HTDC OSBL Onshore Contract

Schedule 1

Employer's Requirements

Contents

Employer's Requirements

The Contractor's scope of work includes the engineering, procurement, construction, erection, pre-commissioning, the rendering of construction, supervision, supply of labor, construction equipment, construction utilities, temporary materials, structures and facilities, the transportation including, without limitation, unloading and hauling to and at the construction site as specified in the Contract or elsewhere in the project specification and in the work procedures.

1. Basic Scope

1.1 Engineering of the complete scope independently, which shall include all disciplines: Civil, Mechanical, Electrical & Instrumentation.

1.2 As-built drawings preparation for plant layout, pipe racks, structure, piping, electrical works, instrument works, and further civil and mechanical works, within the scope of the Contractor to be covered as part of design engineering.

1.3 Procurement of all required material as per engineering data and drawings, reviewed and approved by the Employer.

1.4 Inland transportation and rigging for Materials and Plant from local vendor shop / warehouse and site laydown yard to Construction Site.

1.5 Erection, construction, pre-commissioning, SAT and performance test support including, but not limited to, following main elements, sub-systems and constructions:

- 1.5.1 Civil works for foundations of pipe racks, supports, electrical DBs, equipment etc.
- 1.5.2 Piping works for process, utilities, firewater, drains, etc. circuits.
- 1.5.3 Metal structures for equipment and Plant, complete with platforms, monkey ladders, staircases, railings, etc.
- 1.5.4 Surface finish and painting of piping, structures, etc. as per EPCL's painting management manual specification.
- 1.5.5 Installation of Flange guards on Critical Hydrocarbon Process Service flanges.
- 1.5.6 Cabling from base plant MCC/CCR room to HTDC on pipe rack.
- 1.5.7 Safety Shower, eye washer and other safety equipment
- 1.5.8 Lighting system
- 1.5.9 Cathodic protection and its integration with base plant system.
- 1.5.10 Heat Tracing of piping as per requirement.
- 1.5.11 Insulation of piping as per requirement.
- 1.5.12 Installation of steel structure including gratings, monkey ladders, railings and toe boards (where required).
- 1.5.13 Painting, tagging, insulation and fireproof coating. Tag paining of Electrical and Instrument equipment is included in scope.

2 Scope details

2.1 Engineering:

2.3.3 Piping design from tie in point from existing EPCL base plant up to battery limit of HTDC Unit

2.3.4 Finalization of piping route as per site conditions. Piping route should be optimized to avoid area hindrances, excessive pressure drops, excessive pipe runs etc.

2.3.5 Existing pipe racks adequacy check

2.3.6 Design of new pipe racks (where required)

2.3.7 Design of civil foundations

2.3.8 Evaluation of existing civil foundations (where required)

2.3.9 Piping layouts and piping isometrics generation

2.3.10 Piping hydraulics study, piping stress analysis (including tie-in point from existing piping making sure no extra load is transmitted to existing piping/structure without getting addressed), pipe supports design, provision of drain, vents, steam traps etc.

2.3.11 MTO generation and issuance of IFC drawings

2.3.12 As-building of existing facilities where required for engineering input (where required)

2.3.13 Contractor shall submit a list of mechanical deliverables + software used together with bid (it will include Final TPs with as-built ISO, PID & all QC record, Painting/Sandblasting Dossier, MTCs, Procurement Dossier, Piping Plan, 3D Model, etc.)

2.3.14 3D model shall be developed and reviews for constructability, operation and maintenance shall be done

2.3.15 Piping, painting and insulation spec. of existing plan shall be used

2.3.16 Native files of all engineering documents shall be shared with the Employer.

2.3.17 Timely scaffolding on Tie-In location for Inspection (Thickness Monitoring etc. & in case of any Quality issue same will be taken up by Contractor)

2.3.18 As a result of hydraulic calculation any change/addition of equipment/pump/motor is observed will be taken up by Contractor as a complete workable solution with engineering of same is already covered in this scope while procurement and construction after following agreed terms.

2.3.19 NACE to be followed on all underground piping.

2.3.20 Any work done by Contractor will not be based on EPCL shared documents & all data will be taken from Field (existing Plant / construction facility) by Contractor himself (Pipe Rack Drawings, Piping Layouts, Underground Layout etc.)

2.3.21 In order to confirm UG piping location Contractor will make test pits.

2.3.22 Piping Connections of all Process/Critical Piping shall be welded. While for non-process piping the use of flanged joints in pipe rack systems shall be minimized.

2.3.23 All valves requiring regular attention by the operating and

maintenance personnel should be readily accessible.

2.3.24 Double block and bleed arrangement to be provided by the Contractor at tie-in / boundary limit point OSBL and ISBL.

2.3.25 3D Model of whole OSBL scope (including Tie-ins Point, Foundation/Structure Strengthening etc.)

2.3.26 Line Spacing will follow guidelines as per attached EP-5-1-2.

2.3.27 All tie-ins execution on immediate suction and discharge spools of rotating equipment to be recycled with Expansion Machinery in advance & sufficient resources mobilized by the Contractor (after due approval).

2.3.28 Procedure for any modification/amendment on rotating equipment piping to be recycled and approved

2.3.29 Procedure for any modification on or near a rotating equipment foundation or support to be recycled and due approval taken before proceeding with the field execution.

2.3.30 Line weight or change of Nozzle loading as part of provision of additional tie-in/piping to be considered with respect to existing installations.

2.3.31 Design and construction of chemical drain channel connecting HTDC ISBL with EPCL base plant.

2.2 Procurement:

2.2.1 Contractor's scope shall include all project procurement of material required for the complete construction of HTDC OSBL project

2.2.2 Procurement of piping bulk material including all pipe fittings as per piping isometrics

2.2.3 Steel structure including main beam members, grating, handrails, ladders, embedded plates, piping supports, instrument stanchions etc.

2.2.4 Procurement of all valves from base plant tie-ins to HTDC ISBL tie-ins and procurement of all vent and drain valves as per P&IDs and OSBL design

2.2.5 Procurement of all civil material including but not limited to anchor bolts, concrete, base plates, earth filling soil

2.2.6 Contractor is responsible for procurement of material 100% as per project spec. No deviation will be accepted due to any reason whatsoever. Same to be dealt accordingly in timeline to avoid delays.

2.2.7 All procurement to be done as per the approved vendor list (AVL). If a vendor is not present in the AVL, prior approval of EPCL is mandatory for any procurement via that vendor.

2.3 Construction

2.3.1 Civil

a. Pipe rack foundations construction
b. Foundation construction including provision of anchor bolts and template.
c. Construction of deluge room
d. Concrete road breaking and excavation for underground piping
e. Backfilling of underground piping and concrete road construction

2.3.2 Structure

a. Construction of new pipe racks
b. Construction of pipe racks on existing pipe racks
c. Construction of pipe supports

2.3.3 Piping & fittings

a. Piping sand blasting, painting
b. Installation of deluge valve and piping
c. Pre-fabrication, fabrication, and erection of piping
d. Supports fabrication & installation
e. NDTs as per approved ITP
f. Hydrotesting, Flushing, Blowing and reinstatement
g. 100% Valves + NRVs hydrotest test prior to installation
h. NRVs direction check after installation
i. PSVs / RVs calibration checks followed by installation
j. Torquing (where required)
k. CP system of all underground piping as per area classification.
l. EPCL Flange Box-Up Protocol shall be followed
m. EPCL Chlorine Circuit Procedure to be complied
n. UG piping insulating Kits
o. Piping Fabrication Drawing will be reviewed by EPCL to lock Field & Shop Weld Percentages.

2.3.4 Heat conservation

a. All external insulation (where required) as per approved spec
b. All heat tracing (if required) as per approved spec

2.3.5 Miscellaneous

a. Fire-fighting system (hydrants + monitors, fire extinguishers etc) including deluge system
b. All consumables and equipment for site construction activities (welding rods, gas cylinders, grinders, welding machines etc.
c. All rigging and lifting equipment for site construction activities (lifters, cranes, sling wires, chain blocks, belts, etc.)
d. All safety equipment for site construction activities as per EPCL construction manual requirements (fire extinguishers, fire canopies, fire hoses, water hoses, etc.)
e. Restoration of existing site facilities which are affected due to construction activities
f. Fire-Proofing (if required) will be managed by Contractor in totality.
g. Construction of chemical drain channel connecting HTDC ISBL with EPCL base plant.

2.4 Generally, the Contractor's scope shall include integration of existing facility with new facility (HTDC Unit)

2.5 Contractor also needs to do the following additional tasks (but not limited to) for the successful implementation of the project:

2.6 The Contractor shall also include in its scope all facilities and equipment necessary for smooth operation of plant and all works and services for complete, safe and reliable operation as well as preventive and corrective maintenance.

2.7 The scope also includes works not explicitly stated in the Employer's Requirements or elsewhere in the Contract Documents, but which are reasonably required for the installation and safe operation of the equipment according to Good Engineering Practice.

2.8 The Employer reserves the right to modify scope at later stage. This may include awarding contract of each unit as individual packages or increasing or rationalizing capacities of each unit.

2.9 During different stages of project, all documentation shall be shared with the licensor for review. Any recommendations generated shall be incorporated by Contractor in final design.

2.10 Origin of all items must clearly be mentioned in the proposal together with all assumptions taken for the costing of project. Contractor may quote Chinese origin items.

2.11 All Pre-Commissioning related jobs like PSSR point closure, dew point achievement etc is in the Contractor's scope.

2.12 Contractor also needs to do the following additional tasks (but not limited to) for the successful implementation of the project:

1.1 Occupational health and safety for construction works of the plant as per Employer HSE construction manual and OSHA standard requirements.

1.2 Environmental protection complying with local and international standards

1.3 Complete compliance with HSE Construction Manual attached in the Annexures.

3. PREPARATORY WORKS

Prior to the start of construction and installation, the preparatory works shall be performed in advance so that the erection of the Facility can be realized as planned. At his sole responsibility, the Contractor shall conduct and review, but not limited, to the following preparatory work. A levelled land shall be provided by the Employer.

1. Prepare and share Environmental Management Plan with Employer
2. Prepare and share an Occupational Health and Safety Plan for construction of HTDC plant
3. Obtain all required permits such as BOI, PEC (if required) and Port Qasim required to commence preparatory work at the Employer's Site by the Contractor or its sub-contractors. The Employer has duty to assist the Contractor obtaining work permission which is off-contract regional activities.
4. Provision of temporary laydown areas, warehouses, fabrication shop, sand blasting and painting shop, coating wrapping shop, vehicles, equipment etc. all as necessary for the construction phase at the Employer designated location.
5. Provision of area clearance in TSF, Laydown area or Operating Plant site of construction for any rigging activities, scaffolding activities or any sort of activities related to field installation and construction, shall be in the scope of the Contractor.
6. Warehouse management for material, to ensure inventory management.
7. Disposal of demolition materials to be disposed-off according to local environmental guidelines.
8. Excavated soil will be disposed within plant boundary
9. Provision of temporary firefighting using potable fire extinguishers.

10. Provision of temporary site drainage, storm water and sanitary drainage all as necessary for the site.
11. Disposal of domestic sewage, as necessary.
12. Disposal of waste as per site and local environment guidelines, per categories of metal and non-metal.
13. Provision of accommodation and dining facilities for Contractor's staff outside the Plant boundary walls.
14. Provision of temporary roads/walkways, as required.
15. Provision of temporary site fencing including gates, perimeter lighting.
16. Provision of security for the construction phase and camp site as per insurance requirements
17. Provision of temporary furnished offices for Contractor's employees
18. Provision of temporary room for safety training
19. Site services as required for the construction and pre-commissioning of the Plant such as power supply, service air, fuel supply, telecommunication, etc.; however, water for construction shall be provided by the Employer without charges, nearest tie in location will be specified by the Employer. Electricity for construction and pre-commissioning works may be supplied to the Contractor subject to availability at a rate mutually agreed between the Parties.
20. Hydrocarbon storages but not limited to fuel and lube for generator sets shall be managed as per Employer Site Safety procedure.
21. Provisions of at least three (3) webcam(s) for site and progress supervision from start of construction including GPRS communication system, wide angle, tilt and rotation capability, HD quality and remote-control feature at light poles, as well as appropriate record and storage capabilities.
22. Location of power source may be provided by EPCL (subject to availability at a rate mutually agreed between parties), however, provision and erection of DBs and cables shall be the responsibility of contractor. DBs should be classified (Exd IIB T4) and IP55. Cable specs should Cu/ PVC/ PVC.
23. All cables should be sleeved with flexible PVC pipe.
24. 24V handlamps and 400V/24V transformer must be available with contractor for inspection of reactor, vessels etc.
25. Earthing pit must be made to ground all electrical power tools during construction period.

Commercial impact due to change in the Employer submitted documents with regards to Materials and Plant or Construction Works shall be mutually agreed between both Parties. In case of any dispute the decision of the Employer shall prevail.

4. ENGINEERING AND SERVICES

The Contractor shall share detailed engineering documents based on which construction activities shall be planned and executed. As-built preparation as per existing field conditions on equipment and plant where the Contractor intends to work, shall be part of the scope of the Contractor. Based on those as-built drawings the Contractor shall further their design of new system and drawings. All drawings shall be issued for the approval of the Employer as per requirement and no drawing shall be issued for construction without such approval.

Any change in design deemed necessary by the Contractor shall be notified to the Employer for information and/or review and approval through field change / design change notices as per mutually agreed procedure. Any change in process design required by the Employer shall be reviewed and

concurred by the detailed engineering team of the Contractor before the same is communicated to the execution team.

Any clarification required from the Licensor (EPCL's technology licensor for the VCM Plant) will be routed through Employer. Typical response time shall be 5 days.

For bulk items e.g. gaskets, bolts, glands, termination kits etc. all shall be procured by the Contractor for utilization. All engineering for the Project shall be the Contractor's responsibility.

5. SUPPLY OF EQUIPMENT AND MATERIALS

1 The Contractor shall procure all Materials and Plant as mentioned hereunder for the construction of the facility / work scope from vendors outside and inside Pakistan and provide for the transport and rigging from vendor's shop to the Site and provide for inland safe transport from laydown yard and rigging thereof to the Site and required storage(s). Safe storage in laydown area shall be ensured as per appliable standards and best industrial practices.

2 Any material in the Contractor scope of supply and not available locally will be imported by the Contractor at his own cost.

3 All material procurement shall follow the approved vendor list. In case there is a vendor that the Contractor needs to add / deviate from the AVL, approval from EPCL is mandatory prior to procurement cycle initiation.

4 In an event that imported plant and imported materials supply schedule faces delay or if sequence of delivery is changed, timely information will be passed to the Employer & Contractor by the Offshore Supplier and subsequent changes in construction sequence will be carried out by the Contractor to minimize impact on the overall schedule and to avoid any manpower / equipment idling. Despite that, any idling cost incurred by the Contractor on account of delay in delivery of free issuance equipment shall be reimbursed by the Employer. Any idling cost incurred on account of delays in the shipment schedule on account of the Offshore Supplier shall be catered for in terms of time and cost by the Contractor.

6. CONSTRUCTION

The Contractor shall construct the Plant in accordance with the Engineering & Construction documents approved by the Employer.

1. Benchmark

The Contractor shall be responsible for the true and proper setting-out of the Work in relation to benchmarks. If, at times during the progress of the Work, any error shall appear in the position, level or alignment of the Work, the Contractor shall forthwith notify the Employer of such error and, at its own expense, immediately rectify such error to the reasonable satisfaction of the Employer.

2. Contractor's Supervision

The Contractor shall give or provide all necessary superintendence during the execution of the Work, and the Contractor's representatives (Project Manager or Deputy Project Manager) shall be constantly on the Site to provide full-time superintendence of the Work. The Contractor shall provide and employ only such technical personnel as are skilled and experienced in their respective callings and such supervisory staff as are competent to give adequate supervision to the Work they are required to supervise.

3. Labor

1.1 The Contractor shall provide and employ on the Site in the execution of the Work such skilled, semi-skilled and unskilled labor as is necessary for the proper and timely execution of the Work. Preference to be given to local manpower to maximum possible extent.

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

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

1.4 The Contractor shall at its own expense be responsible for the repatriation of all its and its Sub-contractor's personnel employed upon the Work at the Site to the countries from which they were recruited. The Contractor shall be responsible for the suitable maintenance of all such persons from the cessation of their employment on the Work to their departure from the country and in default the Employer may repatriate and maintain such persons and recover the cost of doing so from the Contractor.

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

1.6 The Contractor shall, in all dealings with its labor and the labor of its Sub-contractors, for the time being employed on or in connection with the Work, pay due regard to all recognized festivals, official holidays and religious or other customs.

1.7 The Contractor shall ensure compliance to all local laws pertaining to labor and shall indemnify Employer against any claims/fines/proceedings brought against the Employer in case of any non-compliance

4 The Contractor shall ensure the design data submitted to the Employer is complied in all respects, which includes, drawings, specification sheets, codes and standards for all construction activities.

7. PUNCH LISTING

As part of the close out portion of the construction process, a punch list will be prepared by the Contractor in the form of a document listing any work that has not been completed or not been completed correctly, and or any other forms of deficiencies or pending work. The Contractor will submit this document to the Employer for review and or addition/modification prior to its finalization. Points may be added by the Employer pursuant to walkdowns by the Employer's Process, QC and Operational personnel. Only the Employer shall be authorized to finalize and approve the punch list and its classifications.

