Switchgear Panel	BHEL
		L&T
		Siemens
		ABB
		Schneider
59	MV Vacuum Type Circuit Breaker	Siemens
		BHEL
		L&T
		ABB
		ABB
		Schneider
60	IEC 61850 compliant Numerical Protection Relays	SEL
		ALSTOM T&D
		ALSTOM T&D
		ABB
		ABB
		GE Multilin
		Schneider
		Siemens
		Siemens
61	Single Rod Air Terminal Lightning Arrestor	Main Contractor approved sources: subject to manufacturer / supplier having valid Type Test Report as per IS 2309: 2005 or equivalent Standard
62	ESE Lightning Arrestor	Main Contractor approved sources: subject to manufacturer / supplier having valid Type Test Report as per latest version of NFC 17-102 & country of origin documents
63	Lighting Poles	Main Contractor approved sources (BIS Licensee as per IS 2713 of 2018)
64	Cable Lug, Gland	Dowell
		Billets Elektro Werke Ltd.
		(3 D)
		Chetna

65	GI Cable Tray, fitting, accessories including bends.	Inar Profiles Ltd
		Vatco
		Indiana cable trays
		Industrial Perforation
		Ratan Projects
		India Electric Syndicate
		Sterlite engg.
		Premier Power Products
		Indiana Gratings
		M.J. Engineering
		T.R.G
		Amtech
66	Cable Tray Flexible Tray Support System	Vatco
		Inar profiles
		Industrial perforations
		Premier power products
		Sterlite engg.
		Indiana gratings
		Amtech
		Ratan Projects
		MKSD Industries
		Maheshwari Electricals Manufacturer Pvt. Ltd
		Indmark Formtech
		Patny Systems
67	Circuit Breaker (outdoor type)	Siemens
		ABB
		CGL
		BHEL
		GE T&D
68	Isolator (outdoor type)	GR Power
		Hivelm
		S&S Power
		Switchgear & Structural
69	CVT/PT (Outdoor Type)	Mehru

		M/s Mehru Electrical and Mechanical Engineers Pvt Ltd
		Vishal Transformer
		Heptacare
70	CURRENT TRANSFORMER (Metering/ Protection)	GE T&D
		ABB
		CGL
		BHEL
		BHEL
		Heptacare
		Mehru
71	Surge Arrestor/LA	Oblum
		Lamco
		ELEKTROLITES
		CGL
72	Disc Insulator/Pin Insulator/ Long rod insulator	Aditya Birla
		IEC
		WSI
		BHEL
		Imperial Ceramics
		SARVANA
73	Bus Post Insulator	Aditya Birla
		IEC
		WSI
		MODERN Insulator
		SARAVANA Global Energy
74	Aluminum tube	HINDALCO
		INDALCO
		CENTURY EXTRUSIONS
		JINDAL ALUMINUM TUBE
		ALOM EXTRUSIONS
		BALCO
		SUDAL
		Banco
75	Switchyard Control & Relay Panel / SAS (including GPS and Network components)	GE (Alstom)
		Siemens
		ABB
		Schneider
		BHEL

76	Numerical Relays for Switchyard	GE
		Siemens
		ABB
77	Transformer (Oil filled type)	BHEL
		GE(T&D)
		Toshiba
		TELK
		ABB
		CG Power & Industrial Solutions Ltd.
		EMCO
		BHEL
		Schneider
		T&R
		Kanohar
		EMCO
		Kirloskar
		Andrew Yule
		Tesla (unit 2)
		Indotech Transformers
		Hammond Power Solutions
		CG Power & Industrial
		Voltamp
		RAYCHEM RPG
		Esennar
78	Dry Type Transformer	ABB
		Raychem
		BHEL
		Kirloskar
		Voltamp
		Hammond Power
79	RMU (Ring Main Unit)	SIEMENS
80	BUSDUCT-ISOLATED PHASE (MV BUSDUCT)	BHEL (CEP)
		C & S ELECTRIC
		REEP INDUSTRIES PVT LTD
		POWERGEAR LTD
81	LT Bus Duct (Insulated Sandwiched Type)	C&S Electric
		Henikwon
		Jasper Engg Ltd

		Schneider
		KGS
		L&T
82	LT Bus Duct (Air Insulated NSPBD)	C&S Electric
		Schneider

Note: Bidder shall also obtain approval of manufacturer/ sub vendors for all equipment required in the package from NTPC.

9. Supply of Feedstock:

S. No	Description	Parameter
a.	MSW-RDF / Agri-waste to be transported in a covered vehicle meeting SWM 2016/Motor vehicle act/applicable regulatory norms;	
b.	MSW-RDF / Agri-waste received at plant gate shall be measured at the weigh bridge;	
c.	Bidder shall have to maintain a stock of raw materials of minimum five days of operation of plant at full capacity;	
d.	Bidder to ensure MSW-RDF / Agri-waste being fed to the gasifier meets the quality specification in terms of particle size, ash, moisture and GCV as required by the gasifier;	
e.	Bidder's pre-processing system has to ensure required quality of MSW-RDF / Agri-waste as per need of the gasifier is produced;	
f.	Representative sampling at the inlet of gasifier will be done thrice a day;	
g.	Analysis of representative sample shall be carried out jointly by NTPC & bidder in the Lab set up at site.	