Punch list will be classified as:

1. A (points requiring hot jobs that must be completed prior to hydrotest of test packs),
2. B (points required to be closed prior to mechanical completion),
3. C1 (point requiring completion prior to hydrocarbon intake) and
4. C2 (completion post start up).

Completion date shall be mutually agreed between both Parties and stewarded through daily test packs meeting.

A Pre-Start-up Safety Review (PSSR) will be conducted prior to start-up. A designated team led by the Employer and consisting of Employer and Contractor commissioning personnel will jointly conduct the PSSR once construction is essentially complete and prior to start-up of any system. The PSSR plans and procedures will be developed by the Employer. The PSSR review shall confirm that, prior to the

introduction of highly hazardous chemicals to a process:

1) Construction and equipment is in accordance with design specifications.
2) Safety, operating, maintenance, and emergency procedures are in place and are adequate. All safety systems are functioning properly.
3) A process hazard analysis has been performed and recommendations have been resolved or implemented before start-up.

Any pre-start up or post start up points highlighted during PSSR shall be attended by the Contractor within agreed target dates.

8. PRECOMMISSIONING, COMMISSIONING AND START-UP SUPERVISION

Pre-commissioning means the testing, checking and other Work specified in this Contract and in the Work Procedure including without limitation the trial operations of equipment which are to be carried out by the Contractor in preparation for Mechanical Completion and Commissioning.

Following are the activities to be carried out during the pre-commissioning phase by Contractor. The list is not exhaustive.

1. Installation of temporary Screens, Strainers, Blinds, gaskets, assemblies, hoses, with connectors.
2. Plant Air, Nitrogen or Steam to be utilized for blowing will be supplied by the Employer.
3. Piping flushing, chemical and mechanical cleaning, will be part of the Contractor's scope, including but not limited to engineering for quantity and process / chemical reaction assessment for supply of chemicals, arrangements for cleaning and passivation activities, temporary pumps, temporary dykes, mixing tanks, cleaning piping pigs, operational support, and overall supervision of the activities for quality and HSE requirements compliance.
4. Arrangement of all material / temporary assets e.g. hoses, blinds, couplings shall be the Contractor's responsibility
5. Cleaning and Passivation
6. Electrical System Energizing
7. Directional Test / Solo Test run of Motors
8. Instrumentation Calibration
9. Control Valve Stroking.
10. Cold loop and Hot loop testing of all instrumentation.

The Contractor shall provide qualified personnel during pre-commissioning in accordance with procedures prepared by the Contractor.

The Contractor shall also provide assistance / support to the Licensor's and Original Equipment Manufacturer's (OEM) specialists (engaged by the Employer) which may be required during these phases.

All hardware and consumables along with chemicals for pre-commissioning such as chemical cleaning passivation, line blowing, drying, inerting, etc. shall be arranged by the Contractor. However, demin water for hydro testing prior to start up and Nitrogen for inerting shall be supplied by the Employer.

9. COMMISSIONING AND ACCEPTANCE

Commissioning of plant shall be commenced by the Employer using the Employer's operating personnel after issuance by the Employer of the Mechanical Completion Certificate. Commissioning shall consist of the Work specified or to be specified in the Work Procedures developed by the Engineering Contractor and Licensor.

If during commissioning the Employer is of the opinion that there still exist some defects or deficiencies, the Employer shall notify the Contractor of the same and the Contractor shall take all necessary steps to rectify promptly such defects and deficiencies to the satisfaction of the Employer. If

such defects are related to Works executed by the Contractor, then the Contractor shall rectify such defects at its cost.

10. TRANSFER OF OWNERSHIP

Ownership of the construction equipment used by the Contractor and its Sub-contractors in connection with the Work shall remain with the Contractor or its Sub-contractors; provided, however, that the Employer shall have the right of first refusal to purchase any such Construction Equipment, which the Contractor decides to sell to any third party after completion of the Work.

Ownership of any surplus and imported plant, imported materials and spare parts not incorporated into the Plant or used in connection with Plant commissioning and start up shall revert to the Employer.

Notwithstanding the transfer of ownership of the materials and plant, the responsibility for care and custody thereof shall remain with the Contractor until Mechanical Completion of the Plant or the part thereof in which such materials and plant are incorporated.

11. DISMANTLING & DEMOBILIZATION

The Contractor shall be responsible for handing over the HTDC Plant premises in acceptable condition to the satisfaction of the Employer. All construction wastage / debris to be disposed off as per approved procedure by Contractor and housekeeping of the area to be done to the satisfaction of the Employer.

12. CONSTRUCTION MANAGEMENT

The Contractor shall be responsible for management and supervision of all construction activities as required for the construction of the Plant which shall include, but not be limited to, the following services:

1. Construction Planning and Implementation
2. Field Services and Inspection
3. Construction Quality Management.
4. Preparation of Construction Sub-contracts
5. Site Security Management.
6. Supervision of Construction Sub-contractors
7. Project Coordination including liaison with statutory authorities
8. Administration of Project Execution

The Contractor shall develop a project specific "Construction Execution Plan" prior to mobilization. The document shall be reviewed and approved by Employer. The plan shall include following as a minimum:

9. Sub-Contractor's list
10. Construction preparation
11. Mobilization plan
12. Interface management
13. Field engineering
14. Rigging and Installation plans
15. Material management and control
16. Construction strategy
17. Key equipment for construction
18. Administration for project execution

In addition to aforementioned list, following administrative procedures shall also be prepared, shared with Employer for approval and implemented for the course of the Project.

19. Security
20. Transport of material & equipment to Site
21. Gate control
22. Sanitation
23. Medical care
24. Fire prevention
25. Guidelines for compliance with labor and other applicable laws and regulations

The Contractor shall supply to the Employer for the Employer's approval an organization chart showing the proposed organization to be established by the Contractor for carrying out the Work including the identities of the key personnel together with the curricula vitae of such key personnel employed in the Work within seven (7) days of the Effective Date. Any revision or alteration to an approved organization chart and all appointment of personnel to key position within the contract organization chart shall be subject to the Employer's prior written approval.

All specifications from Licensor and engineering documents shall be followed during construction.

Construction risk register to be maintained by Contractor at a format mutually agreed at kick off meeting. Updated risk register will be shared part of monthly progress report.

100% hydrotesting of valves, NRVs, GLGs, etc. to be done after arrival at site. Calibration of PSVs / PRVs prior to installation.

Kick off meeting will be conducted prior to construction start. Following will be the agenda as a minimum:

1. Coordination Procedure
2. Schedule Finalization
3. Team / organogram Finalization
4. Deliverable's list
5. Mobilization plan
6. Progress report format / frequency

I. Project Execution Instructions

a. Project Administration: End to end project administration will be with Contractor including Purchasing, Logistics, Subcontracting, Construction etc.
b. Correspondence Procedure: Correspondence procedure shall be developed by Contractor and submitted for Employer's review & approval at kick off meeting
c. For Critical Engineering Transmittals like PR Tier Addition with Adequacy Check will go through a number of review forums before approval. This should be planned accordingly so that it doesn't delay overall activities.
d. Technical Documentation: Contractor shall issue engineering & field change notices during course of project. A record of up to date construction documents shall be maintained by Contractor including red line markups for P&IDS and isometrics. At project completion, all project documentation (including native files of as-built) shall be submitted by Contractor in form of dossiers
e. All activities will be reviewed as per EPCL Constructability Checklist to find flows if any as shared for ISBL.
f. Work Front Availability will depend on Contractor Construction LIs & Critical Safety Observations.
g. All Planning to be done considering we will only have a single Turn Around in project timeline in case any work is missed the whole project will be delayed massively.
h. Material Management: On site warehouse shall be maintained and managed by Contractor
i. Construction services

i. Work Areas: Temporary site office space as well as laydown yard and space for fabrication shop will be provided by Employer. Development of space will be done by Contractor
ii. Temporary Electrical Power: Electricity and water for construction shall be provided by Employer. OSBL areas shall be supplied temporary power using generator sets by Contractor
iii. Security: contractor facilities at site (if any) shall be fenced.
iv. Fire Protection: Adequate fire protection measures shall be adopted by Contractor during construction phase, in line with EPCL HSE Construction manual and industrial best practices
v. Housekeeping and Cleanup: Housekeeping to be carried out of worksite at close of each shift
vi. Hours and Days of Work: Construction shall be carried out 6 days a week, 12 hours a day. Work may continue into night shift for continuing activities like concreting / welding etc. Full time night shift will be at discretion of Employer and subject to project progress and HSE measures to make night work inherently safe
vii. Contract Daily Report: Daily shift report of progress will be issued by Contractor. Format will be locked at kick off meeting
viii. Catering, and Transportation: Catering and transportation of Contractor manpower will be responsibility of Contractor.
ix. **Emergency Alarm**: Being brown field project, all HSE requirements necessary to provide safe, conducive environment for construction shall be provided by Contractor
x. Disposal of Water and Contaminated Materials shall be responsibility of contractor
xi. Installation/Usage of Break Shelters and/or Prayer Shelters: To be installed by Contractor

II. Project Control

a. Contractor shall submit Overall Level IV detailed schedule for the Work which will include activities from award of Contracts to project completion and Final Acceptance of the Plant. These proposed Contract Schedules should identify all major Project activities including procurement of Materials, manufacturing time for critical Equipment, yard pre-fabrication, on-site construction, tie-ins, pre-commissioning, and performance testing and should show all major Subcontracts. These schedules shall be based on the Contractor's proposed optimized schedule.

b. Contractor shall also submit planned procurement and site construction (management, direct hire craft & subcontract) manpower histograms and progress curves, subdivided by discipline and separating its construction management from its Subcontractors' construction management.

c. Contractor shall confirm its proposed duration from Effective Date to Commercial Operation and Provisional Acceptance of the Plant. Contractor shall also indicate timing of when it will require utilities, or any other Employer supplied services.

d. Contractor shall provide a description of the Contractor's scheduling and schedule control methodology and a complete discussion of the specific measures the Contractor plans to implement on this project to tailor its procedures to the requirements of the Project Specification.

e. Sample progress report forms showing frequency of issue and an explanation of how these reports will be used to highlight schedule trends and initiate schedule corrective action. Sample reports shall demonstrate progress measurement systems for vendors/procurement, and construction.

f. Contractor shall provide sample schedules demonstrating the level of details that

would be reported to Employer.

III. Expansion Consideration

a. Layout shall take into consideration future expansion requirements and de-bottlenecking
b. A layout plan suggesting locations of each package are given in in attachment.

IV. Alternatives

Contractor shall consider the requirements outlined in the Employer's Requirements as basis for thedesign; however these shall be critically reviewed and if any improvements in design or efficiency can be achieved to the benefit of the Employer, Contractor shall put forward the alternatives togetherwith Techno-economical comparisons. Employer will evaluate these alternatives and advise Contractor formally the acceptable and final requirements.

V. Method Statement

a. The Contractor shall submit a program of work giving a general description of the methods which the Contractor intends to adopt for the execution of each major stage of the Works such as e.g. for the design, procurement, manufacturing, shipping time incl. custom clearance, inland transport, trial run, warehousing, temporary storage, prefab works, construction, erection, testing, pre-commissioning, and documentation.
b. Being brown field, Employer would prefer modular installation solution from Contractor. Contractor to specifically highlight how modular construction techniques will be incorporated in construction strategy to minimize construction time and work in brownfield area.

VI. Mobilization Schedule

Detailed documents for project management

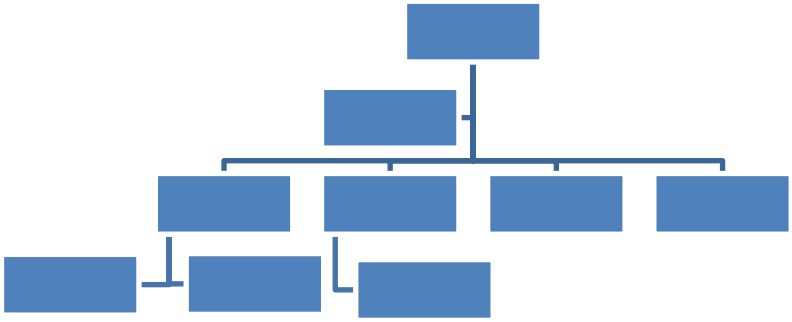
- WBS
- Resource Loading
- Timeline (EPC)
- S-Curve (Separate Engineering, Procurement, Construction & consolidated too)

To be developed by Contractor & same to be approved by EPCL.

VII. Organization Chart

a. The Contractor shall present a detailed organization chart and list of key personnel showing the intended project organization in the Contractor's head office and at site, including involvement ofsubcontractors.
b. All key personnel shall be interviewed & approved by EPCL team.
c. ISBL & OSBL Team shall be separate.
d. The organization chart shall be of the following principal form reflecting the

Contractors way of project execution responsibilities and ways of communication:



VIII. Risk Register

a. Risk register shall be maintained for the project. Risks together with mitigation steps shall be shared on biweekly basis; implementation will be responsibility of finalized Contractor
b. Format shall be discussed with the employer's representatives prior to preparation.
c. To be developed initially before signing contract

13. CONTRACTOR'S PERFORMANCE

The Contractor warrants that it has the experience and capability including sufficient and competent workers, supervisors and other personnel to efficiently and expeditiously accomplish the Work. The Contractor further warrants that it will continuously furnish said personnel and so accomplish the Work in accordance with the Project Specifications and in a manner satisfactory to the Employer. The Contractor further warrants that any additional jobs undertaken by him after the Effective Date will not adversely affect the interests of the Employer or negatively affect his performance and completion of the Work. Provided that the Contractor notifies the Employer of such additional jobs with the sufficient details in order for the Employer to evaluate the accuracy of the Contractor's said warranty. In case the Contractor has been awarded any job, then the Work to be performed pursuant to this Contract shall be given the highest priority over any other Work.

The Contractor acknowledges that it has satisfied himself as to the nature of the Work, the location and peculiarities of the Site, the general character, quality and quantity of equipment and materials required, the type and magnitude of engineering, procurement and construction services and labor required, the general character of construction tools and equipment and facilities required preliminary to and during the execution of the Work, the general and local conditions applicable laws and regulations of Pakistan and all other matters which could affect the Work under the Contract and the Contractor further warrants that it has the necessary engineering know-how and has and/or is in a position to have all the necessary equipment and materials thereof. Any failure by the Contractor to discover matters which affect the Work shall not relieve the Contractor from his obligations under the Contract.

During performance of the Work under the Contract, the Contractor shall maintain appropriate business standards, proper and efficient record keeping procedures, and controls with the objective of avoiding any adverse impact on the interests of the Contractor, the Employer, and any subsidiary or affiliate of Employer. The Contractor shall assign only his employees to all responsible positions which involve or could involve sensitive business relationships with the Suppliers, Vendors, or Sub-contractors.

14. INTERIM REVIEWS

The Employer will carry out quarterly interim reviews of the progress of the Work, the exact timing of which will be mutually agreed between the Parties. The interim reviews will be conducted to assess the position of the Contractor in terms of Project completion and timeline adherence. Any short coming found during the interim reviews will be communicated to the Contractor by the Employer in writing whereupon the Contractor will take the necessary measures to remove such shortcoming at no extra cost to the Employer. Further, Delay Liquidated Damages shall be invoked if the Contractor's progress will not be up to the mark as per the timeline and progress agreed.

15. SAFETY REVIEWS

The Employer will conduct detailed safety review of the Plant when ninety percent (90%) of the construction Work is completed. Any shortcoming found during this review will be promptly removed by the Contractor at no extra cost to the Employer.

16. CONSTRUCTABILITY REVIEW

In order to ensure maximization of value during the construction phase, regular constructability review workshops will be held. Construction contractor will coordinate through Employer for timely and orderly receipt of IFCs and comments with respect to constructability (if any). The Contractor will give regular comment on the delivery schedule of drawings and related technical information in terms of priority to synchronize with the construction schedule. Any additional technical information will be sought well before it is needed by the Contractor to ensure that the Employer obtains and delivers well in time for the Contractor to adhere to comply with the construction schedule.

The Contractor will make dedicated presentation to Employer on critical jobs e.g. rigging of heavy vessels, logistics challenges as well as plans on action related to special administrative measures for weather and or calendar challenges e.g. working during summer heat, rainy season, Ramzan and or Eid breaks.

17. CARE OF WORK

The Contractor will be responsible for the care, custody, and safe-keeping of all materials after delivery to the Site until such time as the Employer issues a Certificate of Mechanical Completion. The Contractor shall also be responsible for care and custody of the Work carried by the Contractor or its Sub- contractors. Responsibility for the care, custody and safekeeping of such Materials will pass to the Employer upon its issuance of a Certificate of Mechanical Completion in respect of the Materials. Prior to the passing of such responsibility to the Employer, the Materials will be in the care and possession of the Contractor solely for the purposes contemplated in this Contract.

18. DOCUMENTS UPON COMPLETION

Promptly (within 45 days of mechanical completion of the Plant), the Contractor will provide the Employer with three (3) sets in hard and one soft copy of each of the following documents. The list is not exhaustive and may be updated during course of Project:

1. as-built drawings, including but not limited to, hard copies, digital native files of drawings which shall include view only and editable formats. Employer will share native files as received from the Engineering Contractor.
2. Computer files of all drawings e.g. PFDs, P&IDS, Isometrics (insofar as they have been compiled by the Contractor or made available to the Contractor in the format of computer files).
3. All test and inspection records.
4. All shop fabrication drawings, field installation plans and drawings, rigging plans, and any other drawings necessary for construction work.