10. Comprehensive Operation & Maintenance of Plant

1	Plant Operation & Maintenance	<ul style="list-style-type: none"> a. The gross and net generation from the plant shall be logged in the PLC/Control room b. Comprehensive O&M includes operation & maintenance of the plant/system right from RDF receiving/ weighing. c. This also includes safe and reliable O&M of all related auxiliaries, electrical, mechanical, C&I systems, Civil maintenance, effluent system, firefighting system, storage/handling of Ash/char/etc,, transferring of inerts segregated from RDF back to source, laboratory testing/up keeping and housekeeping. d. Compliance of emission norms as per SWM rules 2016/CPCB/ UPPCB norms as applicable and other statutory guidelines and its renewal e. Bidder shall ensure proper working of its RDF pre-processing system to achieve designed quality RDF as required at the inlet of bidder's gasifier.
3	Spares, Consumables, Tools and Tackles	<ul style="list-style-type: none"> a. Procurement, supply, maintain & record of the consumables, chemicals, fuels (diesel/petrol/PNG), calibration gases, spares, tools and tackles required and consumed for the plant for the complete O&M period b. To provide adequate manpower for effective O&M of the plant for the contracted period c. Any equipment and services that are not clearly specified but required for effective O&M of the plant shall be in the scope of the bidder.
4	Other Consideration	<ul style="list-style-type: none"> a. The vendor shall, at all times, ensure that all aspects of the plant and the processes employed in the operation and maintenance of the plant facilities shall conform to the laws pertaining to environment, health and safety aspects including all regulatory norms; b. The contractor shall ensure operation of the plant on 24 by 7 basis with all necessary input (man, machinery, material, consumable, electric power, testing, record keeping, spare etc..) on time, without delay and maintain the plant premises and install suitable safeguards and facilities as approved by the

		<p>Engineer-in-Charge from NTPC for meeting general environment requirements;</p> <p>c. Emission parameters shall as per Indian SWM rule 2016/CPCB/UPCB norms;</p> <p>d. Make arrangements to dispose off the inert/solid waste material segregated from the received RDF preferably using the empty vehicle used for delivering RDF to site;</p> <p>e. All repairs and maintenance activities are to be conducted by qualified technicians/engineers only;</p> <p>f. NTPC Ltd reserves the right to insist on usage of original spare parts;</p> <p>g. NTPC Ltd reserves the right to refuse unsatisfactorily qualified technicians/engineers to con/duct repairs and maintenance activities;</p> <p>h. All vehicles and equipment shall be kept in good working order and serviced regularly to maintain the healthiness and noise levels within reasonable limits;</p> <p>i. Control the movement of all vehicles so as to minimize disruption to regular users of the routes;</p> <p>j. During defect liability period, the vendor shall need to replace the equipment / part which is required to achieve the satisfactory performance of the plant on free of cost;</p> <p>k. Establish and maintain a laboratory capable of measuring the various parameters required for proper operation of the plant such as gas composition, proximate analysis of MSW-RDF (GCV and Moisture), Tar measurement.</p> <p>l. The vendor shall prepare and submit to NTPC Daily, Monthly, quarterly and yearly plant performance reports.</p>
5	Project Manager	The bidder shall appoint a facility incharge who will be responsible for all contractual, legal and regulatory aspects related to O&M of plant.
6	Manpower	<p>a. The bidder shall provide adequate numbers of suitably trained staff to complete the scope of work for comprehensive O&M as mentioned above.</p> <p>b. The number of staff to be provided shall be submitted to NTPC to evaluate the adequacy of given manpower to complete the scope of work for comprehensive O&M as mentioned above.</p> <p>c. In case the number of manpower is found to be inadequate or not properly skilled, the vendor shall engage appropriate and competent staff to complete the job.</p> <p>d. The contractor/bidder shall follow all statutory applicable norms labour/factory act with respect to leave, wages, PF, bonus, Medical, Insurance, etc.</p>
7	Safety	<p>a. The bidder should design and follow a safety system and procedure to ensure a safe workplace for man and machine during the O&M period;</p> <p>b. All necessary PPE shall be provided by the bidder to its work force and will ensure everybody wears the same inside plant/project premises;</p> <p>c. Safety belt to be provided by contractor and shall be used when working at height;</p> <p>d. The bidder shall be responsible for all security, environment and safety aspects of plant at all times during the entire award period;</p> <p>e. A protocol for reporting unsafe incident/near missed/accident shall be forwarded to NTPC for approval which needs to be strictly followed during</p>

		O&M period. The services and equipment which are not mentioned above but required for safe operation of plant shall also to be supplied by the vendor.
8	Miscellaneous Scope	<ul style="list-style-type: none"> a. Preventive maintenance and routine breakdown shall be taken care of by the bidder. However, if any specialist/OEM personnel need to be called at site for replacement/installation of equipment/instrument requires outsourced manpower, the charges shall be borne by the bidder; b. All periodic testing, calibration, hydro-test, pneumatic testing, pipelines, equipment will be arranged by bidder & cost will be borne by bidder; c. Any charges regarding the testing of sample other than daily routine analysis (done in site lab) from external agency shall be borne by bidder; d. The contractor and his workman shall ensure all necessary safety precautions and equipment. NTPC shall have no liability in this regard; e. Maintain the entire plant area in an acceptable environment by regularly spraying permitted sprays to avoid any foul smell / odour / control flies. Paramount importance to be given to ensure all these activities are carried out in a healthy environment in the plant so as to provide a clean and foul (smell) free / dust free / free of flying bird in and around the plant facility; f. Register vehicles used for transportation of RDF with the concerned Government agencies and ensure that all taxes are paid up-to-date on such vehicles; g. The agency shall maintain logbook (for keeping records of activities performed during work hour and for recording of the complaints being received). The party may be asked to maintain other records that may be required as and when required.