The delivery of all such documents shall be at the Contractor's expense. All manuals shall be properly bound in box files.

19. ANNEXURES

As discussed in this document, detailed data is available in the annexures for this schedule:

Annexure A.	EPCL HSE Construction Manual
Annexure B.	HSE Penalties
Annexure C.	Process Attachments
Annexure D.	Site Meteorological Data
Annexure E.	Electrical Attachments
Annexure F.	Criteria for Mechanical Completion Certificate
Annexure G.	EPCL - HTDC Scope Split Consolidated List
Annexure H.	List of Codes & Standards
Annexure I.	Cathodic Protection System
Annexure J.	Vendor List
Annexure K.	Consolidated Post Bid Comments - 07-Oct-22
Annexure L.	EPCL's Painting Specifications – C4 and C5
Annexure M.	Line Spacing Standard
Annexure N.	Procurement Schedule
Annexure O.	Project Timeline

Schedule 1 - Part I

Design Philosophy
Health, Safety and Environment

CONTENTS

1. HSE

1.1. The Contractor is expected to provide a sound-working environment to all employees involved in the design, construction and operation of the Plant. This includes the consideration of but not limited to: all applicable national and international laws, guidelines and standards; all applicable national and international codes and standards with respect to Occupational Health and Safety and Environmental Protection.

1.2. The Contractor has to ensure that the following HSE objectives are met during the entire lifetime of the Plant during design, construction and operation:

a) zero accidents and injuries with respect to all involved workers
b) Zero harm to workers, the public and the environment.

1.3. The Contractor must prepare and submit a first initial draft HSE Plan together with the technical proposal considering all needed objectives and subjects associated with the works. This HSE Plan will be subject of review and assessment and will be considered in the evaluation of the bid. The initial draft as well as the final HSE Plan must include the following content and objectives as a minimum:

a) Project HSE policy statement
b) Roles and responsibilities
c) Site regulation, incl. e.g., housekeeping, barricades, excavations, tools and equipment, electrical work, hot work, rigging, ladders and scaffolds etc.
d) Risk management & hazard identification
e) HSE Training
f) HSE management of subcontractors
g) Work permit system
h) Personnel protective equipment
i) Auditing
j) HSE meetings
k) Incident investigation & reporting
l) Site security
m) Medical care & first aid
n) Environmental mitigation and monitoring measures as per the Environmental ManagementPlan
o) Emergency response plan outlining all necessary measures and communication proceduresin case of emergency situations.
p) The safety track record of the Contractor in previous projects should also be highlighted.

1.4. Contractor will be requested to submit a detailed HSE Plan considering the site configuration and the site conditions. The detailed HSE Plan shall demonstrate the Contractor's commitment to the highest standards of personal and safety standards, as well as occupational hygiene. Aforementioned plan shall be in line with EPCL's safetypractices.

1.5. Compliance to cardinal rules and EPCL HSE Construction manual shall be ensured. In an event of a safety incident (near-miss / injury), contractor shall be penalized as per terms and conditions agreed at contract stage. Reference penalties are given in Construction Safety Manual.

1.6. During all stages of engineering and construction, DuPont's PSM elements, OSHA

and NFPA requirements shall be complied with. Further, all local laws and standards must be followed including NEQs, SEPA and Labor Laws.

1.7. Usage of asbestos on site is prohibited.

1.8. HAZOP / PHA's and other safety reviews will be conducted during the course of the project;
recommendations of which shall be incorporated by Contractor at no cost.

1.9. Separate studies such as QRA. FSS, EIA and FRA are in progress through 3rd parties. Recommendations (if any) shall be shared with the Contractor for implementation.

1.10. Utilization of EPCL Site approved escape masks (half face and beard masks) for all personnel working at the construction site, direct and indirect.

2. Security

2.1. Security of all assets and manpower of Contractor shall be the responsibility of the Contractor.For this, the Contractor shall acquire services from the Security Agency already mobilized at Employer's site. Cost of these services shall be borne by the Contractor.

2.2. Any loss, theft, damage or destruction of any of Contractor's tools and/or equipment, in part or in whole, during the entirety of the Project shall be the responsibility of the Contractor. TheEmployer shall not be held responsible for any such loss due to any reason whatsoever.

Schedule 1 – Part II

Quality Assurance and Quality Control Requirements

CONTENTS

1. Quality Management Requirements

1.1. Contractor has QA/QC responsibilities and must develop and present its Quality Control System plans and procedures for handling both, inspection at Vendors Facilities and inspections at Site, in such a manner as to avoid conflicting interest and preserve accountability. Its system should address inspection and testing during all phases of the Project.

1.2. Employer reserves the right to witness/attend any inspection associated with Plant equipment and materials. Contractor shall prepare an overall Schedule for Inspections of completed equipment/Systems to be performed at Vendors Facilities; the schedule shall include Employer'switness for critical equipment/Systems.

1.3. During the course of the Project, Employer will notify Contractor of the specific inspections it plansto attend.

1.4. Employer may engage the services of an independent third party to represent/assist Employer at the inspections desired to be witnessed/attended by Employer. Contractor shall deem the Employer assigned third party representatives, the same as Employer.

1.5. Employer shall be kept in loop for all correspondence between the licensor and Contractor, especially those related to final approvals and confirmations of basic and detailed engineeringpackages.

2. Proposed QA/QC Plan

2.1. Contractor shall submit with his Bid, it's QA/QC Plan for Employer's review and Contract. This
plan shall provide detailed descriptions of:

- Quality Policy
- Quality System Certification to ISO9001:2015
- Quality Manual
- Project Quality Plan
- ITP. Inspection and Test Plan
- Assigned QA and QC Manager and key QA/QC Personnel's CV's
- QAs and NCRs Statistics of previous Projects of 10 Years.
- Proposed Subcontractor/ Vendor Qualification Procedure
- Standard Site Construction Quality Control Plan/System.
- Complete list of all Procedures during all Project Phases, for QA QC Levels.
- Internal and External Audit Program, with non-conformance reports of external audits.
- Detail of SITE Construction QC/Testing database for QC Status monitoring
- Detail of compilation, indexing and control of QC records and certification
- Detail of Handover document format indexing and presentation
- Procedures and organization for Mechanical Completion/ Pre-commissioning activities
- List of Standard Measuring Instruments.

2.2. The project quality plan must also describe the systems that Contractor proposes to use to ensure that quality is an intrinsic part of the engineering, procurement, and construction of the facilities and that Employer's Specifications and applicable

codes and standards are designedinto each part of the facilities and faithfully built into the equipment procured and the facilityconstructed, including:

a) How information, reports and records relating to quality assurance and quality control on the project will flow among the various project groups (e.g. engineering, purchasing, construction, project controls) and Employer.
b) How local codes and standards will be analyzed in conjunction with the Project Specification and Contractor's internal standards to ensure that the engineering design will comply with the Project Specification, sound and generally accepted practice, and regulatory requirements.
c) The preparation of material requisitions and/or other procurement documents to properly establish requirements with Vendors and Sub-Contractors, and how the expediting of Manufacturing shall be pursued, how the monitoring shall be done andhow the Employer shall be kept informed.
d) The review of proposals submitted by Vendors and Sub-Contractors to ensure that those firms selected to participate in the project have the requisite competence, resources, tools and procedures to meet established job requirements, and meetingthe overall QA Objectives.
e) How Vendor calculations and fabrication drawings will be reviewed for consistencywith engineering design and standards.
f) How records will be maintained to demonstrate that all design, materials, equipment, and erection work conforms to established requirements.
g) How non-conformities/Alerts and waivers shall be controlled and resolved.
h) How the Quality Control Measuring Instruments shall be kept calibrated and their traceability demonstrated to measurement standards.
i) The sampling techniques and reviews are to be carried out during detailed engineering to confirm that QA systems are indeed delivering the quality output required.
j) The way it plans to meet Employer's requirements for Source/ Field Inspection, e.g.Alloy Verification of Piping, and Equipment Protection during Construction as set forth inITB.
k) How the Contractors QMS shall cover all Project Engineering disciplines
l) How the site records shell be compiled and finally handed over to Employer as Paper Records and as full text searchable Electronic documents
m) How the Quality Management System Documentation shall be monitored during Construction, to enable Employer to view the process online on a local intranet, statistical analysis, generate reports etc.

3. Contractor's Responsibilities

3.1. Contractor's principal duties with respect to quality control on the project shall include:

a) Preparing, maintaining and implementing appropriate quality assurance/quality control procedures and ensuring that a consistent site wide standard is met.
b) Examining the job specifications, understanding the requirements for the

work established therein and notifying Employer of any deficiencies, omissions, contradictions or ambiguities within the job specifications or between them and sound and generally accepted engineering and construction practice.

c) Translating the requirements of its Project Specification and regulatory requirements into clear, concise and complete engineering drawings and specifications.
d) Developing clear, concise and complete procurement documents.
e) Identifying, segregating, controlling and certifying materials and equipment
f) Substituting or approving for substitution, materials only with the prior approval ofEmployer.
g) Providing in-shop quality control and carrying out inspection at Vendors shop on manufacturing methods, procedures, testing and quality assurance of materials andequipment.
h) Providing field quality control and inspection of equipment, materials, fabrication and erection at the Work Site.
i) Ensuring that Vendors and Sub-Contractors and their suppliers have and utilize adequate procedures, plans and resources to provide equipment, materials and services that will conform to the requirements of the ITB.
j) Ensuring that appropriate records and reports are maintained and turned over to Employer to confirm performance of all work in accordance with the job specifications and regulatory requirements.
k) Providing necessary assistance to Employer and its assigned third party representatives for participating in the inspection as per Employer requirement.

4. Procedural Requirements

4.1. Employer shall have access to all QA/QC related documentation and test records, and shall be able to inspect and/or witness any activities associated with the Work at any time. Contractor shall cooperate with Employer's reasonable requests for documentation, records, inspections andwitnessing.

4.2. Contractor shall arrange for any third party inspection of equipment, materials, installation or erection required by statutory regulations. Contractor shall give Employer at least one day notice of all visits to the Work Site by third party inspectors.

4.3. Contractor shall arrange for constructability input and construction QA/QC input as the engineering design and material requisitions are being developed.

4.4. Contractor shall review and approve, and make available to Employer for its review, all weld procedures, specifications, welder qualification records, testing, inspection and other fabrication procedures (such as those required for post weld heat treatment and tube rolling)that will be used in the performance of all work prior to commencing the associated activities.

5. Documents

5.1. Two copies of all process data, as built drawings, manufacturer's mechanical catalogue, copies of inspection reports/Purchase Order etc.

5.2. As-built documents (P&IDs, PFDs, isometrics, foundation design, calculations) shall be shared at project completion

5.3. Computer searchable soft copies (native files/ pdf) of aforementioned must be shared in the form of USB/CD/DVD

5.4. Contractors are to supply soft copies of any design/detailing done through computer/CAD softwares.

5.5. All documentation shared with the Employer must be in English Language

NCR Penalties:

S#	Description	Time Limit (Exceeding)	Qty	Financial Penalty
1	Non-Conformance Report (NCR)	15 calendar days	Each	25,000
2	QA Corrective Action Request (CAR)	15 calendar days	Each	25,000
3	QA audit Observation (QAO)	5 calendar days	Each	5,000
4	Field Quality Alert (FQA)	5 calendar days	Each	5,000
5	Field/Shop Preservation Issues (FPI/SPI)	2 calendar days	Each	5,000
6	RFI Rejection	Event	Each	5,000
7	FQA converted to NCR	5 calendar days	Each	50,000
8	Shop weld repair rate equals or greater than 4%	Monthly	4%	250,000
9	Field weld repair rate equals or greater than 5%	Monthly	5%	250,000

Definitions:

NCR:
Any deviation from project specifications, approved drawings, ITPs/QIPs, PQP, FQCP, QCPs, Vendor/licensor recommendation, Codes/standards, good engineering practice etc. NCR closure must be done within two weeks of issuance. Else, written extension must be taken from QC manager/lead.

FQA:
Any deviation of minor nature from project specifications, approved drawings, ITPs/QIPs, PQP, FQCP, QCPs, Vendor/licensors recommendation, good engineering practice etc. FQA closure must be done within 5 days of issuance. Overdue FQA will automatically be converted into NCR unless written extension must be taken from QC manager/lead. Employer's QCM will decide the nature of

violation/deviation for categorization as FQA or NCR.

CAR:
Deviation from project's approved procedures in the form of missing records, forgery in documents/records, failure in retrieval of obsolete documents/drawings from site etc., leading to contractor's QMS lapse.

QAO:
Deviation from project approved procedures in the form of missing records, forgery in documents/records, failure in retrieval of obsolete documents/drawings from site, or any QMS loop hole.

FPI/SPI:
Uncovering of pipe end caps unless fabrication ongoing, uncovered flanges, metal to metal contacts prone to serration or any physical damage, ingress of foreign material, anything leading to corrosion, non-application of preservatives, desired coatings/coverings to Employer's material etc.

RFI Rejection:
Work is not ready at the time of Employer's inspection indicates that contractor has not done the inspection themselves; will cause RFI rejection.

RTV:
Use of non-color-coded rigging tools at site, uninspected/unapproved rigging equipment/tool usage, rigging equipment/tools protocols violation etc.

Schedule 1 – Part III

Process Requirements

PROCESS REQUIREMENTS

1.1 INTRODUCTION

The EDC Purification and High Temperature Direct Chlorination (HTDC) unit consists of two distillation columns, the HTDC reactor and associated equipment. The unit separates water, light ends, and heavy ends from crude EDC, import EDC and recycled EDC in order to supply purified EDC to the EDC Pyrolysis Furnace.

1.2 HIBOIL COLUMN SYSTEM

The Hiboil Column system receives EDC from several sources and distills the EDC to remove heavies. The main product (high purity EDC) from the Hiboil Column is taken as a side stream from tray 50. This stream is directed to the Furnace Feed EDC Storage Vessel (OSBL) with also a possibility to send EDC to the Wet Crude EDC Tank (OSBL). The bottoms of the Hiboil Column are sent to the Vacuum Column system (OSBL) for further concentration of heavies, while the vent from the Hiboil Column is cooled down to separate as much EDC as possible, and the rest is compressed and sent to OVR Reactor (OSBL) for ethylene recovery. The overhead liquid condensed in the Hiboil Column Vent Condenser system (containing lights) is sent to the Caustic Wash Drum (OSBL).

EDC is fed to the Hiboil Column system from the following sources:

- Heads Column Bottoms**(OSBL)**
- Blowdown from Cracking Unit EDC Vaporizer **(OSBL)**
- Recycle EDC from Lights Chlorinator **(OSBL)**
- EDC from Vacuum Column Overhead **(OSBL)**
- Vapor from the HTDC Reactor (ISBL)

The HTDC Reactor vapor is fed directly to the Hiboil Column bottoms sump to be used as the reboiling vapor for the column. An additional reboiler is provided to supply remaining heat required for desired reboiling of the Hiboil bottoms.

Recycle EDC from the Lights Chlorinator (OSBL) is pumped to the Hiboil column on tray 8 via an interchanger (OSBL).

The overhead of the Hiboil Column is condensed in the Hiboil Column Condenser. Ethylene or nitrogen is added to the Hiboil Column overhead upstream of the condenser. Oxygen is present in the HTDC Reactor feed. The ethylene or nitrogen is added to the overhead to keep the vent stream mixtures out of the flammable envelope (oxygen lean). The objective is to maintain 6% vol. oxygen in all vent streams. The choice of using ethylene or nitrogen depends on the final destination of the vent stream. Normally the vent is sent to the OVR Reactor **(OSBL)** and thus, ethylene is added for dilution as it will be converted to EDC in the OVR Reactor **(OSBL).** When the vent is sent to the incineration unit (**OSBL**), nitrogen is added to the overhead for dilution. The dilution of the vent streams is controlled by an analyzer at the suction of the vent gas compressor. The analyzer resets the flow of either the nitrogen or ethylene.

The overhead stream from the condenser is separated into vapor and liquid in the Hiboil Column Reflux Drum. The liquid is pumped with the Hiboil Column Reflux Pump to the column as reflux on flow control reset by the level in the reflux drum. A small liquid purge stream that can be taken from the Hiboil Column reflux drum under flow control to the Caustic Wash Drum (**OSBL**) gives the possibility of further reducing the water in the Hiboil Column system. The liquid product from the Hiboil column is taken off as a sidedraw from tray 50 and pumped to the Furnace Feed EDC Storage Vessel (**OSBL**) after cooling with cooling water. As an option it can also be manually diverted to Wet EDC Storage Tank (**OSBL**). The sidedraw flow is set on flow control and reset by the level in the Hiboil Column sump.

The discharge temperature of the Hiboil Column Condenser is controlled by controlling the cooling water flow. The temperature of the condenser outlet is to be kept high enough (66 °C) to prevent the condensation of minute quantities of HCI and water present in the condenser. The downstream condensers and compressor metallurgy have been specified to accommodate HCI and water condensation.

The vent from the Hiboil Column Reflux Drum is sent to the Hiboil Column Vent Condenser to recover more EDC from the vent. The vent from the vent condenser is sent to the Hiboil Column Vent Chiller to further recover EDC and cool the vent. The effluent from the chiller is separated in the Hiboil Column Lights K.O. Drum. The liquid condensate from the condenser and the chiller are collected and pumped Outside Battery Limit to the Caustic Wash Drum (via static mixers) for neutralization of any acidic components. The condensate flow is controlled by level control from the Lights K.O. Drum. The vent from the Hiboil Column Vent K.O. Pot is compressed in the HTDC Vent Gas Compressor and sent to the OVR Reactor (**OSBL**). The column pressure is maintained by control of the compressor spillback flow on pressure control. If the Vent Gas Compressor is not in operation, the vent is diverted to the incinerator (**OSBL**) on pressure control.

The net bottoms of the column are pumped to the Vacuum Column System (**OSBL**) under flow control. Most of the Hiboil Column bottoms is returned to the HTDC reactor for material and energy balance purposes. The recycle of the bottoms to the HTDC reactor are controlled by the level in the HTDC reactor separation section.

1.3 HTDC REACTOR SYSTEM

The HTDC reactor system is part of the EDC purification unit so that the heat of reaction can be effectively utilized.
Chlorine and ethylene (**OSBL**) are fed to the reactor under flow control. Liquid EDC from the Hiboil Column bottoms is also fed to the reactor. It acts as the reaction medium and takes away the heat of reaction. The vapor from the reactor is used in the Hiboil Column as stripping vapor.

A chlorine analyzer is used to closely control the chlorine concentration in the product EDC vapor leaving the reactor. A liquid EDC purge stream from the bottom of the HTDC reactor is fed to the Vacuum Column (**OSBL**) on flow control to control the reactor heavies concentration.

Note: OSBL section is marked in above description that Engineering , Procurement and Construction is the the responsibility of Contractor.

2.0 HTDC OSBL PROCESS DESIGN SCOPE:

The detailed design, procurement and construction performed by the Detailed Engineering Contractor (DEC) shall confirm to all specifications as contained in this package and all other standard specifications required by Employer. The DEC shall utilize the additional information available from purchasing and detailed design activities to perform the functions listed below.

In principle, DEC shall use the information included in attached MOC and BEP as the basis for their detail design.

- The DEC shall check all line sizes and pump and pressure drop based on final OSBL piping layout. Non-pumped systems shall be checked on the basis of available pressure drop.
- The DEC shall verify that equipment and piping design pressures are adequate for the shut-off pressure of existing pumps on final plot layout and piping arrangement.
- The DEC shall determine the hydraulic requirements where applicable.

- The DEC shall determine control valve sizes based on the data provided in the MOC. Control valves sizing and piping hydraulics to be done for cold venting from Hi-Boil Column.
- The DEC shall be responsible for design of all utility generation facilities, utility networks, sewers, and all other such networks Outside the battery limits of the HTDC plant.
- The DEC shall revise utilities and process P&ID's provided as part of the design package and/or develop new P&ID's, as required, to reflect the final design of equipment, piping and instrumentation. Changes from the existing will be clouded.
- The DEC shall prepare utility UFDs to reflect the final design of equipment, piping and instrumentation and plant layout.
- The DEC shall complete the line lists consisting of numerical tabulations of all lines, including as a minimum; line number, size, tracing and insulation requirements, operating conditions, pipe class, design conditions, test pressure, plus any other relevant information required by local regulations.
- The DEC shall be responsible for the instrumentation input on all engineering and utility flow diagrams (P&ID's and UFD's) in accordance with developments during the detailed engineering phase as required to complete fully operable instrumentation and control systems.
- The DEC shall confirm inlet pressure to all utility users (e.g., cooling water, nitrogen, steam) after piping studies.
- In general, pumps are considered to be designed according to ANSI standard. Where other standards are required to be used, such as API-610 for centrifugal pump and API-675 for PD pump(If required)
- Pump hydraulics to be calculated to meet the battery limit conditions.
- All valves with one end open to atmosphere that are in process fluid service shall be provided with caps, plugs, blinds or double valving.
- The DEC shall determine need for stiffening rings on lines subject to full vacuum.
- The DEC shall confirm design pressures of headers where multiple pumps discharge. If necessary, pump casing pressures should be checked for revised line design pressures.
- The DEC shall do hydraulics for the refrigeration system against existing refrigeration package, as applicable.
- The DEC should consider the notes on the P&ID's to be instructions/guidelines.
- The DEC shall verify that the bypass valve and line sizes around control valves have at least the same size/C_v as the control valve.
- The DEC shall define/provide high point vents and low point drains during the detailed design phase.
- DEC is responsible for safety measures of all return lines from the HTDC battery limits to OSBL process destination or storage facilities, as well as of utility headers and networks.
- DEC shall review the design of the vent lines going to the incinerator/cold vent regarding the Nitrogen purge connections, i.e. provide pressure reduction and safeguarding, if necessary, to prevent overpressure, and review related instrumentation accordingly..
- Mark-ups on existing P&IDs have been prepared during the MOC to show the recommended tie-in points. DEC shall verify/check the location of the tie-ins with respect to existing headers, lines and/or equipment and develop the detail design of these tie-ins.
- DEC shall review and update the package/MOC in case of inconsistencies between documents.

- To meet the safety requirements with respect to minimum personal exposure to EDC, all sealed pumps containing significant concentrations will be equipped with double mechanical seals.
- All PHA/ HAZOP recommendation (OSBL) shall be in Contractor scope.
- All P&IDs associated with OSBL part shall be updated by Contractor.
    - Downstream Piping of tiein valve is part of Detailed Engineering Scope.
    - To avoid dead ends in provision of tieins
    - Drain points to be provided on downstream of tiein toward HTDC Facility from tiein point
    - Provided drain points for draining of entire piping from tiein point to HTDC Facility should be done from lowest pt.
- DEC to evaluate deconning points with tee off to both HP and LP headers (for dryout and deconning)
    - High Pressure Deconning Header – Wash Train and Tanks (for Dry Out Header)
    - Low Pressure Deconning Header – Slurp Header
- To provide tie-in valves and associated fittings as per this process spec
    - To provide accessibility of tie-in valve in area as recommended in PHA
    - To ensure straight rule while taking tie-in downstream or upstream of FT
    - Location of tie-in point to be made safe for operation with adequate space
    - Proper Pipe Supports to be installed, after evaluation
    - Pipe rack load to be evaluated for addition of above-mentioned piping.
    - To ensure HT valves are installed
    - Safe practices to be followed for Chlorine Service
    - Box up protocol for 'Clean for chlorine service' to be filled for all the new flanges being added.
    - Compatible material gasket on the new flanges to be used as per piping spec
    - Painting & Greasing protocol to be followed for Chlorine Tiein
    - Priority of Type of Valve should be as per mentioned in Spec, Priority 2 type of valve should be Ball mentioned in P of same piping spec
    - To provide accessibility of tie-in valve in area as recommended in PHA.
    - Orientation of tie-ins to be followed as marked in MOC and to be evaluated in detailed engineering phase

2.1 Operation & Maintenance Design Consideration

Maintenance Philosophy & Operational Requirements for the Detailed Design Package (DDP), will be as follows:
For daily operation and maintenance of instruments and valves and piping components which are elevated over 2300mm above grade (High point paving) or 1800mm above platform, permanent ladders shall be provided. In addition, permanent ladders will be provided for the following;

- Hand holes
- Pressure Gauges and Thermometers
- Gate, Globe & Check Valves with NPS < 3"

Permanent platforms will be provided for the following;

- Motor Operating Valves
- Control Valves – all sizes
- Manholes: Platforms shall be provided for manholes more than 2.5 meters above grade (High point paving)
- Process Blinds
- Gate, Globe, Check and other hand operated valves larger than 4".
- Sampling Devices.

2.2 SAFETY

Piping and Layout design shall be continually reviewed for safety during its development. Particular attention shall be paid to adequate escape routes and access to safety equipment i.e. safety showers, operability and access to process equipment and instruments. (HTDC OSBL)

2.3 Pipe Rack/Piping

The DEC shall be responsible for design of all utility and process networks, vents and drain systems, and all other such networks outside the battery limits of the HTDC Unit. Note: only for HTDC process and utility piping.

The DEC shall route all lines taking in to account all the process requirements indicated on the P&ID (slope, free draining, no pockets etc..).
The location of the condensate collection systems is by the DEC during the detail engineering phase.
The DEC to evaluate the requirement of steam trap in steam network and provide the steam trap wherever required.
The drain to be provided at lowest point and dead end of piping.
The vent/bleed to be provided at highest point of the piping.

2.4 PIPE CLASS QUALIFICATION

- The pipe specifications should be updated during detail design to add all necessary requirements.
- Additional detail information regarding valve, pipe fittings and flanges shall be provided by DEC during detail design.
- Full vacuum design requirements shall be incorporated by DEC when required.
- Dimensional or fabrication standards shall be provided by DEC during detail design.
- Environmental requirements shall be provided by DEC during detail design.
- Test methods and procedures will be provided by DEC during detail phase.
- All DEC pipe classes shall be submitted including a cross-reference table referring to the OxyVinyls specifications. (Piping standard ASME)

2.5 DELUGE SYSTEMS – OSBL

The HTDC ISBL contractor design the HTDC ISBL Scope includes Piping layout, sprinkler specification, no. of branches, line sizing and P&ID. The OSBL DEC to install the deluge room and its actuation system including all the OSBL piping.

2.6 FIRE HYDRANT/MONITOR

The DEC to supply and install the Fire hydrant & monitor as per FRA report recommendation.

2.6.1 MONITOR NOZZLES

It is recommended that monitor nozzles be installed along with hydrants at strategic locations within and around the perimeter of the process area. Final plant layout will determine their location. All monitor nozzles should be equipped with variable nozzles that can be adjusted from wide fog to narrow stream.

2.7 FIRE WATER SUPPLY & DISTRIBUTION

The fire water distribution shall be through an underground piping closed loop system. Looping the system permits optimum pipe sizing and provides fire water supply to all sides of each block. The size of pipe will be dependent upon fire water demand. It is expected that the loop system will be no smaller than 12 inch diameter piping. Adequate isolation PIVs shall be used to provide flexibility in case of line breaks. Branch lines from supply mains shall not be smaller than 6 inch.

Completed system shall be hydrostatically tested and flushed as specified in NFPA 24. In general, the plant should be ringed with hose houses or monitors at spacing intervals not to exceed 60 meters.

- Fire Protection (FP) Design, Engineering and Supply are by DEC. All Fire Protection and Detection systems and their design shall be in accordance with the requirements of national and local codes.
- Main underground fire water lines should be 14"/12" diameter. Secondary lines to hydrants and monitors should be 6" diameter. DEC to validate the required sizing based on hydraulic calculations.
- DEC shall verify the tie-in point types, locations and buried depths of the underground fire water lines OSBL.
- DEC shall verify the local standards and locations of valve pits for underground block valves in fire water lines and adjust accordingly.
- Fire water drainage shall be calculated and designed by DEC.
- Hydraulic Isometrics and Hydraulic calculations of the underground and above ground fire water lines shall be made in accordance with the local rules using hydraulic calculation program approved by the authorities.

2.8 OSBL DOSING SYSTEMS DESIGN

Sodium Thiosulfate solution (10 wt% Na2S2O3) must be used to reduce the free chlorine in the exhaust of the incinerator, but also in the streams from ISBL to the existing Caustic Wash.

The HTDC lights and Hiboil Column liquid distillate (streams 330 and 331 of the HMB) contain an estimated total of 6 kg/h free Chlorine. To neutralize the sodium hypochlorite which will form in the existing Caustic Wash tank (MS-106) due to the reaction of free chlorine and caustic, approximately 170 kg/h of Sodium Thiosulfate solution (10 wt%) must be added. All EPC work related to Sodium Thiosulfate dosing shall be in contractor scope.

3.0 Process Tie-ins:

1. Tiein # T-001 – Heads Bottoms Pumps to new Hiboil Column Feed.

4" Tiein will be taken from 4" discharge of PP-401 AB downstream of the bypass toward MF-701A. Single Isolation Valve (4", Gate with Handle, F01 Spec, 300lb) and end blind with drain point (1", Gate with Handle, ABA Spec, 300lb) and end blind upstream of the Tiein Valve. Purpose of this tiein is to provide Feed to new Hiboil Column with 1" deconning point. Tiein taken from 4" existing piping will have spec break from AAC to ABA for connection of tiein point.
Double Block Valves with Spectacle Blind (4", Gate with Handle, AAC Spec, 150lb) to be provided on this piping 4"-CS-1H-34-3412-EDCD-4024(INS) toward old Hiboil Column in order to isolate after commissioning of New Unit. Tiein to be taken from Piperack. Notes:
• To ensure 10D/5D rule while taking tiein downstream or upstream of FT
• Evaluation of FT-427 and LV-401 to be made of Detailed Engineering Scope
• The tiein is not adequate to provide necessary pressure at maximum flow conditions of 50,000 kg/hr however limitation to Pressure in tiein to be evaluated by Detailed Engineering Contractor for appropriate proposal for tiein point limitations.

2. Tiein # T-002A/B – New Hiboil Column Purges to Caustic Wash Drum MS-106

3" Tiein with isolation valve and end blind (3", Gate Valve, C71 Spec, 150lb) will be taken from available 3" point on MS-105 outlet to MS-106. 3" Isolation Valve to be exchanged with existing tee upstream of valve in order to isolate MS-105. Future piping to be connected to available drain point. Purges from Hiboil Column Refux pump (PP-452) and PP-450AB (HIboil Lights Pump) will be sent to the Caustic Wash Drum.
Notes:
• Chemical Dosing will be part of Detailed Engineering Scope (See section 2.8)

3. Tiein # T-003 – EDC Product Cooler Outlet to Furnace Feed

6" tiein to be taken from 8" piping from TT-412 to MS-403 downstream of MS-403 bypass toward PP-703 AB. Single Isolation Valve (6", Gate Valve with Handle, C01A Spec, 150lb) will be provided with end blind on first Platform with an isolation valve and spectacle blind immediate to tiein point to be provided upstream of the tiein on the same piping (8", Gate Valve with Handle, AAC Spec, 150lb). TT-453 Outlet will be connected here.

Notes:
• Hydraulic of Hiboil Side Draw Pump to be made part of Detailed Engineering Scope (OSBL section)

4. Tiein # T-004A&B - HTDC Bottoms Pumps to both Vacuum Column AS-404 and AS-404B

1.5" Piping will be connected to both Old and New Vacuum Column T2 nozzle of 4" with reducer where 4" sparger is installed. Each point will be provided with a tiein valve (1.5", Ball Valve, C01A Spec, 150lb)
• Evaluation of Vacuum Columns Operating Scheme to be made part of Detailed Engineering Scope

5. Tiein # T-005A&B - Vacuum Col Purges (From Reflux Pump PP-409) to New Hiboil Column

3" Tiein to be taken from available bleed point downstream of LV-415 on PP-409 Discharge to divert purges from Vacuum Col to New HiBoil Column. Similar scheme to be followed for new Vacuum Column AS-404B, i.e. 3" tiein to be taken with isolation valve and end blind on manifold piping to Tank downstream of LV-415B on PP-409B discharge upstream of isolation valve. (3", Ball Valve, C01A, 150lb)
Piping connected to this valve will be directed to new Hiboil Column Tray No. 08. Notes:

• EDC from Vacuum Col to enter into piping from Chlorinator to new Hiboil Column near the column where pressure zone is low.
• Evaluation of Vacuum Columns Operating Scheme is a part of Detailed Engineering Scope (OSBL)

6. Tiein # T-006A - EDC Recycle from Lights Chlorinator Interchanger

6" Tiein to be taken from 6" Line on Shell Outlet of TT-351 Lights Chlorinator Exchanger downstream of Heat Exchanger bypass. This piping will be connected to new HiBoil Column Tray 8 with tiein valve (6", Ball Valve with Handle, C01A Spec, 150lb). Additionally, double block valves with spectacle blind to be provided on piping towards old Hiboil Column (6", Ball Valve with Handle, C01A Spec, 150lb). Notes:
• The tiein is not adequate to provide necessary pressure however limitation to Pressure in tiein to be evaluated by Detailed Engineering Contractor for appropriate proposal for tiein point limitations.
• Evaluation of case of series lineup of Chlorinator and Lights Column to be done Detailed Engineering Scope
• Tiein should be provided in such position to avoid dead ends

7. Tiein # T-006B - EDC Recycle from Lights Column

6" Tiein to be taken from 6" from downstream of LV-405A on Lights Column Bottoms after expander 3"x6". This piping will be connected to new HiBoil Column Tray 8 with tiein valve (6", Ball Valve with Handle, C01A Spec, 150lb). This tiein is in backup for T-006A. Additionally, double block valves with spectacle blind to be provided on piping towards old Hiboil Column (6", Ball Valve with Handle, AAC Spec, 150lb).
Notes:
- Evaluation of case of series lineup of Chlorinator and Lights Column to be done Detailed Engineering Scope

• Updation of FT-419 to be covered in Detailed Engineering Scope.

8. Tiein # T-T007 - EDC Blowdown from QBS EDC Vaporizer TT-310 Combine Line

Equal Tee to be provided on 1" where one side will be tiein for TT-310B (DSQ Tiein 08) and the other will be provided to new Hiboil Column with 1" Plug Valve (1", Plug with Handle, F01 Spec, 300lb).

9. **Tiein T-008 - To/From Dry EDC Strorage Tank T-80B** 2" Gate Valve with End Blind to be provided on line D/S of PP-610 and NP-401 Combine Discharge to PP-407 Suction. (S/D Job) (3", Gate Valve with Handle, F01 Spec, 300lb)

10. Tiein # T-009 - PP-703 AB Discharge to/from T-80B & PP-453 AB
3" Plug Valve tiein with End Blind to be provided (Hot S/D Job) on PP-703 AB discharge in Area 100 on 6" upstream of 2" valve to MS-102 AB (3", Gate Valve with Handle, F01 Spec, 300lb). Additionally, isolation valve to be provided (2", Gate Valve with Handle, ABA Spec, 300lb) on piping towards LTC to avoid any dead end.

11 Tiein # T-010 (New) - Chlorine from Chlorine plant

8" tie-in connection to be provided with double block ball valve for chlorine supply to HTDC reactor (Piping spec F01A should be followed for isolation valve and piping) from line no. CGD-14613-8''-B2RF6-HI (outlet of Chlorine bullet to LTC) . This line shall be electrically traced to maintain 40 deg C temperature.

Notes:
• Downstream piping including Chlorine piping to Chlorinator will be covered in detailed engineering.
• Provision of automated Control Valve or Battery Limit Valve to be considered in Detailed Engineering Scope.
• Safe practices to be followed for Chlorine Service
• Box up protocol for 'Clean for chlorine service' to be filled for all the new flanges being added
• Compatible material gasket on the new flanges to be used
• Painting & Greasing protocol to be followed for Chlorine Tiein

12 Tiein # T-011 - Ethylene Feed

6" Plug Valve with End Blind (6", Plug Valve with Handle, F01 Spec, 300lb to be provided upstream of SV-192 (Cold Shutdown Job).

13 Tiein # T-013 - GY-201 from OVR Tiein
6" Plug Valve with Equal Tee and End Blind to be provided on OVR Tiein 005 (6", Ball Valve with Handle, C01A Spec, 150lb)

14 Tiein # T018 - Deconning to WashTrain PP-424 Suction (To Tanks)
3" Tien with an NRV, isolation valve and endblind to be taken from PP-424 6" Suction Line, for deconning header to Wash Train then tanks. (3", Ball Valve, C01A, 150lb)

15 Tiein # T019- Deconning to PP-602/701 Recirculation Line (To Tanks MF-701)

6" Gate Valve with Equal Tee and End Blind to be provided on PPP_701 & PP-602 recirculation lin (6", Ball Valve with Handle, C01A Spec, 150lb) upstream of OVR Tiein. Piping from PP-454 AB Side draw product outlet to be connected here. 3" Tien with an isolation valve and endblind upstream of 6" tiein for deconning header, upstream of OVR Tiein 11 (3", Ball Valve, 150lb)

16 Tiein # T20- Deconning to Wash train from PP-454.

This is an 3" ISBL tie-in shall be connected with T018 piping at ISBL B.L.

17. Tie-in #T021 and T022 New Piping - 6" Tiein from MS-905 A & MS-905B for Vents from PC-450 Suction
6" Tiein to be taken from 6" piping to MS-905 A and MS-905 B from Emergency Relief Header, downstream isolation valve to KO Pot. (6", Ball Valve, C01A, 150lb) Another block valve and spectacle blind to be added upstream of immediate isolation valve. (6", Ball Valve, AAC, 150lb) (to be handed over with Incinerator A and B)
Notes:
• PSL Interlock on MS-905A/B to be evaluated and Pressure Control valve to be provided

All the HTDC vent DVH, WVH, HTV shall be connected to this tie-in point header. Therefore, T016 and T024 are merged into this tie-in.

18. Tie-in #23A &23B- New Piping -Hiboil Bottoms (From PP-451 A/B) To Vacuum Col AS-404 & AS-404B

6" new piping from new Hi-Boil column bottom pump to be connected to old vacuum Column (AS-404) on 4" nozzle near tray#13/14 and also connected with new vacuum column (AS-404B) on 4"

nozzle with individual isolation valves (6", plug valve, AAC spec, 150lb).

Note: Existing Hi-Boil column bottom pump piping will be remain same. However, existing line shall be isolated with new isolation valve (4", PLUG VALVE, AAC, 150#). Please see P&ID for details.

Evaluation of FV-420 A and B to be covered in Detailed Engineering Phase.

19. Tie-in #27- New Piping – HTDC Vents Gas to OVR Reactor Feed

6" Piping to be connected to Ethylene Feed to OVR Reactor upstream of Static Mixer SM-201 with Plug Valve. (6", Plug Valve, C01A Spec, 150lb). This line shall be electrically traced to maintain PC-451 discharge temperature.

20 Tie-in #25- New Piping - 8" Tiein to Existing Cold Vent Header.

Tie-in for HTDC Cold vent is proposed on existing cold vent. 8" tie-in with an isolation valve and end blind to be provided on existing cold vent header line number 6"-CS-1H-39-3694-WGD-631. Piping spec should be same as of tie-in point. The tie-in location is upstream of MS-713. Please see attached P&ID for detail.

8" tiein with an isolation valve and end blind, to be provided from Cold Vent Header for vents from HTDC Unit. (8", Ball Valve with Handle, 150b).

4. Utility Tie-ins:

1. Tiein # T-0028 – Low Pressure Condensate

4" Tiein will be taken (4", Gate with Handle, C01 Spec, 150lb, Downward orientation) with Spec Break (EAA to C01) and end blind from 6" Piping from MS-412 to MS-503 upstream of Isolation Valve, toward MS-503 location. This will be installed with an additional Isolation Valve toward MS-412 for isolation of existing system (6", Gate with Handle, EAA, 150lb) with additional drain point of ¾"
Note: LP Condensate of Old Hiboil Column 20.7 t/h will be replaced with New Hiboil Column Condensate.
Spectacle Blind will be provided on the piping towards HTDC (downstream of Second Isolation Valve).

2. Tiein # T-029 – Steam 7 barg

12" Tiein with Gate Valve to be taken from Main Steam Header in Area 100 Piperack PV-501 downstream on LP Header (12", Gate with Handle, F01 Spec, 300lb, upward orientation).
Note: Steam Flow of Old Hiboil Column 20.7 t/h will be replaced with New Hiboil Column Steam. Around 3 tph (Design) and 6tph (Normal) of Import Steam will be saved as per approved balance in MOC: 65216
Spectacle Blind will be provided on the piping towards HTDC (downstream of Second Isolation Valve).

3. Tiein # T-030 – Steam 10 barg

12" Tiein with Gate Valve to be taken from Main Steam Header in Area 100 Piperack upstream of

PV-501 on LP Header (12", Gate with Handle, F01 Spec, 300lb, upward orientation).
Note: Steam Flow of Old Hiboil Column 20.7 t/h will be replaced with New Hiboil Column Steam. Around 3 tph (Design) and 6tph (Normal) of Import Steam will be saved as per approved balance in MOC: 65216.
Spectacle Blind will be provided on the piping towards HTDC (downstream of Second Isolation Valve).

4. Tiein # T-031 – N2 Gas for Purging

3" Point to be taken on Ghani Gas piping will be utilized for N2 Purging near VCM Battery Limit upstream of 4"x3" reducer (3", Ball Valve, B2RF1, 150lb). This will become part of future evaluation which will be taken up separately before line-up to HTDC.

5. Tiein # T-032– Cooling Water Supply

14" Tiein to be taken with an isolation valve and end blind (14", Gate w/ Handle, 150lb, C01C Spec, upward orientation) on Cooling Water Supply 24" Piping CA Plant Underground to LTC Reactor. Valve will be provided in segregated pit.

6. Tiein # T-033– Cooling Water Return

14" Tiein to be taken with an isolation valve and end blind (14", Gate w/ Handle, 150lb, C01C Spec, upward orientation) on Cooling Water Return 24" Piping CA Plant Underground to LTC Reactor.. Valve will be provided in segregated pit.

7. Tiein # T-034 – N2 Gas for Pumps

1" Tiein to be taken from BOC VIE Header from 1" Piping in Area 100 with Ball Valve (1", Ball Valve, 150lb, AAA). Double NRVs will be provided on this tiein point of different type to prevent N2 back flow. After that 4" line to be connected with ISBL piping.

8. Tiein # T-035 – Instrument Air

2" Tiein to be taken from JOTI Piping UTY II near OVR Tiein TP 017 with Ball Valve (2", Ball Valve, 150lb, A2TJ1 Spec).
For N2, IA, PA Tieins Normal Lineup will be from UTYII, Emergency Lineup will be from UTYIII

9. Tiein # T-036 – Plant Air

2" Tiein to be taken from JOTI Piping UTY II near OVR Tiein TP 018 with Ball Valve (2", Ball Valve, 150lb, B2RF1 Spec). This will be utilized for Utility Point.
For N2, IA, PA Tieins Normal Lineup will be from UTYII, Emergency Lineup will be from UTYIII

10. Tiein # T-037 – N2 UTY Point

2" point to be taken from JOTI Piping UTY II near OVR Tiein TP 019 (2", Ball Valve, 150lb, B2RF1 Spec). This will be utilized for Utility Point as well as Compressor.
For N2, IA, PA Tieins Normal Lineup will be from UTYII, Emergency Lineup will be from UTYIII

11. Tiein # T-038 – IW for Eye Shower/Safety Shower

4" Isolation Valve and End Blind to be taken from Area 1200 near Chlorine Isolation Bullets V-1520 A/B from header. This will be utilized for Eye Shower and Safety Shower and Utility Point, after removal of piping for Chlorine Isolation Bullets, which is subject to Management Approval. End Blind to be provided (B2RF1 Spec)

12. Tiein # T-032B– Cooling Water Supply (CT-IV)

24" Tiein to be taken with an isolation valve (24", Gate w/ Handle, 150lb, C01C Spec, upward orientation) from Cooling tower IV supply header.

13. Tiein # T-033B – Cooling Water Return (CT-IV)

24" Tiein to be taken with an isolation valve (24", Gate w/ Handle, 150lb, C01C Spec, upward orientation) to Cooling tower IV return header.

14. Tiein # T-039 – Refrigerant Supply to HTDC Vent Gas Chiller (TT-454)

6'' tie-in, tee point with isolation valve (ball valve and end blind to be taken from new GR-301B upstream of LV-306B to HI boil column vent Gas chiller TT 454 (HTDC Unit). Piping spec should be same as of tie-in point (LT CS). Please see clouded mark up only and description in attached P&ID.

15.Tiein # T-040 – Refrigerant Return to HTDC Vent Gas Chiller (TT-454)

6'' tie-in, tee point with isolation valve (ball valve)and end blind to be taken from piping to new GR-301B near TT-207B return connection.). Piping spec should be same as of tie-in point. Please see clouded mark up only and description in attached P&ID

16. <u>Tie-in # T-041- Refrigerant liquid return/De-oiling Tie-in :</u>

¾" tie-in, tee point with isolation valve (ball valve and end blind to be taken from new GR-301B oil bleed point. Piping spec should be F03. Please see attached P&ID for detail.

Note: 2" line shall be connected with T-041.

<u>17. Tie-in# 42 HTDC Slurp Vessel Vent discharge tie-in to PC-820</u>

6" globe valve of same piping spec as of tie-in to be installed at PC-820 suction header for MS-494 (HTDC Slurp vessel) Vents. Please see the attached P&ID.

18.Tie-in # T-043 -Polish water tie-in for HTDC Unit:

2'' tie-in point to be taken from polish water line from CA plant Chilled water tank. An isolation globe valve (2") 'B2RF1' of same piping spec as of tie-in point to be installed. Please see attached marked P&ID for scope detail.

Only required for make up of PC-451 cooling circuit.

19 .Tie-in# T-44 (FW1) Fire water supply tie-in from fire water header (CA Unit):

12'' tie in point to be taken from 12" existing underground fire water header at West side of electrolyzer room. 12" Post indicative type manual isolation gate valve (150# CS) of line piping spec 12"-FW-150#-CS to be installed with end blind at tie in point. Please see attached P&ID for detail.

20. Tie-in#T-45(FW2) Fire water supply tie-in from fire water header (EDCVCM Unit):

12'' tie in point to be taken from 12" existing underground fire water header at West side of OVR emergency N2 VIE. 12" Post indicative type manual isolation gate valve (150# CS) of line piping spec 12"-FW-150#-CS to be installed with end blind at tie in point. Please see attached P&ID for

detail.

Note: Existing isolation valve spec shall be followed for tie-in.

5. General Scope:

Following line/piping and equipment detailed engineering, procurement and construction includes in DEC scope;

- The vapor is compressed and recycled to the OHCl Reactor OSBL. The condensate is pumped to Caustic Wash OSBL.
- The Hiboil Column will be checked for 120% of the normal Heads Column bottoms stream (to account for flushing/drying operations). DEC to evaluate to meet the BL condition
- A continuous small purge from the reflux drum to caustic wash will be provided. OSBL piping hydraulic check to meet the B.L requirement.
- In case of emergency the reactor contents will be sent to the Crude EDC Storage Tank OSBL. The purge from the reactor to the vacuum column is normally fed in a separate nozzle on the column. OSBL piping hydraulic check to meet the B.L requirement.
- Vent gases from the Hiboil Column are cooled, compressed in the vent gas compressor and routed to the OHCl unit OSBL.
- Heads column bottom pump to be evaluate to meet the HTDC B.L requirement.
- The Recycle EDC from Lights Chlorinator reactor to HTDC unit B.L.
- Refrigerant supply from GR-301B to HTDC Vent gas Chiller (TT-454). EPC is responsible to perform the hydraulics and take necessary action to meet the BL condition.
- Hi-Boil column draw-off will be lined-up towards Furnace feed drum (MS-403) through a pump
- VCL bottom line-up towards Hi-Boil column through Chlorinator.
- Vacuum columns would be away from new Hi-Boil column so hydraulics evaluation will be done in detail design
- QBS vaporizer blowdown line will also be away from new Hi-Boil column so hydraulic evaluation to be done in detail design
- Chlorinator outlet line feeding to new Hi-boil column to be evaluated in detail design.
- Individual double isolation valves to be provided on Ethylene feed line towards HTDC and Hi-Boil vent Ethylene dilution line
- Chlorine tie-in point for chlorinator to be re-reviewed considering new HTDC will be fed directly from CA Plant.
- EDC start up deconning from pump and vaporizer back to crude tank to be evaluated in detail design.
- Utilities piping line size to be evaluated to meet the BL conditions
- Temp/Pressure indications on CW supply and return to be reviewed and to be added in design. Also perform the hydraulics of CWS and CWR line to meet the B.L condition. Similarly for refrigerant system
- ALL the deconning system (DEG01, DEG2a, DEG2b) piping to be evaluated.
- Chlorine line connection with HTDC reactor cl2 supply line.
- Ethylene Supply Line to HTDC B.L
- Slurp system 3" discharge line to be connected with caustic wash train.
- New Cooling water supply and return line to HTDC B.L for Hi-Boil Column condenser.
- Existing Cooling water supply and return line to HTDC B.L.
- Fire water tie-in and its supply to HTDC B.L
- Deluge system design and supply (OSBL)

- GASCO to guarantee flowrate and pressure conditions
- The tie-in valve size, type and line size mentioned in above section 3.0 will supersede the P&ID mark up if there is any conflict. the Contractor to highlight the same to EPCL.
- the Contractor to consider the line size based on OSBL and ISBL tie-in size whichever is greater or based on hydraulic calculation if line size to be increased.
- Three block valve to be installed on PC-451 discharge line to OVR reactor Feed. Please see P&ID for details.
- Pressure control valve to be provided on cold vent line with pressure control loops and interlock.
- Requirement of Flow control valve to be evaluated on back up ethylene supply line to OVR reactor in case of PC-451 trip.
- Double block and bleed arrangement to be provided by the Contractor at tie-in point OSBL and ISBL.
- Steam trap to be provided as per standard and low points.
- the Contractor to consider the operability and accessibility at each tie-in valves.

6. Process Deliverable:

1. Hydraulic calculation of all the piping and Selection of line size based on hydraulic calculation
2. Piping layout
3. P&IDs
4. Line List
5. Tie-in list and tie-in detail
6. Pump Evaluation and datasheet (if applicable)
7. Closure Report & implementation of all PHA /HAZOP points related to OSBL
8. Steam trap datasheet (Provide steam trap wherever required as per detail design)
9. Provide the drain and vents as per piping layout and updated in P&ID
10. Separate hydraulic report for refrigerant system.
11. FERA Study recommendation implementation and closure report.
12. Control valve datasheet
13. Control narrative
14. Adequacy check of all the tie-ins valve and line size.
15. Chemical dosing system design.
16. Flow meter datasheet (if applicable)

Note: Engineering, Procurement and Construction of all the above-mentioned points shall be in Contractor scope to complete the entire HTDC OSBL Project. If any equipment / pipe / support / instrument will observe inadequate. Contractor will propose the engineering solution and after EPCL approval, the job shall be executed.

7. Attachments

1. Plot plant with marked tie-ins
2. Tie-in List
3. Battery Limit Schedule
4. OSBL P&IDs
5. HTDC ISBL P&ID

Schedule 1 – Part IV

Mechanical Requirements

CONTENTS

1. General Design Philosophy

1.1. Maximum consideration shall be given to the Design Philosophy from the point of view of:

i. Safety (Human and Equipment)
ii. Reliability
iii. Stability of Operation
iv. Ease of Operation and maintenance, including start-up, shutdown, normal operation, emergency shutdown and other possible operating conditions.

1.2. Design life of the new Plant shall be 30 years

1.3. Proven design and equipment shall always be used, and in no case shall equipment be used which has not had minimum of five years successful and continuous operation at the rated duty. Contractor shall furnish comparative details of technical features of proposed major andcritical equipment with that of validly similar references. This information is required in the Contractor's offer for Employer's evaluation.

1.4. It is the aim of the Employer to reduce the number of Vendors and the types of equipment to beused in the Project without incurring an increment to the Project's cost. Therefore, similar equipment and makes should be used in the different areas of the Project of unified sizes wherever practicable.

1.5. In case of Pumps required for the expansion project, Employer prefers to limit to 2 to 3 reliable and proven vendors in order to achieve standardization, interchangeability and uniformity. Contractor to assess this requirement and provide the recommendations with details in the bid.

1.6. The design of equipment shall permit easy access for inspection, cleaning and maintenance, and on line stream testing. Platforms, walkways, stairs and ladders shall be provided in designto ensure easy and safe access to valves, control valves, instrument components, vessel blankoff flanges and all points requiring attention. Employer reserves the right to demand these auxiliaries/accessories and seek changes as needed at any stage of the project without any cost and schedule implications.

1.7. Contractor shall use best possible material of construction for piping, equipment's etc. depending on the service & fluid. For any failure, Contractor shall be responsible and penalized.

1.8. Asbestosis usage is banned at site. Copper or Copper Alloys and Aluminum is discouraged.

1.9. The criteria for noise level shall be in accordance with the design limits specified by OSHA.

2. Measurement System and Units

2.1. Metric unit (SI) system will be applied throughout for this power plant (SI =International Unit).This means that all drawings, data, information and calculations will be presented in the metric unit system. Equipment nameplates, instrument local indicators and DCS screens haveto be in metric units too.

3. Main Codes and Standards and their Application Areas

3.1. Contractor shall formulate an Engineering Standardization Philosophy that covers all Disciplines, all Project Phases and binds all of their Sub-vendors as well. The Standardization Philosophy shall be submitted in the Bid.

3.2. Employer intends to apply US Standards for the Project. However, European, Japanese Standards shall also be permitted. The included list mentions such Standards.

3.3. The Order of precedence shall be US/Canadian→, European→ Japanese, etc., The Included Listof applicable Standards mentions the Standards in the above order of Precedence.

HSE	OSHA, Dupont, CFR (OSHA), NFPA, EPCL's Safety Manual, , SEPA, NEQS
QA/QC	ISO, CTI
Civil Design	ASCE, ACI, AIA, AISC, AISE, AISI, ISO, UBC, IBC, BS/EN, Local Codes
Concrete	ACI & ASCE
Mechanical Design	ASME, ASTM, ANSI, ISO, IMC, IPC, Local Codes, BS/EN,CTI
Electrical Design	IEC, IEEE, NEC, BS/EN
Instrumentation Design	ISA. IEC, API, NEC, EIA. IEEE, ASTM. UL, FM, NEMA, ISO, VDE, DIN, BS/EN,
Testing	ASME(PTCs), ASTM, DIN, ISO, BS/EN, CTI
HVAC	ASHRAE, ISO, CTI
Pumps	API, Hydraulics Institute
Heat Exchangers	TEMA, HEI
Expansion joints	ASTM/DIN
Welding	AWS
Valves/Fittings	ASME, ANSI
Noise	IEC, BS
Vibrations	API, ISO, VDI
Control Valves Sizing and Testing	ISA, ASME, ANS
Electrical Grounding	IEEE, NFPA
Motors	IEC
Cables	IEC, ASTM, UL, BS
Electrical/C&I Enclosure Protection	IP, NEMA
Classified Area Hazard Protection	IEC
Corrosion Protection	NACE
Corrosion Protection (Atmospheric)	ISO
Piping	ASME, API
Steel Structure	SDI, SSPC

3.4. Specific Codes and Standards to be used for the Project shall include, but not restricted to:

8.28.1	Pumps	API/ANSI
8.28.2	Electrical Motors	IEC/NEMA
8.28.3	Fire Water Pumps	NFPA
8.28.4	Other Rotating Equipment	IP/API
8.28.5	Piping,	ANSI / ASME
8.28.6	Storage Tanks	API 650 or Equivalent
8.28.7	Steel Flanges & Fitting	ANSI
8.28.8	Standards for welding	API 1104 x AWS
8.28.9	Safety shower	ANSI
8.28.10	Fire fighting network	NFPA
8.28.11	Cooling Tower	CTI

Engineering Standardization Philosophy

3.5. International standards, applicable codes and practices of associations and approval bodies, in general use by industry, shall apply in cases not covered above.

Precedence (Order of priority)

3.6. Whenever conflicts arise among regulations, international standards or codes, the following precedence rules apply: Any discrepancies or conflicts among the documents listed above shall be formally brought to the attention of the Project Manager by the Contractor for necessary approval prior to providing the bid, design, purchase or fabrication. Project Manager decision is final and binding on the Contractor. In the absence of such interaction, Contractor shall apply the most stringent requirement as a general guideline. Employer may relaxthe above precedence in specific cases if it is proven or demonstrated that Licensor's standards are better than all other reference specifications/standards. Contractor shall highlight these cases and obtain necessary approvals from Project Manager, formally.

4. Criteria to meet Climatic Conditions

4.1. The climatic conditions are stated in the relevant Sections. For Plant design, emphasis is required on the following:

i. Hot and Humid Tropical Coastal Environment, having a high degree of humidity is oftenpresent with high salinity.

ii. All materials shall meet the highly corrosive environment.

iii. Sand and fine dust are present all the time, and may be blown about by winds and storms.

iv. Sand and dust infiltrate easily into minute voids and openings. All field equipment design shall recognize these problems and effectively compensate for them.

v. Highest rainfall in recent times shall be considered for storm sewer design. After due review of prevailing routes of rain water flow through the proposed expansion site, Contractor shall design the storm water system accordingly.

vi. Maximum wind velocity shall be considered for tower design.

vii. Efforts shall be exercised in the design for water recovery and conservation. Contractor shall include all condensate recovery from steam traps, as well as from other drains.

viii. Design of air coolers must consider the prevailing humid and dusty conditions. Appropriate washing arrangements to clean the fins shall be provided. Air cooler design shall also consider high ambient temperatures and maximum humidity (100%) and shall be sized for these severe conditions.

5. Isolations

5.1. Double isolation and bleed valves for high pressure service shall be provided. Double block and bleed and by pass valves shall be provided for all the critical control valves. Contractor shall provide the list of these valves, in the bid for evaluation by Employer. PHA findings, if any onthis subject will have to be complied by the Contractor, fully.

5.2. All the isolation valves, control valves with hand jack, Pump strainers etc., shall be accessible and where required shall be provided with operating platforms. Isolation valves shall be non-passing tight shut off type.

5.3. All isolations from a fire protection aspect shall be provided outside the fire protection zone.

5.4. Contractor shall ensure that adequate means are provided for isolation of critical equipment'swhich can be isolated without causing a shutdown -so that maintenance or repair work can be carried out on such items (e.g. block valves on rotating equipment provided with standby Units, automatic and safe venting with control valves, block valves and by-pass on control valves, etc.).

5.5. In addition, isolation valves are required in the header at the off take points of Utilities including steam traps and at the user point shall be provided. These shall be reviewed during engineering with Employer's approval.

5.6. The bleed and drain points shall be provided with isolation valves wherever necessary and with blinding facility. These shall be finalized during design with Employer's approval.

5.7. Spectacle blinds, as required shall be provided. These shall be finalized during design with Employer's approval.

6. Hydro Testing Provisions

6.1. Necessary arrangements shall be provided to facilitate hydro testing of exchangers, whenever required. Specific requirements shall be identified during detailed design and mutually agreed.

6.2. Utility Points for Purging and Flushing Services and matching hoses to be provided by Contractor meeting the following requirements.

6.3. All utility points namely nitrogen, flushing water, hot condensate, plant air shall be provided by Contractor along with reliable non return valves to prevent back flow.

6.4. Matching hose assemblies complete with connectors, fittings and couplings shall be providedby Contractor.

7. Corrosion Protection

7.1. In addition to the salt laden coastal environment, highly corrosive Chlorine and onsite PVC Plant emissions are present in the atmosphere. Further a coal plant, an NPK Fertilizer Plant and an adjoining Chemicals plant all are contributing to the corrosive environment. To avoid the affect of salt heap all materials shall meet the environment and appropriate measures for comprehensive corrosion protection need to be adopted (on equipment's, concrete structure and accessories etc.) to meet the plant design life.

7.2. An ambient air survey taking into account the above pollutants is to be undertaken and appropriate measures for comprehensive corrosion protection need to be adopted to meet the plant design life.

7.3. It is the responsibility of contractor to ensure all piping is painted as per the specifications shared by EPCL in the Painting Management manual, as per Spec C5.

8. Piping System

8.1. Pipe Size

i. In sizing of the lines, due allowance shall be made for process conditions and fluid properties that require a certain pressure drop or fluid velocity, difference in elevations, precipitation of solids, erosion from solids, occurrence of mixed phase flow, noise level and potential for static charging.

ii. Pump, compressor and blower piping circuits shall be sized on the basis of the connected equipment which accommodate process flow variables (at equipment design speeds) with allowance for control reduced to zero, if necessary.

iii. Piping in intermittent-service (such as start-up and bypass lines) shall be sized on the basis of available pressure differential.

iv. In case of long lines and lines made of high cost grades, the line shall be sized to have the best compromise between the investment and operating cost.

v. In general, Pipe sizes 1-1/4", 2-1/2", 3-1/2", 5", 7" and 9" shall not be used except whereequipment connections are these sizes. In such cases, transitions to other commercial pipe sizes shall be made as close as possible to the equipment connection.

8.2. Dimension

i. The metric system for dimensioning shall be adopted throughout the project. Pipe sizes shall however be expressed in inches.

8.3. Class Break

i. Where a line with a lower rating connects to pipe or equipment of a higher rating, it shalltake the higher rating to and including the first block valve, control valve or check valve,and to and the second valve when using double block valves

ii. Where pressure drops across a control valve cause a change in downstream material classification, design conditions of the entire control set shall conform to those of the upstream of the control valve.

iii. Where a line is to be connected to a pump, the rating of the flange shall be the same rating as the pump nozzle.

iv. When a fitting of a line does not meet the service class the line, it shall be indicated on the Piping Layout Drawings.

8.4. Design Temperature

i. The design temperature of piping shall be the design temperature of connected equipment, according to the following principles.
   a) Where the fluid is to be heated in the upstream equipment, the design temperatureof the upstream equipment shall govern.
   b) Where the fluid is to be cooled in the upstream equipment, design temperature ofthe downstream equipment shall govern.

ii. The design temperature of steam jacketed piping shall be the temperature of the steam

8.5. Design Pressure

i. The design pressure of piping shall be the higher pressure of the following:
   a) Design pressure of the equipment to which it is connected
   b) Set pressure of the relief valve which protects the equipment

ii. Discharge piping of centrifugal pump, not protected by a pressure relief valve or similardevice shall be designed to the pump shut off pressure

iii. Design pressure shall be applied from the source to the last valve before entering a lower pressure rated equipment.

8.6. Pipe-ways

i. In general, process lines, utility lines (except large diameter water lines) and instrument& electrical ducts shall be carried on overhead pipe ways at established

elevation.

ii. All piping entering / leaving the plant shall be grouped to the extent possible on overhead pipe ways.

8.7. Overhead Clearance

i. Equipment, structure, platform, piping, and its supports shall be arranged to provide thefollowing minimum overhead clearance.
- Over plant roads for major mobile equipment: 6.0 meters
- Over secondary roads for truck and equipment access ways: 4.5 meters
- At pump row accessway, {under pipe way) to nearest obstruction: 3.7 meters
- Over pumps and turbines, from high point of finished grade: 3.0 meters
- Overhead walkways, passageways, and platforms, to nearest obstruction (except at deadends): 2.1 meters

ii. The minimum clearance between the finished grade (or floor plate) and the bottom ofpiping or insulation are as follows:
- Under low level piping in pave or unpaved areas: 0.3 meters
- Under drain piping: 0.15 meters

8.8. Horizontal Clearance

i. The minimum horizontal clearance for piping arrangement are as follows:

ii. Passage of mobile equipment: 3.0 meters
- Operating aisles: 1.2 meters
- At driver end of pumps: 1.5 meters
- At shell cover end of exchanger at grade for access: 1.2 meters
- Maintenance platform at channel end of elevated exchanger: 1.2 meters
- In front of manways: 0.9 meters
- Minimum passageways at grade and on elevated platforms including stairway: 0.8 meters
- Between extremities, including piping of adjacent pumps: 0.8 meters
- Between extremities, including insulation of paired exchangers or vessels: 0.5 meters
- Between piping and handrails, or between other obstructions, where occasional access isrequired for maintenance only: 0.5 meters

8.9. Maintenance Access for Valves

i. Operator access requirements for valves including platform and ladder shall be as follows:

	Grade or fixed platform	Fixed Ladder	Portable Ladder
Operating Valves[i]	Yes	No	No
Operating valves small [i & iii]	Yes	Yes	No
Non-Operating Valves [ii]	Yes	No	No
Non-Operating Valves small [ii & iii]	Yes	Yes	Yes

i) Operating valves are valves that are essential for plant operation

ii) Non-Operating valves are valves that are not essential for plant operation

iii) Small valves are defined as valves that can easily be operated with one hand andnormally 1-1/2" and smaller, such as first valves of orifice tap, vents and drains

8.10. Underground piping

i. Cooling water & fire water lines shall be buried. The minimum depth of cover shall be 800 mm for fire water lines, and 310 mm for cooling water lines. For the road crossing points, the depth of cover shall be increased or protection by concrete encasement, pipesleeves or concrete slab shall be adopted considering traffic load.

ii. The cathodic protection system of impressed current type shall be provided for the underground piping of fire water lines and cooling water lines in Plant Site.

iii. Insulating flange set shall be provided on all cathodically protected lines just before theline goes underground.

8.11. Pipe Supports

i. All piping shall be adequately supported and restrained so as to prevent undue vibration, deflection, stresses or loads on equipment. Piping shall be supported from below in preference to hanging from above.

ii. Consideration shall be given to differential expansion between supported and supporting pipe for intermediate supporting of smaller lines from the larger.

iii. Piping sections requiring frequent dismantling shall be provided with permanent supports for the dismantled conditions.

iv. All pipe supports, guides etc. shall be shown on the piping arrangement drawing.

v. Piping support shall be suitable for carrying the weight of the piping when filled with water during hydraulic test.

8.12. Piping Flexibility Analysis

i. Piping flexibility analysis shall be performed
ii. Design for wind and earthquake shall be based on the data for structures to the extentrequired.
iii. Expansion bellows may be used with Employer's approval.

8.13. Branch Connections

i. Branch connections shall be made by the use of tees, reducing tees, socket weldingcouplings (bosses) or stub-ins. Section of branch methods shall be in accordance with

the Piping Standard Drawings. Connections 1-1/2" and smaller shall be reinforced withgusset plates where vibration may cause line failure.
ii. Reinforcement pads for branch connection shall be in accordance with the Piping Standard Drawings, where required
iii. Guidelines must be provided at engineering phase for all off-takes and branch connections for utility and process piping

8.14. Valves

i. Valves that must be accessible during plant operation shall be located between 0.75meters and 1.8 meters above the operating floor level.
ii. Block valves shall be provided at the following location:
- Suction and discharge piping of equipment
- All auxiliary piping where it is necessary to allow removal of the equipment duringoperation of unit.
- in all lines where for process or safety reasons, a particular section of the plant orequipment has to be shutdown, and in lines connected to vessel nozzles located below the maximum liquid level.
- Double block and bleed valves shall be provided in piping connecting systemswhere contamination cannot be tolerated

iii. In general block valves shall be of gate, globe, lubricated plug or resilient seated type. Other valve type such as diaphragm, pinch, butterfly may be used when advantageous for specific applications.

8.15. Drain, Vents & Purge points

i. Vent connections shall be furnished on trapped high point of piping 3" and larger and drain connections on a low point of all lines.
ii. In general, size of those connections shall be 3/4"

iii. Valved vent and drain connections shall be furnished on all equipment that are not selfventing or self-draining. Connections shall be located on equipment if practicable. Otherwise, they may be located in connected piping where there are no valves or blocksbetween the vent and drain connections and the equipment.
iv. Drains shall be routed to appropriate locations to avoid splashing and hazard to personnel
v. Plugs, caps or end blinds to be installed on all drains

8.16. Sample Connections

i. The sample connections shall be located for easy access from grade (grade preferred) orfixed platform.
ii. If required, adequate sampling facility with provision of purging of sample collection potshall be provided

8.17. Line Blinds

i. Blinds shall be positioned so that the volume of fluid that must be discharged prior toinstallation of the blank is kept to a minimum.
ii. For larger diameter piping or locations where frequent blinding is required, spectacleblinds shall be provided.
iii. Jack screw shall be provided at locations where frequent blinding activity is requiredsuch as at grade changes

8.18. Relief Vent System

i. Pressure Relief Systems with Pressure Relief valves, ruptured discs as per requirementsshall be provided. Some specific applications would require isolation for safety relief valve and rupture disc. To identify such applications, Contractor shall review factors likeloss of production, pollution abutment, minimum down time etc. Based on this review, Contractor shall provide dual relief System with isolation for Employer's review.
ii. A HAZOP study section wise and Unit wise shall then be carried out to identify implications, which may result in special operating procedures. A safe disposal System down stream of rupture disc/safety valve shall be provided.
iii. The vents from relief valves must be adequately positioned to avoid hazard in area backed by dispersion modelling studies
iv. The release must comply with local and international laws

8.19. Steam Traps

i. Steam traps discharging to atmosphere shall be provided with an upstream block valve
ii. Steam traps, discharging to condensate collecting system shall be provided with an

upstream block valve and downstream block valve

iii. Bypass shall be provided on all steam traps

iv. Permanent strainer shall be provided to the steam traps (strainer may be integrated tothe traps)

v. All condensate of stream traps to be recovered

8.20. Air Piping (vent)

i. Air piping system shall be designed for good drainage.

ii. Drain valve shall be provided at the low points of systems.

iii. Branch connection shall be taken-off from the top of the header.

8.21. Pump Piping

i. Suction lines shall be arranged as short and direct as possible.

ii. Suction and discharge piping shall be supported so that minimum pipe load is transmitted to equipment.

iii. When the piping is supported from the grade, adjustable pipe supports shall be used and shall not be supported from maintenance areas.

iv. Reducer in the horizontal suction lines of the pump shall be eccentric and shall be installed top flat to avoid pocketing of vapors in the horizontal line.

v. In general, check valve shall be provided between the block valve and discharge nozzle of the pump, unless specified.

vi. The piping at pumps and turbines shall be arranged to avoid interference of operation and maintenance access. Removable spool pieces shall be provided as appropriate, such as at end suction pump inlets, to permit maintenance without major piping disassembly.

vii. Min. 6 times pipe diameters of straight length will be provided before pump suction, unless the fluid velocity is less than 2.1 straightening vanes are used.

8.22. Storage Tank Piping

i. Block valves shall be provided directly on all lower tank nozzles where practical.

ii. Adequate flexibility shall be provided in connecting piping so that the tank nozzles and valves will not be distorted if tank settlement occurs

8.23. Instrument Air Piping

i. Pipe of instrument air headers shall be as per standard

ii. Branch connections with block valve shall be taken off from the top of the header

8.24. Control Valves

i. Control valves no 1-1/2" and smaller line sizes shall be furnished with block valves andbypass valves
ii. For 2" and larger lines, control valves shall have two block valves and a bypass valves,unless otherwise dictated by process requirement
iii. By pass valve shall not be provided for:
   a) Slurry service where bypass would plug and freeze
   b) For butterfly or three-way valve
   c) Emergency valve, dump valve, vent valve etc.
iv. Control valves shall be easily accessible for operation and maintenance
v. Drain valve shall be provided upstream of the control valve, unless otherwise specified

8.25. Pressure & Level Instruments

i. Pressure & level instruments should be accessible from floor, platform or fixed ladder.
ii. Isolation valves to be provided on Pressure & Level transmitters

8.26. Temperature Instruments

i. Permanent ladder and platforms are not necessary to access thermocouple and thermowells
ii. Thermowell shall be installed perpendicular to or towards the flow in line.

8.27. Flow Instrument

i. Orifice shall be placed in horizontal or vertical flows. Straight pipe runs shall be inaccordance with piping standard
ii. Minimum length of straight pipe as specified/recommended by vendor shall be requiredupstream and downstream of turbine meters and magnetic flow meters
iii. Jack screws shall be provided for orifice flange sets

8.28. Steel Structure Requirements

8.28.1 MATERIALS

8.28.2 <u>General</u>

8.28.3 Materials furnished under this Practice shall be new and of first quality conforming to the applicable specifications referenced herein.

8.28.4 Certified mill test reports shall be submitted to the Inspector for structural steel.

8.28.5 The Manufacturer's certification stating conformity of the welding filler materials with this specification shall be submitted to the Inspector upon request.

8.28.6 The Manufacturer's certification stating conformity of bolts, nuts, and washers with this specification shall be submitted to the Inspector upon request.

8.28.7 No substitution of materials, sizes, or shapes shall be made without the prior written approval of the Purchaser.

8.28.8 Structural Steel

8.28.9 Steel shapes and plates shall conform to ASTM A992/A992M or ASTM A36/A36M and its general requirements specification ASTM A6/A6M. Angles, channels, and plates shall conform to ASTM A36/A36M and its general requirements specification ASTM A6/A6M.

8.28.10 Steel pipe for structural applications shall conform to ASTM A53/A53M, Type E or S, Grade B, open hearth or basic oxygen steel.

8.28.11 Structural square and rectangular tubing shall conform to ASTM A500/A500M or ASTM A501/A501M.

8.28.12 Bolting

8.28.13 Structural bolts shall conform to ASTM A307 Grade A and high strength bolts shall conform to ASTM F3125/F3125M Grade A325 or Grade 490 for service temperatures above -20°F (-29°C). For service temperatures below -20°F (-29°C), appropriate austenitic bolting material shall be specified in the Order. Structural carbon and alloy steel nuts shall conform to ASTMA563.

8.28.14 Washers for use with structural bolting shall conform to the following:

8.28.15 Hardened washers shall conform to ASTM F436/F436M.

8.28.16 Load indicator washers shall be as approved by Employer's Engineer.

8.28.17 The Manufacturer shall supply all bolts, nuts, and washers necessary for erection purposes and permanent field connections. The Manufacturer shall supply the required number of bolts, nuts, and washers for each length and diameter plus 10% excess.

8.28.18 Floor Plate

8.28.19 Floor plate shall be nonskid checkered plate, raised pattern, made of carbon steel in accordance with ASTM A36/A36M. The plate thickness shall be as indicated on the applicable Standard Drawings. The minimum permissible plate thickness is 1/4 inch (6 mm).

8.28.20 Grating and Stair Treads

8.28.21 Unless otherwise specified by the Employer's Engineer, rectangular open-type welded grating, with 3/16 inch x 1-1/4 inch (5 mm x 32 mm) serrated bearing bars with a 1-3/16 inch (30 mm) center spacing shall be used. Materials for grating shall conform to ASTM A1011/A1011M.

8.28.22 Banding of open grating shall be performed by the Manufacturer at the following locations:

i. Open ends of grating at head of ladder approaches to platform.

ii. All hinged sections.

iii. Grating panels with four or less cross bars.

iv. All openings where more than four bars are cut in gratings including field cut openings.

8.28.23 The band bar shall be the same size as the bearing bars, except where a toe-plate is specified in place of a banding bar. The band bar shall extend to the first continuous bearing bar on each side of cutout and shall be welded to each cut bearing bar and to each continuous bearing bar with a single full-length 1/8

inch (3 mm) fillet weld.

8.28.24 Stair treads shall be welded steel grating with non-skid type nosing and shall conform to ASTM A1011/A1011M.

8.28.25 Grating and stair treads shall be hot-dipped galvanized after fabrication in accordance with EP 10-3-8.

8.28.26 All grating penetrations shall be banded unless approved otherwise by Employer's Engineer.

8.28.27 DESIGN

8.28.28 General

8.28.29 The criteria, loads, and load combinations for design of structural steel shall be in accordance with AISC 325 Steel Construction Manual.

8.28.30 For structural elements continuously exposed to heat above 500°F (260°C), the allowable design stresses shall be reduced in proportion to reductions in yield strength of the steel at the design temperature.

8.28.31 For structural elements exposed to severe corrosion or wear conditions, special materials, protection, or material thickness allowance shall be employed instead of decreasing allowable stresses.

8.28.32 Allowable Stress Design (ASD) shall be used, unless the Employer's Engineer approves the use of Load and Resistance Factor Design (LRFD).

8.28.33 Suitable adjustment shall be made to the computed length of all diagonal angle bracing longer than 10 feet (3.0 m) to account for elastic extension or compression from design loading.

8.28.34 Angle bracing shall have the vertical leg turned down unless specifically shown otherwise.

8.28.35 All structural steel designs, specifications, drawings, and calculations shall be approved and signed by an engineer acceptable to the jurisdiction to perform engineering activities, and to the Employer.

8.28.36 All structural steel designs, specifications, drawings, and calculations shall be approved and signed and submitted to the Employer.

8.28.37 To minimize moisture retention and subsequent pipe corrosion, all support members shall be equipped with a steel bar welded to the support beam (not the pipe) to provide point support of the pipe and to provide a minimum of 1/2 inch (13 mm) clearance from the support members.

8.28.38 Connections

8.28.39 Except as modified by drawings, connections shall be designed and detailed as follows:

8.28.40 Shop connections shall be welded. Bolts may be used for shop connections only where welding is impractical.

8.28.41 Field connections shall be bolted wherever practical. Exceptions to this requirement shall be approved by the Employer's Engineer.

8.28.42 Beveled washers shall be furnished for structural and high strength bolted connections to sloping flanges, and when required for flanges for diagonal tie rod bracing connections.

8.28.43 Where beam connections are not detailed or described on design drawings, and no reaction value is specified, they shall be detailed by the fabricator or detailer to resist the reactions specified in the sub-paragraph below. Where reaction values are specified on the drawings, they shall be detailed for these values, except that they shall also meet the requirements of the sub-paragraph below.

8.28.44 For structural steel in EPCL facilities, the connections shall be designed to resist, as a minimum, the reactions caused by the allowable uniform load shown in the beam tables of AISC 325.

8.28.45 Each bolted joint shall have at least two bolts.

8.28.46 For EPCL facilities, in no case shall the number of rows of bolts be less than the minimum shown required for the member loading in the applicable table of AISC 325.

8.28.47 Unless otherwise indicated on the fabrication drawings, all connections for diagonal bracing and connections at the ends of tension or compression members in trusses shall be designed to develop the force due to the design load. As a minimum, these connections shall also be designed to develop the greater of 50% of the allowable tension capacity of the bracing member or 6 kips (26.69kN), in ASCE 7 Seismic Design Categories A and B, and the greater of 100% of the allowable tension capacity of the bracing member or 6 kips (27 kN), in ASCE 7 Seismic Design Categories C and above. The allowable tension capacity shall be calculated using the gross cross-sectional area of the member. Working points for designing and detailing the connections shall be as shown on the fabrication drawings.

8.28.48 Bolted connections for ladders, handrail posts, stair stringers, purlins, and girts shall be made with structural bolts. All other bolted connections shall be made with high strength bolts. High strength bolted connections shall be in accordance with the RSCS Specification for Structural Joints Using High Strength Bolts.

8.28.49 Bolt sizes shall be in accordance with the following requirements:

i. Structural bolts with hex bolt head shall be 5/8 inch (16 mm) minimum diameter unless limited by the size of the connected parts.

ii. High strength bolts with heavy hex bolt head shall be 3/4 inch (19 mm) minimum diameter unless otherwise specified on the design drawings.

8.28.50 Heads and nuts of high strength bolts shall bear on hardened steel washers.

8.28.51 Gusset plates and bracing connection plates shall have a minimum thickness of 3/8 inch (10 mm) and a minimum of two bolts per member for bolted connections.

8.28.52 Clips and brackets shall be as follows:

i. All clips for attaching platform brackets, ladders, davits, etc., will be furnished shop-welded to vessel or tank by the vessel fabricator unless otherwise noted.

ii. Where field welding is specified, the structural steel fabricator shall furnish necessary erection clips and bolts.

8.28.53 <u>Auxiliary Structures for Operation and Maintenance</u>

8.28.54 Design requirements for platforms, ladders, stairways and other auxiliary structures for operation and maintenance shall be in accordance with the requirements of AISC

8.28.55 Platforms, stairways, and handrails shall be shop-assembled in the largest units for handling, shipping, and erection, unless otherwise noted on drawings.

8.28.56 FABRICATION DRAWINGS

8.28.57 The Manufacturer shall prepare complete fabrication and erection drawings including shop details and bills of material. Erection drawings shall be cross-referenced to the design drawings and shall show erection marks, and a complete erection bolt schedule for each connection.

8.28.58 The Manufacturer shall submit shop and erection drawings for approval to the Employer's Engineer, and shall not proceed with fabrication until approval is received in writing. Approval of shop drawings by the Employer's Engineer shall be construed as approval of general methods only, and shall not constitute verification of proper member sizes, dimensions, details, or quantities. The Manufacturer shall be solely responsible for correctness of the fabrication and erection drawings. Final fabrication and erection drawings shall be reviewed and approved by an EPCL representative.

8.28.59 The Manufacturer shall be responsible for correct interpretation of design drawings and shall call to the attention of the Employer's Engineer any discrepancies found on the drawings. The Manufacturer shall be responsible for dimensions or details not shown on design drawings. The Manufacturer shall be solely responsible for detailing and fabrication to ensure that erection will be convenient and free from all interferences, drilling, or cutting.

8.28.60 Regardless of the design drawing presentation, the Manufacturer shall be responsible for the constructability of the structure. If, in order to achieve constructability, shop detailing that alters the design intent is required, the Employer's Engineer shall be consulted for approval before proceeding.

8.28.61 FIREPROOFING

8.28.62 Fireproofing of structural steel shall be in accordance with AISC's Design Guide 19: Fire Resistance of Structural Steel Framing, NFPA 30, API 2218 & ICC-IBC standards.

8.28.63 SANDBLASTING & PAINTING

8.28.64 Sandblasting and painting of all structure material shall follow the specifications shared in EPCL's Painting Management Manual, specification C5.

Schedule 1 – Part V

Civil Requirements

Civil Requirements

1.1. DESIGN

1.1.1. Allowable soil bearing pressures shall be based on the results of a soils investigation and a consideration of permissible total and differential settlements; see EP 4-2-1.

1.1.2. Footing size and shape shall be determined by settlement considerations, if specified, and by the following criteria.

1.1.2.1. Foundation loads and load combinations shall be in accordance with EP 4-1-1.

1.1.2.2. Under the action of vertical or lateral loads, or both, with loading combinations which result in maximum vertical load or overturning moment, or both, the maximum soil pressure shall not exceed the applicable allowable value.

1.1.2.3. Applicable allowable values of bearing pressure for various loading combinations shall be as specified in the soils investigation report. However, unless a lower factor is specified in the applicable local, state, provincial, or country building code, the maximum increase of the basic allowable bearing pressure permitted for loading combinations that include wind, seismic or other occasional loading conditions shall be 33%.

1.1.2.4. Unless a higher minimum safety factor is specified in the applicable building code, foundations shall be designed to have a minimum safety factor of 1.5 against overturning, 1.5 against uplift, and 1.5 against sliding. If wind, rather than seismic load governs, the uplift and sliding factors of safety may be reduced by 15% for the initial erection load case, and by 25% for the periodic maintenance load case. The safety factor against flotation shall be at least 1.2 against the highest anticipated water level. In determining the safety factor against flotation, allowance should be made for future removal of soil above the foundation or of equipment from it, and for possible loss of skin friction from the sides. No reduction to the flotation or overturning factors of safety is permitted.

1.1.2.5. For foundations bearing on cohesionless soil supporting towers or other slender structures with heights greater than 100 ft. (30 m) and a ratio of total height to skirt or base diameter greater than 10: 85% of the foundation shall be in compression for the design overturning moment during erection and 100% of the foundation shall be in compression for the design overturning moment during normal operation. In lieu of these requirements, foundations may be designed based on the factors of safety given in paragraph 4.2.4, provided base shear, uplift and overturning moment are determined from dynamic wind and/or seismic analyses in addition to a consideration of all static loading conditions. In this case, all other requirements in this Section shall be met, except the increase allowed in the basic allowable bearing pressure for occasional loads shall be prohibited.

1.1.2.6. Loads and reactions from piping shall be considered in the design of foundations, supports for equipment, and other such structures. Foundations for elevated pipe support shall be designed for a minimum of 20 percent future increase in pipe loadings.

1.1.2.7. If not otherwise specified, the maximum permitted long-term settlement for foundations shall be 1.0 inch (25 mm), and the maximum differential, long-term settlement shall be 1/2 inch (13 mm).

1.1.3. The bottoms of soil bearing foundations for all major structures and equipment shall be located below the frost line as defined in EP 4-2-1.

1.1.4. Design of reinforced concrete shall be in accordance with the requirements of this Practice and EP 4-3-1.

1.1.5. The top of concrete shall be a minimum of 8 inches (200 mm) above finished grade or high point of paving for foundation under the following equipment:

1.1.5.1. Steel column bases of open structural framing.

1.1.5.2. Pipeway supports.

1.1.5.3. Pumps, fans, compressors, and legs or skirts of towers, drums and exchangers.

1.1.6. For commercial or industrial type buildings, the top of concrete piers shall be flush with the floor.

1.1.7. As a minimum, piers under base plates and pedestals supporting vessels with skirts shall extend 1-1/2 (38 mm) inch minimum beyond the base plates, or skirt base rings and lugs, in all directions.

1.1.8. Piers and pedestals shall be reinforced to resist thermal stresses due to expansion of base plates, soleplates, rails, skirt base rings and lugs, anchor bolts, and concrete. The minimum ratio of vertical reinforcement for compression members per ACI 318 shall be required. When approved by the Employer's Engineer, the minimum ratio may be determined using the area of concrete required to carry the factored load with the additional concrete added to the cross- section not included in the gross area per the ACI commentary. Additionally, as a minimum, vertical reinforcing shall be tied as follows:

1.1.8.1. For EPCL facilities, the minimum ratio of vertical reinforcement for compression members shall be per ACI 318.

1.1.9. Additionally, as a minimum, vertical reinforcing shall be tied as follows:

1.1.9.1. For piers in U.S. facilities, vertical reinforcing shall be enclosed in lateral ties per ACI 318 requirements for tie reinforcement of compression members.

1.1.9.2. For piers in Canadian facilities, vertical reinforcing shall be enclosed in lateral ties per CSA 23.3 for tie reinforcement of compression members.

1.1.9.3. For pedestals in U.S. facilities, vertical reinforcing shall be enclosed by complete circumferential ties meeting the size and spacing requirements of ACI 318 for tie reinforcement of compression members.

1.1.9.4. For pedestals in Canadian facilities, vertical reinforcing shall be enclosed by complete circumferential ties meeting the size and spacing requirements of CSA 23.3 for tie reinforcement of compression members.

1.1.10. The spacing between the top two ties in piers and pedestals shall not exceed 4 inches (100mm).

1.1.11. Concrete in piers and pedestals, and grout under base plates, soleplates, rails, skirt base rings and lugs, shall not extend above the bottom face of these structural support components.

1.1.12. If required by the Employer's Engineer, pedestals for vessels with skirts shall have the area within the skirt sloped for drainage, and a suitable embedded pipe or opening in the grout provided, discharging to the pavement outside the skirt.

1.1.13. At least 3 inches (75 mm) of concrete protection shall be provided between the outside diameter

1.1.14. of the anchor bolt sleeve and the soil-contact surface of the concrete. Anchor bolts shall be located inside the reinforcing steel cage.

1.1.15. Small equipment and pipe base supports with vertical loads less than 1000 lbs. (4.4 kN), and stair and ladder pads shall be supported on reinforced concrete paving or floor slabs. Small equipment and pipe base supports with vertical loads greater than 1000 lbs. (4.4 kN) may be supported on reinforced concrete paving or floor slabs when the design is shown to be acceptable by analysis. In such cases, the Employer's Engineer shall review the results of the analysis and approve the subsequent design. In unpaved areas, these items shall be supported on concrete foundations with a minimum embedment depth below the frost line.

1.1.16. Concrete foundation members shall be isolated from adjacent equipment slabs, or pavements using joint filler and sealer, unless otherwise specified by the Employer's Engineer.

1.1.17. The sealer shall be a two component polysulfide component, unless otherwise specified by the Employer's Engineer.

1.1.18. Foundation design calculations and input and output from any computer analyses performed in the foundation design process, shall be submitted to the Employer's Engineer for review.

1.2. ANCHOR BOLTS

1.2.1. Anchor bolts shall be designed to resist all conditions of tension and shear at the base of
1.2.2. structures, including the tension effects of any bending moments which may result from fixation.

1.2.3. For EPCL facilities, anchor bolts shall be sized using allowable stresses given in AISC 325; however, no increase in allowable stresses shall be taken when wind or earthquakes are considered.

1.2.4. Anchor bolt sizes determined by this method shall have their diameters increased by 1/8 inch (3mm) as a corrosion allowance.

1.2.5. For EPCL facilities, the embedment depth and loads transferred to the concrete shall be evaluated based on ACI 318.

1.2.6. Anchor bolts shall have a minimum clearance of 3 inches (75 mm) from the faces of piers or foundation blocks.

1.2.7. Material for carbon steel anchor bolts shall be ASTM F1554 Grade 36 unless otherwise specified. Material of nuts for carbon steel anchor bolts shall be per ASTM A563, Grade DH, hexagon, heavy series, or ASTM F3125/F3125M, Grade A325, Type 3. For U.S. facilities, material for high strength alloy steel anchor bolts shall be per ASTM A354 Grade BC or in accordance with AISC 325. Material of nuts for alloy steel anchor bolts shall be per ASTM A563, Grade DH, hexagonal, heavy series.

1.2.8. For situations when anchor bolts may be exposed to elevated temperatures, anchor bolt material shall be ASTM A193/A193M and nuts shall be ASTM A194/A194M Grade 2H, hexagonal, heavy hex.

1.2.9. Alloy bolting material with a washer and two nuts shall be used when anchoring reciprocating compressors and other equipment subject to severe vibration.

1.2.10. If difficulty is expected in maintaining anchor bolt alignment, sleeves shall be specified.

1.2.11. Unless otherwise approved by the Employer's Engineer, sleeves shall not be used with bolts larger than 1-1/2 inches (38 mm) in diameter or when multiple anchor bolts are required in a small area. Templates shall be used for such bolts. Unless specified by the Employer, sleeves shall not be used for anchor bolts for column base plates.

1.2.12. When protective coatings are required for anchor bolts, they shall be galvanized.

1.2.13. Acceptable anchor bolt details are given in Figure 5. Alternate designs shall be submitted to the Employer's Engineer for approval. As-built plan, elevation and detail drawings of anchor bolt placement and design shall be submitted to the Employer's Engineer.

1.3. ADDITIONAL REQUIREMENTS FOR LIGHT MACHINERY

1.3.1. The ratio of concrete foundation weight to equipment weight shall be as follows:
- 1.3.1.1. Rotary Equipment – 3:1.
- 1.3.1.2. Reciprocating Equipment – 5:1.

1.3.2. Typical pump foundation and pump slab details are shown in Figure 1 and Figure 2. Piping elbow supports located adjacent to the pump and driver shall rest on a concrete base that is integral with the equipment foundation. Details of the base shall be shown on foundation drawings per Figure 3. Pump slabs shall be provided with wash down facilities when specified by Employer's Engineer.

1.3.3. In addition to reinforcing steel required by design, a minimum of two rows of ties around tops of anchor bolts in the pump pedestal and temperature steel in the top of the slab shall be provided.

1.3.4. On pump slabs, the pump foundations may be an integral part of the slab. When this is done, the mass ratio shall be computed as the ratio of the weight of the entire pump slab to the combined weight of the pump equipment.

1.3.5. Pump slabs shall be provided with drains to catch basins, which shall be located at the edge of the slab. The slab shall be sloped to drain spills away from the pumps. Individual drains are required for all pumps handling flammables and shall be piped to a catch basin or manhole under seal. If the pump base plate is not provided with a drip

pan, a two by four-inch (50 mm by 100 mm) nominal slot shall be provided around the pump pedestal sloped to an open hub. Drain trenches and pipe trenches are not permitted unless approved by Employer.

1.3.6. Electrical conduits shall be provided to the pump foundation before the slab is poured.

Schedule 1 – Part VI

Electrical Requirements

ELECTRICAL REQUIREMENTS

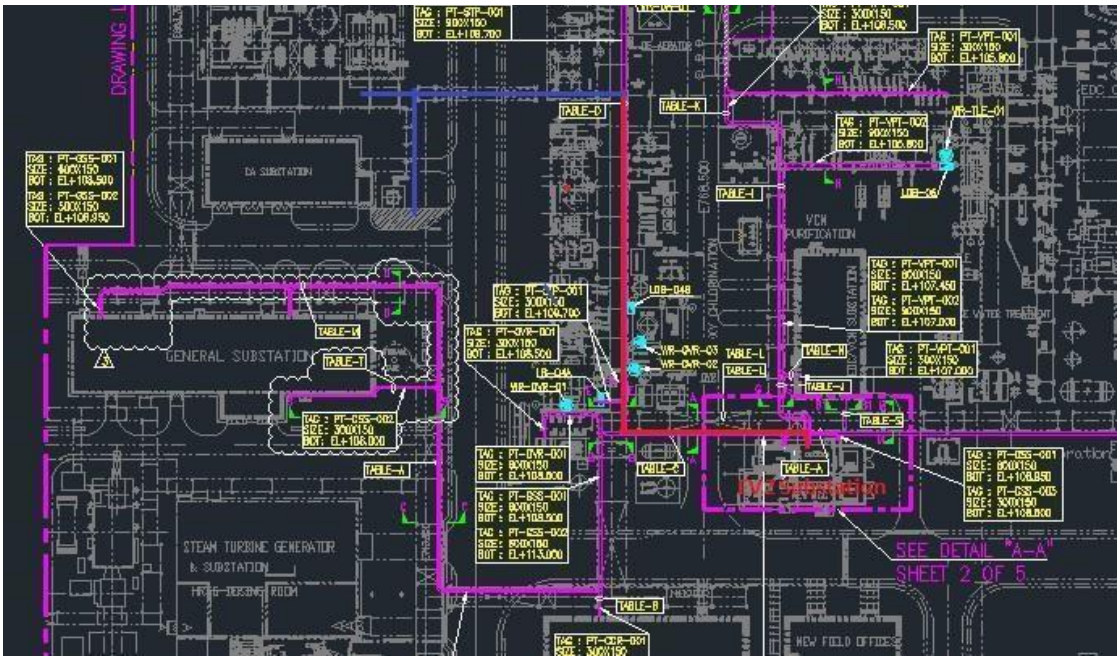
Designing/ engineering, procurement, installation, and commissioning of following items is includedin contractor scope.

1) Submission of as built drawings of VCM DBN MCC after the installation of HTDC equipment in MCCwhich includes single line drawing, substation layout drawing, schematic drawing, wiring drawing,relay settings, UPS drawing, fire alarm system drawing, paging system drawing, IO panel drawing,drawing for panel frame modification for LV panels and drawing for panel frame modification forUPS distribution panel. [Drawings must be provided in hard copy and soft copy. For soft copy, pdf and AutoCAD files are required]
2) HTDC UPS distribution panel shall be installed on ground floor of VCM DBN Substation. UPS distribution panel has been procured by EPCL.

Following scope needs to be executed by contractor.

a) Modification and extension of panel base frame. Procurement, shifting, installation (via welding, cutting, grinding), civil scope (if any) and painting of base frame material shall be theresponsibility of contractor.
b) Shifting of UPS distribution panel from EPCL warehouse to ground floor of VCM DBN substation.
c) Installation of UPS distribution panel on base frame. All accessories and tools required for panel shifting/ installation shall be the scope of contractor.
d) UPS distribution panel shall be coupled with existing UPS already installed on ground floor ofVCM DBN substation. Material and services required for hook-up of UPS distribution panel with existing UPS (via cable connection) shall be the scope of contractor.
e) Contractor shall perform the hook-up/ coupling and testing of UPS distribution panel.
f) UPS distribution panel shall be powered up by contractor.
g) Grounding of new UPS distribution panel shall be done by contractor. Grounding resistance should be less than 1 Ohm.

3) Drawing containing cable route from VCM DBN MCC till HTDC battery limit and from VCN DBN MCC till control room needs to be provided by contractor after site visit. All cables will be laid overhead. Proposed cable route is shown below.



Red and blue Line shows cable tray Layout of MCC to HTDC unit

4) Designing, fabrication and installation of galvanized cable tray supports from VCM DBN MCC till HTDC battery limit and from VCM DBN MCC till control room shall be the scope of contractor. Cable tray supports shall be installed by means of welding and shall be of same material as that ofexisting plant supports. Painting of cable tray supports is also the scope of contractor. Designing, fabrication and installation of galvanized cable ladders and cable trays from VCM DBN MCC till start of HTDC battery limit and from VCM DBN MCC till control room shall be the scope of contractor.

Cable tray supports shall be a combination of H beams, C channels and angles. Cable ladders, cable trays and their supports shall be strong enough to meet the load requirements of the cable management system. Support systems can be broken down into several elements or components. To design a safe system it is necessary to check each element in turn to ensure.

- That it can safely support the loads being imposed upon it.
- That the proposed fixings to adjacent components are also strong enough for theintended load.
- That any declared deflection limits are not exceeded.

Electrical cables ladders shall comply with following specifications.

- Hot dip galvanized
- 12 SWG (at least)
- Cable ladder should have covers with clamp arrangement so that cable ladder coversmay not get dislodged during high winds.

Separate cable trays will be used for LV power cables, LV control cables, communication cablesand fire alarm cables.

5) Cables will be provided by EPCL, however, laying from VCM DBN MCC till HTDC battery limit and from VCM DBN MCC till control room shall be the scope of contractor. Cable testing, loop testing will also be in contractor scope
6) Interconnection drawing between I/O panel and low voltage Electrical panels in VCM DBN

substation shall be provided by contractor. Cables will be provided by EPCL, however, cable layingand termination along with cable markers and core tagging shall be the scope of contractor. Cable testing, loop testing will also be in contractor scope

7) Tagging with paint on ISBL and OSBL electrical equipment, motors, feeders, LCS, DBs, etc.) shall be the scope of contractor.
8) Tagging of feeders with metallic tags like existing ones will be provided and installed by contractor.
9) End to end testing of Electrical equipment from VCM DBN MCC till equipment will be the scope ofcontractor.
10) Blank reports for QA/QC checks of motors, LCS, lighting, receptacles, and grounding network (endto end loop) will be provided by contractor.
11) General note: drawings must be provided in hard copy and soft copy. For soft copy, pdf and AutoCAD files are required.
12) IEC standards shall be followed.
13) Installation of 02 redundant parallel UPS system for HTDC compressor lube oil pump shall be thescope of contractor. UPS shall be installed on 2nd floor of VCM DBN MCC. Installation (end to end scope including cables) and commissioning shall be the scope of contractor. Wiring, Cable Laying, Installation, Termination part of GASCO Scope. 3 control cables mentioned in post bid shall be laid, termination, testing, any other scope related to installation.
14) Following studies shall be provided by contractor from HTDC point of view.
    - Short circuit calculations.
    - Load flow analysis.
    - Protection coordination study.
    - Stability analysis of VCM DBN substation with HTDC loads. EPCL will provide GSS and EDC/VCM network study results.
    - Protection relay settings of HTDC shall be provided by engineering contractor in hard copy and soft copy.
15) Complete electrical scope (Designing, procurement, installation, testing) of electrical heat tracing lies with contractor responsibility. All panels, JBs, etc. must comply hazard area classification (Exd IIB T4 or above). Cable glands must be of SS. Conduits will be of GI Galvanized. Armored XLPE FR Cables (Pakistan, Fast Cables) to be considered. Circuit breaker should be of ABB, Siemens, schneider. GASCO must be considered incoming cable to heat tracing panel from switchgear. All cables required for the scope must be considered.
16) Complete lighting scope on new pipe rack scope lies with contractor. Explosion proof flood lights (Qty. 08) must be considered along with their supports and accessories.
17) New PR earthing will be in contractor scope, bonding continuity lugs for piping is also in contractor scope.
18) All activities and material related to support services, like cable laying, termination, electrical DBs, Lights, Receptacles, etc will be contractor scope.
19) All drawings related to above points shall be provided by contractor.
20) Contractor shall submit a list of Electrical deliverables along with their quote.
21) Power cable from VCM MCC has been considered for transformer, 01xUPS, Electrical Heat tracing,
22) Firewater UG, CP, UPS, UPS Cabling, Cable Trays has been considered in GASCO Proposal.

Attachment:

- Annexure 1 - EV2 Substation Layout
- Annexure 2 - UPS Distribution Panel Drawing

Schedule 1 – Part VII

Instrument & Control Requirements

Instrument and Control Requirements

I. Power cables procurement, laying, termination of cables from new EDC/VCM Substation to DCS, ESD and PC-451 Compressor Control Cabinets.

II. Signals / control cables procurement, laying, termination of cables from new EDC/VCM IO Panel to DCS, ESD and PC-451 Compressor Control Cabinets.

III. Installation of PC-451 Panel and Annunciator console along with interconnection terminations between all Panels/consoles.

IV. Supply, Installation & Loop Testing of Control valves / On/off valves, Field Instrumentation & Junction Box along with glands (03 Control Valves, 03 Shutoff Valves, 02 PT's, 01 FT & 02 JB's) as per process requirement along with its associated control cables & cable tray Procurement, Installation/Laying, termination & loop testing to be considered in instrumentation scope.

V. Make of Valves shall be fisher. Sizing and datasheet to be shared by GASCO.

VI. Engineering supply hot work / fabrication & installation of cable trays for the OSBL route from HTDC ISBL battery limit to the CCR System & Marshalling control cabinets to be considered in instrumentation scope. Proposed route given below.

VII. Termination / interconnection of safety, system, and chassis (DCS, ESD and Compressor Control Cabinets) grounding wires with base plant grounding network.

VIII. OSBL Scope Cable tray tentative length from field till CCR is Approx 500m, Also cable tray entry into existing CCR to be carried out by core cutting on CCR north side wall with proper sealing same as done on VCM DBN.

IX. Analyzers Interconnection with Process piping's (Sample line, Instrument Air, Sample drain/Vents, Calibration Gases etc.)

X. New JBs separate for DCS and ESD will be procured and installed. No ISBL or base plant JB will be allowed for OSBL scope.

Proposed Cables Route: