TENDER DOCUMENT

For

Design, Engineering, Procurement, Fabrication, Supply, Construction and Commissioning on LSTK Basis of One No. Central Gas Gathering Station & Off Take Point at Madhuban and One No. Field Gathering Station at Chabua, Assam, India

VOLUME-II OF VI TECHNICAL

TENDER NO. OIL/CCO/PDNG/GLOBAL/215/2008

Saipem Triune Engineering Pvt. Ltd.
NEW DELHI
INDIA
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1.0 INTRODUCTION

Oil India Limited (OIL) is a premier national oil company, engaged in the business of Exploration, Production and Transportation of crude oil and natural gas. Oil India Limited is schedule-A company under the ministry of petroleum and natural Gas Govt of India has its Headquarter at Duliajan, Assam. The nearest Airport at Dibrugarh is about 45 km from Duliajan.

The development of non-associated gas field in OIL’s Upper Assam operational area is underway. As a part of this development scheme, OIL desires to construct state-of-the-art stations namely, one non-associated gas production set up (Field Gathering Station: FGS) at Chabua and one High volume Self Contained Gas Gathering, Custody Transfer and Metering Delivery Terminal (Central Gas Gathering Station and Off-take Point; CGGS & OTP) at Madhuban, Duliajan in Upper Assam, India.

The Field Gathering Stations in particular, would also be utilized to test gas wells, generate adequate data / information required for proper reservoir management. The fluid produced at these stations will be measured separately and after disposing of the produced formation water, if any, the condensate and the gas will be re-mixed for transportation through trunk pipeline. These features would be based on latest control system available. The CGGS & OTP shall also have online monitoring and control facility for multi-line incoming and outgoing gas streams and custody transfer measurement for all sale gas. Besides it would have efficient condensate and effluent handling system.

All stations shall have stand-alone facilities. Stations will have relevant ISO/ ISRS certification. All electrical & instrument items installed in Hazardous location should have valid DGMS approval.

SAIPEM TRIUNE ENGINEERING PVT LTD, (STEP) New Delhi, India has been engaged by OIL as Engineering and Project Management Consultant (EPMC) for installation of the facilities proposed to be set up. The FEED Package has been developed by STEP and implementation of the facilities shall be done by engagement of an Engineering, Procurement and construction (EPC) contract on LSTK basis.

2.0 BRIEF DESCRIPTION OF WORK

Residual Basic Engineering and Design, Detail Engineering based on FEED, Soil Investigation, Procurement, Supply, Manufacture, Fabrication, Carrying out Route Survey wherever required, for over dimensional consignments, Transportation of all equipment and material to site including loading, unloading, storage, insurance, and maintenance, Installation, Construction, Obtaining all necessary approvals
from statutory bodies as applicable, Hook up, Testing, Pre-commissioning, Performance Guarantee Test Runs including Total Project Management and 3 (Three) years of Operation & Maintenance of 1 No. Central Gas Gathering Station and Offtake Point at Madhuban and 1 No. Field Gas Gathering Station at Chabua, Assam, India.

3.0 COMMENCEMENT AND COMPLETION PERIOD

Date of Notification of Award (NOA) to the Contractor shall be the date for commencement of the job (Zero Date). Completion period of the job is 18 months from the date of NOA excluding Operation & Maintenance period.

4.0 SITE LOCATION AND ENVIRONMENTAL DATA

4.1 LOCATION:
Location of FGS/ CGGS and OT Point Sites is as follows:

<table>
<thead>
<tr>
<th></th>
<th>MADHUBAN</th>
<th>CHABUA</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATE</td>
<td>ASSAM</td>
<td>ASSAM</td>
</tr>
<tr>
<td>NEAREST IMPORTANT TOWN AND DISTANCE</td>
<td>TINSUKIA, 21Km. (Approx)</td>
<td>DIBRUGARH, 35Km (Approx)</td>
</tr>
<tr>
<td>NEAREST RAILWAY STATION AND DISTANCE</td>
<td>BORDUBI, 2Km. (Approx)</td>
<td>CHABUA, 3 Km (approx)</td>
</tr>
<tr>
<td>PROPOSED RAILWAY APPROACH</td>
<td>Existing PWD road to Tinsukia.</td>
<td>No direct approach is available.</td>
</tr>
<tr>
<td>NEAREST PORT</td>
<td>No port existing.</td>
<td>No port existing.</td>
</tr>
<tr>
<td>NEAREST AIRPORT AND DISTANCE</td>
<td>DIBRUGARH (Mohanbari), 54Km</td>
<td>DIBRUGARH (Mohanbari), 26Km</td>
</tr>
<tr>
<td>NEAREST HIGHWAY MILESTONE AND DISTANCE</td>
<td>NH-37 at a distance of approx 21Km</td>
<td>NH-37 At 3Km</td>
</tr>
<tr>
<td>APPROACH ROAD</td>
<td>Existing PWD road to Tinsukia.</td>
<td>SMALL GARDEN ROAD AVAILABLE. New road will be constructed by OIL.</td>
</tr>
</tbody>
</table>
### 4.2 GEOGRAPHICAL DATA

<table>
<thead>
<tr>
<th></th>
<th>MADHUBAN</th>
<th>CHABUA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HEIGHT ABOVE MEAN SEA LEVEL</strong></td>
<td>119.344m</td>
<td>121.20 m</td>
</tr>
<tr>
<td><strong>BENCH MARK LEVEL AND LOCATION</strong></td>
<td>119.34m over cellar of Well-50</td>
<td>121.20 m over cellar of Chabua Well-1</td>
</tr>
<tr>
<td><strong>TERRAIN TYPE, HIGH/LOW POINT</strong></td>
<td>Low lying paddy land</td>
<td>Low lying paddy land</td>
</tr>
<tr>
<td><strong>OVERHEAD POWER LINES</strong></td>
<td>Yes</td>
<td>Nil</td>
</tr>
<tr>
<td><strong>UNDERGROUND LINES OBSTRACTIONS</strong></td>
<td>Yes</td>
<td>Nil</td>
</tr>
<tr>
<td><strong>HISTORICAL MONUMENTS/SPECIAL FEATURE</strong></td>
<td>Well-50 boundary surrounded by High brick wall.</td>
<td>Well Head of Chabua Well-1</td>
</tr>
</tbody>
</table>

### 4.3 METEOROLOGICAL DATA

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<tr>
<th></th>
<th>MADHUBAN</th>
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<tbody>
<tr>
<td><strong>CLIMATE</strong></td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>TEMPERATURE</strong></td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>MAXIMUM/MINIMUM DRY BULB TEMPERATURE</strong></td>
<td>40 degree / 7 degree Celsius</td>
<td>40 degree / 7 degree Celsius</td>
</tr>
<tr>
<td><strong>DESIGN DRY BULB/ ET BULB TEMPERATURE</strong></td>
<td>24 degree / 21 degree Celsius</td>
<td>24 degree / 21 degree Celsius</td>
</tr>
</tbody>
</table>

### 4.4 RAINFALL

<table>
<thead>
<tr>
<th></th>
<th>MADHUBAN</th>
<th>CHABUA</th>
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<tbody>
<tr>
<td><strong>RAINY SEASON</strong></td>
<td>194.20cm in whole monsoon.</td>
<td>194.20cm in whole monsoon.</td>
</tr>
<tr>
<td><strong>MAXIMUM RECORDED IN 24 HOURS</strong></td>
<td>15.90cm</td>
<td>15.90cm</td>
</tr>
</tbody>
</table>

### 4.5 WIND

<p>|                               | MADHUBAN          | CHABUA            |</p>
<table>
<thead>
<tr>
<th>Wind Velocity and Direction</th>
<th>Refer Wind Roses Data</th>
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<tr>
<td>Basic Wind Speed</td>
<td>50 m/sec at 10 m height</td>
</tr>
<tr>
<td>Wind Direction and Percentage</td>
<td>Refer Wind Roses Data</td>
</tr>
<tr>
<td>Prevailing Wind Direction</td>
<td>Refer Wind Roses Data</td>
</tr>
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</table>

### 4.6 Relative Humidity

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<th>Madhuban</th>
<th>Chabua</th>
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</thead>
<tbody>
<tr>
<td>Minimum Relative Humidity</td>
<td>78%</td>
<td>78%</td>
</tr>
<tr>
<td>Relative Humidity @ Max Temperature</td>
<td>96%</td>
<td>96%</td>
</tr>
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</table>

### 4.7 Site Grading / Roads Drains

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<thead>
<tr>
<th></th>
<th>Madhuban</th>
<th>Chabua</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design HFL for Grading</td>
<td>118.894m</td>
<td>99.50</td>
</tr>
<tr>
<td>Proposed FGL</td>
<td>119.344m</td>
<td>100.300</td>
</tr>
<tr>
<td>CBR Value for Road Design</td>
<td></td>
<td>As per soil report</td>
</tr>
<tr>
<td>Storm Water Disposal Point</td>
<td>To be shown at site</td>
<td>To be shown at site</td>
</tr>
</tbody>
</table>

### 4.8 Water Supply

<table>
<thead>
<tr>
<th></th>
<th>Madhuban</th>
<th>Chabua</th>
</tr>
</thead>
</table>


### Source of Water

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<thead>
<tr>
<th></th>
<th>Deep Tube-well</th>
<th>Deep Tube-well</th>
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### 4.9 Railway

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<tr>
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<th>Madhuban</th>
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<tr>
<td>Railway Station for Connection</td>
<td>Duliajan</td>
<td>Chabua</td>
</tr>
<tr>
<td>Gauge of Railway</td>
<td>Broad</td>
<td>Broad</td>
</tr>
</tbody>
</table>
5.0 PROJECT DESCRIPTION:

5.1 BRIEF PROCESS DESCRIPTION

5.1.1 FGS CHABUA (Green field Project)

Field Gathering Station at Chabua is designed to receive well fluids from 10 nos. of wells. 5 Nos. of Indirect Bath Heaters (E-3001 A/B/C/D/E) are provided, each catering to 2nos. of wells. The well fluid is heated from 7 deg C to 70 deg C in the first compartment of bath heater and then pressure reduction to 30 kg/cm²g is effected through choke valve. In the second compartment the fluid is again heated to 40 deg C. Bath heaters are skid mounted for ease in relocation. Three inlet manifolds are provided, namely Test manifold, Lean gas manifold and Rich gas manifold. Each well can be connected to any of the three manifolds. All the three manifolds are designed on modular concept (for easy relocation) and one module of a manifold cater to 4nos. of wells. Test manifold is designed for 0.5 MMSCMD capacity and Lean & Rich Gas manifolds each are designed for 1.25 MMSCMD capacities.

All the separators are skid mounted for easy relocation. 1 No. of horizontal 3-phase separator (V-3001) of 0.5 MMSCMD capacity is provided to test individual wells. Mass Flow Meters/Ultrasonic flowmeter are provided for accurate measurement of condensate and water/Gas during detailed well testing. To cross check the quantities of condensate and water separated in the test separator during detailed well testing, Condensate Gauge Tank (T-3001) and Water Gauge Tank (T-3002) are provided for accurate measurement of the fluids. Ultrasonic type flow meter is provided to measure the gas flow from the separator.

2 Nos. (1W + 1S) Production Separators (V-3002A/B) for lean gas and 2 Nos. (1W + 1S) Production Separators (V-3003A/B) are provided. Gas and condensate are mixed and sent to CGGS Madhuban through 16” pipeline. Separated water shall be sent to ETP for treatment and disposal.

The flare system shall receive PSV discharges, blowdowns and other ventings from equipment and inlet manifold in a Flare KOD (V-3004) and then goes to Ground Flare System (X-3001). The Flare KOD also receives recovered oil from CBD and OWS system. The collected oil from Flare KOD is recycled back to inlet of Production Separator with the help of Oil Recycle Pump.

The Ground Flare Package is designed for 1.25 MMSCMD and it includes a PLC based burner management system, water seal etc.
5.1.2 CGGS MADHUBAN

Gas Treatment Trains

There will be total 9 nos. of trains as follows:

1. Lean Gas Train for Chabua
2. Rich Gas Train for Dikom – Tengakhat
3. Rich Gas Train for Well # 308
4. Lean Gas Train for Baghjan (Future)
5. Lean Gas-I Train (Future)
6. Lean Gas-II Train (Future)
7. Rich Gas Train for Ex-LPG (Future)
8. Rich Gas-I Train (Future)
9. Rich Gas-II Train (Future)

Gas from each train is received in a Slug Catcher. Slug Catcher removes slug of condensate if any from the gas. The gas then passes through Two Phase KOD and Filter Separator for removal of residual condensate present in the gas.

The lean gas then goes to Lean Gas Header operating at 15 Kg / cm²g and the rich gas goes to Rich Gas Header operating at 9 Kg / cm²g. Condensates separated out from Slug Catchers and Two Phase KODs of each train are taken to a Condensate Flash Separator under level control for stabilization of condensate.

Water separated out from Slug Catchers, Two Phase KODs, Filter Separator and Condensate Flash Separator is drained to Effluent Tank.

Condensate Storage and Loading

The stabilized condensate from condensate Flash Separator is collected in a Condensate Storage Tank (T-1001) of 250m³ capacity. The condensate is then pumped to nearest OCS or loaded in truck tanker for dispatch. Two more Condensate Storage Tanks (T-1002 and T-1003) each of 500m³ shall be provided at a future date.

Gas Distribution Headers

The Lean Distribution Header operating at 15 kg/cm² receives lean gases from Baghjan, Chabua, Lean Gas-I and Lean Gas-II trains. From this header lean gas is
sent to BVFCL/APL/ASEB/Lakwa, DTACT, NRL, Tea Gardens, OCS-4 and internal consumptions.

The Rich Distribution Header operating at 9 kg/cm²g receives rich gases from Well # 308, Ex-LPG, Dikom-Tengakhat, Rich Gas-I and Rich Gas-II trains. From this header rich gas is sent to Assam Gas Cracker Project.

The lean gas coming back from Assam Gas Cracker Project is received in a HP header(25kg/cm²) and sent to Digboi and Moran customers.

**Flare System (Non-luminous, low db and eco-friendly)**

The flare system shall receive PSV discharges, blowdowns and other ventings from equipment and distribution headers in a Flare KOD (V-1029) and then goes to Ground Flare System (X-1001). The Flare KOD also receives recovered oil from CBD and OWS system. The collected oil from Flare KOD is recycled back to Condensate Flash Vessel with the help of Oil Recycle Pump.

The Ground Flare Package is designed for 12.5 MMSCMD to cater to the needs of 9 upcoming trains.

**Effluent System**

The water from various Slug Catchers, KODs, Filter Separators, and Storage Tanks etc. are received in Effluent Water Tank (T-1007). The oily waste water is sent to ETP for treatment and then sent to nearest Oil Collecting Station (OCS) for disposal by OIL. Provision is also made to load this effluent in tanker for further transport by OIL to nearest OCS / ETP. The provision for ETP is to be carried out as per design.

Process Description is further elaborated in Process Design Basis – Doc. No.9473-01-DB-002 Rev.0 provided in Book-I.
6.0 SCOPE OF WORK

6.1 General

The CONTRACTOR’S scope and obligations based on FEED package, Residual Basic Engineering and design, Detailed Engineering, Soil investigation, Procurement, Supply, Manufacture, Fabrication, Route survey wherever required for over dimensional consignments, Transportation of all equipment and material to site including loading, unloading, storage, insurance and maintenance, Installation, Construction, Obtaining all Government approvals as applicable, Hook up, Testing, Pre-commissioning, Commissioning, Performance test runs including total Project Management and handing over of One No. Central Gas Gathering Station & Off take Point at Madhuban and One No. Field Gas Gathering Station at Chabua, Assam, India on Turnkey basis.

FEED Package is provided along with the tender documents, which consists of Design Basis, PFDs, P&IDs, Process Data Sheets for equipment, instruments and packages, Mechanical data sheets for equipment, Plot Plan and other related Civil Drawings, equipment layout, scope drawings, area classification drawings, specifications and standards etc.

All the required static and rotary equipment, packages, instrumentation items, electrical items, air conditioning equipment, laboratory equipment and other bulk materials shall be supplied by the contractor as per approved specification from the vendors included in the Vendor List given elsewhere in the bid document. Moreover, the standard furniture (as per tender specification) required for control room building will be under the scope of the contractor.

The contractor has to ensure the following:

i. Verification of Process Data and Confirmation of additional requirement, if any.

ii. Provide guarantee for Equipment Performance

Bidder shall arrange for the visit of vendor specialists for minimum two occasions during engineering stage without any cost implication to owner.

Contractor shall verify the information and requirement provided herein and satisfy them for the proper execution of the job. Once the Contractor is satisfied, the Contractor without any additional cost and time to the Owner shall supply any item not specifically included herein but required for the completion of the project.

CONTRACTOR shall visit the site at their cost prior to submission of bid and apprise himself of the existing conditions.
The requirement stipulated in the Bid Document is the minimum requirement for the project. Any item that was not covered in the document but required, as per assessment of the Bidder, for fulfilling the performance of the system/stations, contractor may indicate the same with techno-economical justification for Owners consideration along with the BID.

The drawing of the buildings and architecture shown in the drawings are also indicative of minimum requirement. Any alternate scheme within the built-in area provided may be suggested to make the building more suitable, useful and beautiful without incurring any additional cost.

6.2 ENGINEERING

6.2.1 Scope of Work of CONTRACTOR includes acceptance of the FEED package for execution, Residual Basic Engineering and design, Engineering, Procurement, Fabrication, Supply, Construction and Commissioning on LSTK basis.

6.2.2 Engineering required to be done by the CONTRACTOR may arise singularly or in combination be it manufactured / fabricated / purchased / construction / commissioning / statutory requirements, Govt. Regulations / safety requirements, site conditions. Resultant total procurement and construction installation, testing, insulation, painting and commissioning are also in the scope of CONTRACTOR.

6.2.3 The CONTRACTOR shall comply with all prerequisites mentioned in the contract document.

6.2.4 The CONTRACTOR shall carry out engineering based on the Front End Engineering and Design (FEED) Package provided in the bid document. The CONTRACTOR shall enter into a secrecy agreement with the Owner / EPMC for non-disclosure of any data / details without written consent of the Owner / EPMC.

6.2.5 No changes to the basic parameters provided in the Engineering Package shall be acceptable. If for any technical reason a change is warranted then such changes required by the CONTRACTOR shall be requested to Owner / EPMC, with detailed explanation, for obtaining Owner’s / EPMC approval / clarification. The CONTRACTOR shall do the changes only if agreed by the Owner / EPMC. Such changes shall be deemed as a part of scope of work of the CONTRACTOR and shall have no additional cost and time implication to Owner / EPMC. However, if the agreed changes / deviations result in cost saving, then the same shall be passed on to Owner.

6.2.6 Any clarification required on package by the CONTRACTOR shall be sent to Owner / EPMC. The CONTRACTOR shall abide by the Owner / EPMC’s clarification and shall be deemed as a part of scope of work of the CONTRACTOR and shall have no additional cost and time implication to Owner / EPMC. However,
if the agreed changes / deviations result in cost saving, then the same shall be passed on to Owner.

6.2.7 Equipment Layout Plans have been developed indicating the respective locations of various equipment envisaged under the above project. The plot plan provided in the tender document has to be suitably prepared by the EPC contractor. The CONTRACTOR may develop better to improve human engineering and shall fit in all the facilities within this area.

6.2.8 The CONTRACTOR shall indicate the area for hardstand of crane in the equipment layout. It shall be noted that the erection scheme of the equipment is to be finalized in such a manner that there is NO HOLD on any of the adjoining foundations / structures / equipments whatsoever. The construction of hardstand, shall be in the scope of the CONTRACTOR.

6.2.9 The nos. of Gas Chromatograph in installations is to be fixed depending on the 'availability of nos. of channel per chromatograph instrument'. The EPC bidder will specifically define the vendor for this item and hence, the nos. shall be determined.

6.2.10 The LSTK Contractor shall perform the detail engineering for Slug catchers. Suitable provision has to be kept in case of selection of Slug Catchers for Baghjan and Chabua train for Reengineering / Detail Engineering/ Material selection of the Slug Catchers by the EPC contractor based on actual field data depending on the route and contour of the pipelines from the Field Gathering Stations to the CGGS. The EPC contractor will have to reconfirm the suitability of the design. The design of Slug Catcher given elsewhere in Tender Documents is indicative & for Bidding purpose only, further CONTRACTOR has to pass on any Cost benefit which may comes during Detailed Engineering to OIL.

6.2.11 The type of Flow Meters, type and nos. of Flow Computers and On Line GC's for both the stations need to be finalized in consultation with DCS suppliers, to optimize the requirement during detailed engineering to be done by EPC contractor (due to non-availability of the sufficient information both at OIL and STEP).
6.3 PROCUREMENT AND SUPPLY

6.3.1 The procurement to be carried out by the CONTRACTOR shall cover the purchasing including ordering and supply, inspection, expediting, custom clearance where applicable, transportation to site, stores management which includes preservation and storage of equipment and materials, uncovered storage, air conditioned storage and open storage. Contractor shall issue request for quotation and obtain offers from the approved vendors based upon the bid specifications and submit the purchase requisition along with the complete filled up data sheets, specifications, vendor catalogs/drawings to Owner/EPMC for review/approval.

6.3.2 Following items are identified as critical for timely completion of the project. Contractor shall ensure finalization of the orders for the same within 90 days from the date of award of the job:

a. Ordering of Separators, Slug catchers including control gears
b. Ordering of vendor specific items / equipment (viz Indirect Water Bath Heater etc.)
c. Gas Generating and Diesel Generating Set.
d. Line pipes of various sizes.

6.3.3 All skid mounted major equipment such as slug catchers, separators, tanks, metering arrangement etc, as indicated in the tender document, shall be supplied as a complete functional unit. The packaging of the skids with all accessories, control system, valves and fittings etc. shall be done by the main equipment manufacturer and shall be responsible for the performance of the total skid mounted package,

6.3.4 The EPC contractor shall be responsible to ensure that different vendors responsible for supplying different skid mounted packages provide valves, Control valves and gears, other fittings and accessories of same make and type primarily to facilitate inventory control of spares and also to establish standard operation and maintenance procedures.

6.3.5 Covered storage and air-conditioned storage, if required, shall be in the scope of the CONTRACTOR. Contractor shall submit the details of the items contemplated for fabrication at site to be submitted along with the bid.

6.3.6 Before ordering, clearances for technical portion should be taken from OWNER / EPMC in respect of items defined else where in the bid document. Before ordering any equipment and material the Contractor shall submit the purchase requisition and obtain approval from the OWNER / EPMC. Any items ordered which do not conform to the contractual requirement identified at any stage of the project, shall be rejected. Replacement / modification and the cost impact, project delay arising out of such rejection shall be solely to the account of the CONTRACTOR.
Replacement / modification leading to cost implication, project delay arising out of any kind of rejection of equipment and materials shall be solely to the Contractor's account. All equipment / materials shall be procured from the approved vendors as per the approved vendor list given in the bid package. In the event any item is not covered, Contractor shall get the approval for the vendor by submitting the credentials of the vendor.

6.3.7 Procurement and supply of commissioning spares as necessary and mandatory spares, as mentioned in this bid document is also in the scope of the CONTRACTOR within the quoted price.

6.3.8 The CONTRACTOR shall also quote spares for two years operation and maintenance for all items. Owner will decide on ordering during the tenure of the project.

6.3.9 The CONTRACTOR is required to organize a proper inspection and expedition system so as to ensure timely delivery of all the items / equipment meeting the specified quality criteria. Bidders are required to engage a third party Inspection Agency.

6.3.10 The Inspection agency for inspection services shall be from one of the followings:

i. Bureau Veritas Industrial Services (I) Pvt. Ltd., Mumbai along with Bureau Veritas Worldwide.
ii. R I T E S.
iii. Det Norske Veritas AS, Mumbai along with Det Norske Veritas worldwide.
iv. Germanischer Lloyd Industrial Services India Pvt. Ltd., Navi Mumbai along with Germanischer Lloyd worldwide.
v. Lloyd’s Register Asia, Mumbai along with Lloyd’s Asia worldwide.
vi. Tuboscope Vetco.
vii. IRS

Owner reserves the right to add or delete any agency.

Bidders are required to include the TPI charges within their lump sum prices and indicate the name of the TPI proposed in their offer.

6.3.11 Inspection shall be carried out by Owner / EPMC. A list of items shall be finalized after the award of the job clearly identifying the items to be inspected by Owner/EPMC with details of the location and schedule for inspection. However, Contractor shall have his own inspection organization in place to carry out inspection activities in respect of indigenous and imported equipment / materials through an Owner / EPMC approved third party inspection agency. The payments to be made to the third party inspection agency towards third party inspection shall be borne by the CONTRACTOR and shall be the total responsibility of the CONTRACTOR. Further, the responsibility for inspection / testing as per
specifications, approved documents and agreed inspection test plans shall be that of the CONTRACTOR.

Owner reserves the right to inspect the items deemed necessary by them without any time and cost implication. A clear two weeks notice in writing (10 working days) is required to be provided by the CONTRACTOR for such items where Owner / EPMC require inspection. The inspection charges of Owner including stay at vendor’s city shall be borne by Owner. The CONTRACTOR shall be responsible for all coordination of inspection by Owner / EPMC. The inspection by the TPI / Owner / EPMC shall NOT ABSOLVE the CONTRACTOR from his responsibilities under this Contract.

6.3.12 The CONTRACTOR is required to organize a custom clearance and transportation system to ensure prompt clearance of imported equipments from customs and transportation of equipments / materials to project site from Ports / Vendor’s works. CONTRACTOR shall maintain supervision, monitoring and coordination of above contracts for import clearance and transportation without any extra cost to Owner.

6.4 TENDERING

Tendering activities of the CONTRACTOR, if required, shall be properly organized to ensure award of various contracts to complete their works as per terms and conditions of Contract Document.

6.5 CONSTRUCTION AND INSTALLATION

6.5.1 Supply of construction materials, supply of flanges, valves, bolts, nuts, gaskets, spectacle blinds, temporary supports for the purpose of isolation of equipment during removal stage, labor and labor supervision, arranging boarding and lodging for the Contractor’s personnel at site, tools, tackles, cranes for heavy lifts, chain pulley blocks, consumables and accessories not specifically mentioned herein but nevertheless necessary, as per OWNER / EPMC for the fabrication, construction, installation, mechanical completion, testing and commissioning of the complete system including the cranes or any other material handling equipment is also part of scope of works.

6.5.2 Water and power

Contractor shall arrange water and power for construction activities fabrication, testing and commissioning. Owner shall not provide power and water from any source.
6.5.3 CONTRACTOR shall arrange for the fire hoses with adaptor and nozzles and other fire fighting facilities like barricading arrangement for welding activities during construction at site at their own cost.

6.5.4 Space for temporary office, storage and piping fabrication shall be provided by Owner at work site as demarcated as “White Area”. Contractor shall satisfy himself for the adequacy of the same. If the Contractor requires additional space, Contractor shall arrange the same outside the plant premises at his own cost. For fabrication of any equipment, Contractor shall arrange for the space outside the plant facilities at their own cost. Contractor shall arrange for boarding and lodging facilities for its personnel at his own cost.

6.6 PRE-COMMISSIONING AND COMMISSIONING

6.6.1 The CONTRACTOR shall pre-commission and later commission the Plant as per the requirement of the bid. Pre-commissioning and commissioning activities will be taken up after mechanical completion upon receiving clearance from OWNER/EPMC.

6.6.2 The scope includes providing technical experts / technicians for critical equipment, mobilizing equipment supplier’s representative for commissioning supervision as shall be deemed necessary by OWNER/EPMC.

6.6.3 The CONTRACTOR’s scope also covers supply and fill of initial lubricants, spares required for start up and supply of recommended lubricants for a period of six months from the date of commissioning. CONTRACTOR shall submit the details of the same along with the offer for review by the OWNER / EPMC.

6.7 POST COMMISSIONING

6.7.1 The scope covers carrying out performance test run for a period of 72 hours on each Train basis in the presence of Owner / EPMC.

6.7.2 After successful Commissioning and Performance guarantee test run to the satisfaction of Owner and their customer; to operate and maintain the plants including training owners operation and maintenance staff for a minimum period of three months.

6.7.3 The Contractor is to specify manpower requirement (indicating the minimum qualification criteria and detailed job description for each post) for operation and maintenance of the plants for continuous operation installation-wise.

6.8 QUALITY ASSURANCE

6.8.1 The desired quality is to be met for different activities at various stages of work. The quality checks by Owner / EPMC could be of audit type / involvement at a few
stages. CONTRACTOR is required to submit detailed Quality Control (QC) measures to be adopted for this job for all stages / types of activities and assures quality through own QA /QC personnel and TPI.

6.9 STATUTORY APPROVALS / STATE REGULATIONS / PERMISSIONS

6.9.1 Statutory regulations as required during the currency of the contract shall be adhered to for engineering, preparation of drawings /documents, fabrication, manufacturing, purchased items, construction and commissioning.

6.9.2 Documents as required shall be generated and submitted for approval of the statutory authorities (including but not limited to DGMS approval on individual items as applicable). Follow up and obtaining clearances shall be the responsibility of the CONTRACTOR.

6.9.3 The CONTRACTOR as and when applicable for different phases of the project shall adhere to State Government Regulations.

6.9.4 Statutory approval / permissions from any authorities as per statutory rules and regulations of Central / State Government shall be CONTRACTOR’s responsibility. The application on behalf of the Owner for submission to relevant authorities along with copies of required certificates complete in all respects shall be prepared by the CONTRACTOR well ahead of time so that the actual construction / commissioning of the work is not delayed for want of approval / inspection by concerned authorities.

6.9.5 The CONTRACTOR shall arrange the inspection of the works by the appropriate Authorities and necessary coordination and liaison work in this respect shall be the responsibility of the CONTRACTOR.

6.9.6 Any and all fees required to be submitted / paid to the Statutory authorities / State / Central Government regulatory bodies etc shall be borne by the CONTRACTOR as a part of his scope. No reimbursement whatsoever shall be made by Owner / EPMC.

6.9.7 Any additions / changes / modifications required to be made to meet the requirements of the statutory authorities / regulatory boards shall be carried out by the CONTRACTOR without any extra cost to the Owner and shall have no implication on time schedule. The inspection and acceptance of the work by the statutory authorities shall however, NOT ABSOLVE the CONTRACTOR from his responsibilities under this contract.

6.9.8 CONTRACTOR shall obtain necessary permissions from the concerned authorities like railways, national / state high way authorities, forest, canal / river authorities, local bodies as required. All associated costs shall be borne by CONTRACTOR. OWNER shall provide recommendatory letters wherever required. All such
approvals and any other approval / clearance not specifically mentioned herein but never less required shall be carried out at no extra time and cost to owner.

6.10 Spares

6.10.1 CONTRACTOR’s scope of supply shall include supply of mandatory spares, commissioning spares and initial fill of lubes on as required basis and also spares for Six months operation and maintenance after successful commissioning and acceptance by Owner. Contractor shall submit a list of mandatory spares and commissioning spares along with the offer for review by Owner/EPMC.

6.10.2 Apart from above Contractor shall submit item wise list of recommended spares for 2 years smooth operation along with the offer. Prices for the same shall remain valid till the currency of the job. Owner shall place order for the same separately.

6.11 Soil Investigation

6.11.1 Soil Investigation Report is given for Chabua. Further investigation, if required, shall have to be carried out by the Contractor under his scope at his own cost.

6.11.2 Complete Soil Investigation for Madhuban is to be carried out by contractor as per drawings given elsewhere.

6.12 Certificates for Installation

Fulfillment of all requirements during creation of the stations for obtaining relevant QHSE, ISO and ISRS certification for the installations shall be responsibility of the Contractor. Further the contractor has to give all required assistance to the owner to enable owner to obtain all the above certificates within a period of 3 months from the date of commissioning. The above services should be included in Lump Sum quoted price.

OISD & DGMS norms & their amendments if any during the currency of the contract shall be complied by the CONTRACTOR within the Lump Sum quoted price.

6.13 Chemical Laboratory

The LSTK Contractor has to establish laboratories in CGGS and FGS for carrying out required testing for gas, condensate, water analysis, dew point analysis and other general analysis to meet required standard of an ISO laboratory. Details of the requirement are given in Scope of Work for Laboratory.

6.14 Visits within India and Overseas

The LSTK Contractor has to make arrangements for visit,
A. To vendors’ shops and also
B. To at least two gas fields: one within India and one abroad, for Owner’s representatives as required to establish performance of equipment, instruments, packages etc. The expenses towards such visits of Owner’s personnel shall be borne by Owner.
7.0 DISCIPLINEWISE SCOPE OF WORK & DESIGN BASIS
DISCIPLINEWISE SCOPE OF WORK AND DESIGN BASIS

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7.1 SCOPE OF WORK AND DESIGN BASIS FOR PIPING
EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA

PIPING
SCOPE OF WORK
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
(7.1.1- MADHUBAN)
INDEX

1. GENERAL
2. SCOPE OF WORK
3. SCOPE OF SUPPLY
4. PIPING FABRICATION & ERECTION
5. INSPECTION, FLUSHING & TESTING
6. PAINTING
7. LIST OF ATTACHMENTS
7.1.1.1 GENERAL

a. CONTRACTOR shall convert the Engineered package to AFC status in accordance with requirements of the Engineering Design Basis-Piping (9473-03-DB-001), Codes & Standards, Specifications, Drawings, P&IDs and Data sheets perform design, balanced engineering and associated work for the various facilities covered under this contract. The requirements contained in the specifications, drawings etc. attached with the bid document are minimum, which Contractor has to comply with. Piping design /documents including layout, stress analysis and resolution of any fouling with adjacent facility etc. shall be performed by the Contractor.

b. The CONTRACTOR'S SCOPE OF WORK shall include, balance engineering, generation of GAD using AutoCAD latest version, preparation of drawings and documents, supply & procurement of all materials and consumables, flexibility analysis, supporting, fabrication, laying, erection, bolt torquing, maintenance provisions as required, cleaning, testing, flushing and precommissioning, drying, complete in all respects, of all piping in accordance with the Process Package which will result in successful commissioning, trouble free operation and maintenance of the plant. In addition to the above piping scope also includes painting and obtaining all statutory approvals and clearance. The Contractor's battery limit (B/L) shall be as per scope drawing.

c. ERECTION OF EQUIPMENTS :- Following equipments shall be erected at site by the contractor. Handling of equipments from storage to site, putting on foundation/ alignment etc. shall form contractor's scope of work.

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### 7.1.1.2 SCOPE OF WORK

#### ABOVE GROUND

Following minimum drawings and documents shall be prepared by the CONTRACTOR FOR EXECUTION OF PIPING WORKS. These documents and drawings shall be submitted to OWNER/STEP for approval/review/information.

- Update Piping Material Specification.
• Update of Valve Material Specification.
• Update welding chart.
• Finalization of Equipment Layout in plans, sections (with dimension) including incorporation of vendor data and other requirements as per job specification. It is binding that all the equipments indicated in P&ID / Process datasheet / equipment data sheets are to be shown by the Contractor in the equipment layout.
• Key Plan and Area Division shall be done by contractor with the help of scope drawings.
• Piping General Arrangement Drawings shall be done by contractor with the help of scope drawings.
• Nozzle Orientation for all Vessels, tanks showing all nozzles including any modification / change shall be done by contractor as per Piping layout.
• Piping Isometrics for All Lines including small bore lines with Support Marking and Bill of Material.
• Trim drawings with support marking & bill of material for all Equipment Mountings.
• Flexibility Analysis reports (static analysis) / Dynamic analysis (2-phase flow) / Flange leakage calculation reports.
• Engineering Data sheets/sketches for any miscellaneous items/special valves.
• Special support drawings and pipe support cleats on Equipments. Pipe support standards/drawings to cover entire piping including slope lines. A list indicating all lines numbers for flexibility analysis shall be submitted.
• Specifications for procurement taking into account the requirements contained in General Requirements for Procurements of Piping materials and additional requirements indicated in process package and PMS.
• TIE IN POINT schedule & details.
• Procedure for stress analysis outlining methods and scope of stress control. Pipe flexibility calculations shall conform to ASME B31.3 and associated codes of practice.
• Provide stress sketches and calculations of all lines as per stress index.
• Engineering support services including carrying out of rectification, replacements, for any trouble shooting service for failure/malfunction during plant operation after handling over.
• Contractor shall coordinate with OWNER/STEP for tie-up finalization.
• Piping quality plan for piping activities.
• LSTK contractor shall provide 1” tubing for 900# rating and Pipe material is of SS316L in Chemical service lines.
• Pipe as well as Valve Material for foam concentrate handling lines shall be Furnished by LSTK contractor.

7.1.1.3 SCOPE OF SUPPLY

Scope of supply shall include but not be limited to the followings:-

• Supply, Procure & Store all piping materials within CONTRACTOR’S B/L along with all material test certificates.
• Prepare final Bill of Materials including material summary on the basis of P&IDs, GADs, Isometrics including fabrication allowance, precommissioning and commissioning spares and mandatory spares.
• Prepare Material Requisitions, Material Status Reports etc.
• Place purchase orders for all piping items as per approved vendor list of OWNER/STEP. Furnish Final vendor drawings for piping items e.g. Valves, Traps, Special tagged items etc.
• Arrange 3rd party inspection of materials by approved inspecting agencies as per requirements, transport and receive materials at site and store with proper identification tag.
• Supply paint and execute painting of all piping, and other miscellaneous item as per specifications.
• Supply of all support materials, pipe supports including material for pipe support pedestals.
• Any other items which are not specified above but essentially required for completeness of the project.
• Supply of “jacked out” facility for tube bundle pulling.

7.1.1.4 PIPING CONSTRUCTION

CONTRACTOR shall provide for:

• WPS/PQR for OWNER/STEP reviews and maintain for welder qualification and welder testing.
• Receipt of materials at WORKSITE offloading, checking, warehousing, proper storage and protection and material control facilities, including storage and retrieval of associated Certification documentation. CONTRACTOR shall also operate a separate quarantine stores/compound for storage of materials, which arrive without suitable documentation.
• Fabrication including prefabrication, lifting, laying, erection, transportation from warehouse to fabrication yard, bolt torquing, supporting and installation, pre and post weld heat treatment, inspection, non-destructive testing including radiography and hydrostatic test, water flushing, air drying, nitrogen purging and other testing of piping installations, above and below ground, Installation of all valves and other miscellaneous in line /on line items. Open ends of Piping valves shall be protected with wooden blanking plates securely fastened with wire or by plastic insert plugs.
• Supply all testing apparatus, appurtenances and fittings and the like and special testing fluids where required.
• Cleaning water, air drying, disposal of fluids offsite, reinstatement, preservation of piping and miscellaneous items following hydro test, nitrogen purging, cleaning, chemical cleaning, painting, insulation as per specifications.
• Fabrication and installation, setting and commissioning of pipe supports, guides, anchors and spring supports as required, construction of RCC pipe support pedestals from floor pavements. In case of pipe supports which are not from floor pavement, pipe support foundation locations to
be finalized/ furnished by the contractor before commencement of pavement construction.

- Supply paint and execute painting of all equipments, piping (including small bore piping), structures like platform, railing.
- Execute all mechanical jobs identified during OWNER/Licensor’s checklist, Technical audits, pre-commissioning and commissioning, including additional supports required to restrain pipe movement avoiding interference with nearby structural/piping.
- Set up field engineering Cell and execute field engineering, which becomes necessary to resolve problems arising during prefabrication, shop fabrication, field fabrication or erection at site & based on sub vendor data. Necessary field design change drawing shall be prepared by CONTRACTOR and submitted to (OWNER/STEP) for information/review as the case may be and shall be reflected in the As Built Drawings, Documents.
- Supply of all piping materials required for testing and pre-commissioning e.g. piping spools, bolting and gaskets, flanges, blinds or any other piping materials for carrying out this activity.
- Development and agreement with STEP of a system base for Mechanical Completion and handover of sections of the work. CONTRACTOR shall adopt OWNER/STEP requirements regarding sequence of system completion and handover.
- Installation of any necessary blind or additional valving not identified on CONTRACTOR P&ID’s to isolate lines to facilitate phased commissioning and start-up.
- CONTRACTOR shall comply with the requirements of Mechanical Completion as described in relevant Sections of the Engineered package Document.
- Radiography/Testing of welds/flanged joints not subjected to hydro testing.
- All materials, consumables, tools & tackles required for cutting, fitting, welding, brazing, cleaning, grinding, threading and other dismantling works.
- All industrial gases such as oxygen, acetylene, inert gases, all types of electrodes, filler wire, flux wire, brushes, etc.
- MS Tube, Bolts/Anchor fasteners, nuts, washers, spring washer including hangers, U/bolts with nuts, clamps, graphite and Teflon pads, dummy pipe & pipes for low supports (CS all grades), pipe / steel plates (CS all grades) for reinforcement pads & pipe supports, angles, beams, channels etc. for pipe supports, platforms, ladders, stairways and all miscellaneous steel structure, supporting steel plates, wires, and strip for attachment of steam tracers etc.
- Shims, wedges, and packing plates (machined wherever required).
- All materials such as hydraulic pumps, metallic blinds, temporary gaskets etc. and arrangement required for pressure testing.
- Wherever Valves require extended spindle the same shall be provided. The arrangement for the extended spindle shall be prepared by the Contractor and submitted to Engineer-in-charge for approval.
• All sealing and protecting materials required for protecting materials/equipments supplied by Contractor.
• Oil, grease, graphite, molykote, sealing tapes, cleaning agents including acids for cleaning of internals/packing/trough/tray etc.
• Asbestos cloth and water hoses for fire and safety protection as required.
• Supply, fabrication, welding of hot dip galvanized plates, for earth wire lug connection required for earthling of pipes.
• Contractor shall provide engineering support services for trouble shooting up to two years after the handing over of the plant for any rectification replacement for any defect / malfunctioning / failure of the piping / package units, etc that may be referred to them by the OWNER / STEP.

7.1.1.5 FLUSHING AND TESTING

For all piping Flushing and testing shall be carried out up to unit battery limit shown in individual equipment layouts/ piping layouts or as identified by Engineer-in-charge. Flushing and testing of all piping systems shall be carried out as per standard specification for inspection, flushing and testing of piping system (Spec. no. 9473-03-TS-008). The limit shown is applicable for all elevations along that coordinate. The accessories required for blinding the line with suitable plates are to be arranged by contractor. The scope of testing shall be inclusive of de-blinding the system after test and re-boxing up including torque tightening / bolt tensioning as per specifications. Any defects noticed during hydro testing shall be made good by the Contractor. Wherever new hook-ups are made the hook-up along with the existing piping shall be tested up to the point of closest isolation (e.g.: valve, spectacle blind).

7.1.1.6 PAINTING

7.1.1.6.1 The scope of work broadly consists of painting of equipments, vessels, pumps, piping and structural steel work as detailed in schedule of rates and instructions of Engineer-in-charge.

The scope of work shall consist of surface preparation as required, selection and application of required paints on surfaces of vessels, equipments, machinery, piping, steel structures etc. including but not limited to:

i All un-insulated piping and fittings including flanges and valves (Including providing identification marks).

ii All equipments like Test & Production separators etc. as specified.

iii Painting of hook-ups prior to commissioning.

iv Any other surface as directed by Engineer-in-charge.

v Identification, colour bands on all painted surface of equipments/piping.
vi Identification lettering/numbering on all painted / insulated surface of equipments/piping.

vii Hazardous content marking / identification signs on painted surface of equipments/piping.

viii Cleaning up the working areas regularly during the course of work for purpose of good house keeping as well as cleaning up the site on completion of the work as directed by the Engineer-in-charge.

ix All other incidental/auxiliary /ancillary/accessory or any enabling work/materials not specifically mentioned in the specifications but necessary for the execution and completion of work as envisaged in the tender document.

x Any damage to painting during transportation or due to any other cause shall be made good by the contractor. The OWNER/ STEP specification for painting shall be followed in such cases.

7.1.1.6.2 Contractor shall supply the following for carrying out painting jobs

- All primers and finish paints.
- All equipments required for surface preparation.
- All consumables required for surface preparation.
- All equipments for paint application like Brushes, Spray nozzles, Spray Pumps, Blowers etc.
- All equipments like dust collector, protection shield etc. for conducting the job.

7.1.1.7 LIST OF ATTACHMENTS

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<td>Stub – In Standard</td>
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<td>Support lug (single) fixed for bare and insulated pipe 1” thru 24” type-C13</td>
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<td>Pipe U-clamp for bare pipe ½&quot; thru 24&quot; type-C-15</td>
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<td>Pipe clamp for bare pipe ½” thru 24” type-C16</td>
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<td>Dummy pipe support for bare pipe 2” thru 24” type-B29</td>
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<td>Pipe support brackets type-B42</td>
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<td>Pipe support brackets type-B43</td>
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<td>Pipe support bracket from pipe 3” thru 24” type-B44</td>
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**NOTE:**
All above-mentioned attachments are same for three sites (Madhuban, Baghjan & Chabua. All the common attachments are enclosed with Madhuban package.
EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA

PIPING

SCOPE OF WORK
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
(7.1.3 - CHABUA)
INDEX

1. GENERAL
2. SCOPE OF WORK
3. SCOPE OF SUPPLY
4. PIPING FABRICATION & ERECTION
5. INSPECTION, FLUSHING & TESTING
6. PAINTING
7. LIST OF ATTACHMENTS
7.1.3.1 GENERAL

a. CONTRACTOR shall convert the Engineered package to AFC status in accordance with requirements of the Engineering Design Basis-Piping (9473-03-DB-001), Codes & Standards, Specifications, Drawings, P&IDs and Data sheets perform design, balanced engineering and associated work for the various facilities covered under this contract. The requirements contained in the specifications, drawings etc. attached with the bid document are minimum, which Contractor has to comply with. Piping design /documents including layout, stress analysis and resolution of any fouling with adjacent facility etc. shall be performed by the Contractor.

b. The CONTRACTOR’S SCOPE OF WORK shall include, balance engineering, generation of GAD using AutoCAD latest version, preparation of drawings and documents, supply & procurement of all materials and consumables, flexibility analysis, supporting, fabrication, laying, erection, bolt torquing, maintenance provisions as required, cleaning, testing, flushing and precommissioning, drying, complete in all respects, of all piping in accordance with the Process Package which will result in successful commissioning, trouble free operation and maintenance of the plant. In addition to the above piping scope also includes painting and obtaining all statutory approvals and clearance. The Contractor’s battery limit (B/L) shall be as per scope drawing.

c. ERECTION OF EQUIPMENTS :- Following equipments shall be erected at site by the contractor. Handling of equipments from storage to site, putting on foundation/ alignment etc. shall form contractor’s scope of work.

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<thead>
<tr>
<th>S NO</th>
<th>TAG NO</th>
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<td>TEST CONDENSATE PUMP</td>
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<td>17</td>
<td>V-3007</td>
<td>CLOSED BLOW DOWN VESSEL</td>
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7.1.3.2 SCOPE OF WORK

ABOVE GROUND

Following minimum drawings and documents shall be prepared by the CONTRACTOR FOR EXECUTION OF PIPING WORKS. These documents and drawings shall be submitted to OWNER/STEP for approval/review/information.

- Update Piping Material Specification.
- Update of Valve Material Specification.
- Update welding chart.
- Finalization of Equipment Layout in plans, sections (with dimension) including incorporation of vendor data and other requirements as per job specification. It is binding that all the equipments indicated in P&ID/Process datasheet/equipment data sheets are to be shown by the Contractor in the equipment layout.
- Key Plan and Area Division shall be done by contractor with the help of scope drawings.
- Piping General Arrangement Drawings shall be done by contractor with the help of scope drawings.
- Nozzle Orientation for all Vessels, tanks showing all nozzles including any modification / change shall be done by contractor as per Piping layout.
- Piping Isometrics for All Lines including small bore lines with Support Marking and Bill of Material.
- Trim drawings with support marking & bill of material for all Equipment Mountings.
- Flexibility Analysis reports (static analysis) / Dynamic analysis (2-phase flow) / Flange leakage calculation reports.
- Engineering Data sheets/sketches for any miscellaneous items/special valves.
• Special support drawings and pipe support cleats on Equipments. Pipe support standards/drawings to cover entire piping including slope lines. A list indicating all lines numbers for flexibility analysis shall be submitted.
• Specifications for procurement taking into account the requirements contained in General Requirements for Procurements of Piping materials and additional requirements indicated in process package and PMS.
• TIE IN POINT schedule & details.
• Procedure for stress analysis outlining methods and scope of stress control. Pipe flexibility calculations shall conform to ASME B31.3 and associated codes of practice.
• Provide stress sketches and calculations of all lines as per stress index.
• Engineering support services including carrying out of rectification, replacements, for any trouble shooting service for failure/malfunction during plant operation after handling over.
• Contractor shall coordinate with OWNER/STEP for tie- up finalization.
• Piping quality plan for piping activities.
• LSTK contractor shall provide 1” tubing for 900# rating, base material is of SS316L in chemical service lines.
• Pipe as well as valve Material for foam concentrate handling lines shall be decided by LSTK contractor.

7.1.3.3 SCOPE OF SUPPLY

Scope of supply shall include but not be limited to the followings:-

• Supply, Procure & Store all piping materials within CONTRACTOR’S B/L along with all material test certificates.
• Prepare final Bill of Materials including material summary on the basis of P&IDs, GADs, Isometrics including fabrication allowance, precommissioning and commissioning spares and mandatory spares.
• Prepare Material Requisitions, Material Status Reports etc.
• Place purchase orders for all piping items as per approved vendor list of OWNER/STEP. Furnish Final vendor drawings for piping items e.g. Valves, Traps, Special tagged items etc.
• Arrange 3rd party inspection of materials by approved inspecting agencies as per requirements, transport and receive materials at site and store with proper identification tag.
• Supply paint and execute painting of all piping, and other miscellaneous item as per specifications.
• Supply of all support materials, pipe supports including material for pipe support pedestals.
• Any other items which are not specified above but essentially required for completeness of the project.
• Supply of “jacked out” facility for tube bundle pulling.

7.1.3.4 PIPING CONSTRUCTION

CONTRACTOR shall provide for:
• WPS/PQR for OWNER/STEP reviews and maintain for welder qualification and welder testing.
• Receipt of materials at WORKSITE offloading, checking, warehousing, proper storage and protection and material control facilities, including storage and retrieval of associated Certification documentation. CONTRACTOR shall also operate a separate quarantine stores/compound for storage of materials, which arrive without suitable documentation.
• Fabrication including prefabrication, lifting, laying, erection, transportation from warehouse to fabrication yard, bolt torquing, supporting and installation, pre and post weld heat treatment, inspection, non-destructive testing including radiography and hydrostatic test, water flushing, air drying, nitrogen purging and other testing of piping installations, above and below ground, Installation of all valves and other miscellaneous in line/on line items. Open ends of Piping valves shall be protected with wooden blanking plates securely fastened with wire or by plastic insert plugs.
• Supply all testing apparatus, appurtenances and fittings and the like and special testing fluids where required.
• Cleaning water, air drying, disposal of fluids offsite, reinstatement, preservation of piping and miscellaneous items following hydro test, nitrogen purging, cleaning, chemical cleaning, painting, insulation as per specifications.
• Fabrication and installation, setting and commissioning of pipe supports, guides, anchors and spring supports as required, construction of RCC pipe support pedestals from floor pavements. In case of pipe supports which are not from floor pavement, pipe support foundation locations to be finalized/ furnished by the contractor before commencement of pavement construction.
• Supply paint and execute painting of all equipments, piping (including small bore piping), structures like platform, railing.
• Execute all mechanical jobs identified during OWNER/Licensor’s check list, Technical audits, pre-commissioning and commissioning, including additional supports required to restrain pipe movement avoiding interference with nearby structural/piping.
• Set up field engineering Cell and execute field engineering, which becomes necessary to resolve problems arising during prefabrication, shop fabrication, field fabrication or erection at site & based on sub vendor data. Necessary field design change drawing shall be prepared by CONTRACTOR and submitted to (OWNER/STEP) for information/review as the case may be and shall be reflected in the As Built Drawings, Documents.
• Supply of all piping materials required for testing and pre-commissioning e.g. piping spools, bolting and gaskets, flanges, blinds or any other piping materials for carrying out this activity.
• Development and agreement with STEP of a system base for Mechanical Completion and handover of sections of the work. CONTRACTOR shall adopt
• OWNER/STEP requirements regarding sequence of system completion and handover.
• Installation of any necessary blind or additional valving not identified on CONTRACTOR P&ID’s to isolate lines to facilitate phased commissioning and start-up.
• CONTRACTOR shall comply with the requirements of Mechanical Completion as described in relevant Sections of the Engineered package Document.
• Radiography/Testing of welds/flanged joints not subjected to hydro testing.
• All materials, consumables, tools & tackles required for cutting, fitting, welding, brazing, cleaning, grinding, threading and other dismantling works.
• All industrial gases such as oxygen, acetylene, inert gases, all types of electrodes, filler wire, flux wire, brushes, etc.
• MS Tube, Bolts/Anchor fasteners, nuts, washers, spring washer including hangers, U/bolts with nuts, clamps, graphite and Teflon pads, dummy pipe & pipes for low supports (CS all grades), pipe / steel plates (CS all grades) for reinforcement pads & pipe supports, angles, beams, channels etc. for pipe supports, platforms, ladders, stairways and all miscellaneous steel structure, supporting steel plates, wires, and strip for attachment of steam tracers etc.
• Shims, wedges, and packing plates (machined wherever required).
• All materials such as hydraulic pumps, metallic blinds, temporary gaskets etc. and arrangement required for pressure testing.
• Wherever Valves require extended spindle the same shall be provided. The arrangement for the extended spindle shall be prepared by the Contractor and submitted to Engineer-in-charge for approval.
• All sealing and protecting materials required for protecting materials/equipments supplied by Contractor.
• Oil, grease, graphite, molykote, sealing tapes, cleaning agents including acids for cleaning of internals/packing/trough/tray etc.
• Asbestos cloth and water hoses for fire and safety protection as required.
• Supply, fabrication, welding of hot dip galvanized plates, for earth wire lug connection required for earthing of pipes.
• Contractor shall provide engineering support services for trouble shooting up to two years after the handing over of the plant for any rectification replacement for any defect / malfunctioning / failure of the piping / package units, etc that may be referred to them by the OWNER / STEP.

7.1.3.5 FLUSHING AND TESTING

For all piping Flushing and testing shall be carried out up to unit battery limit shown in individual equipment layouts/ piping layouts or as identified by Engineer-in-charge. Flushing and testing of all piping systems shall be carried out as per standard
Specification for inspection, flushing and testing of piping system (Spec. no. 9473-03-TS-008). The limit shown is applicable for all elevations along that coordinate. The accessories required for blinding the line with suitable plates are to be arranged by contractor. The scope of testing shall be inclusive of de-blinding the system after test and re-boxing up including torque tightening / bolt tensioning as per specifications. Any defects noticed during hydro testing shall be made good by the Contractor. Wherever new hook-ups are made the hook-up along with the existing piping shall be tested up to the point of closest isolation (e.g.: valve, spectacle blind).

7.1.3.6 PAINTING

7.1.3.6.1 The scope of work broadly consists of painting of equipments, vessels, pumps, piping and structural steel work as detailed in schedule of rates and instructions of Engineer-in-charge.

The scope of work shall consist of surface preparation as required, selection and application of required paints on surfaces of vessels, equipments, machinery, piping, steel structures etc. including but not limited to:

i All un-insulated piping and fittings including flanges and valves (Including providing identification marks).

ii All equipments like Test & Production separators etc. as specified.

iii Painting of hook-ups prior to commissioning.

iv Any other surface as directed by Engineer-in-charge.

v Identification, colour bands on all painted surface of equipments/piping.

vi Identification lettering/numbering on all painted / insulated surface of equipments/piping.

vii Hazardous content marking / identification signs on painted surface of equipments/piping.

viii Cleaning up the working areas regularly during the course of work for purpose of good house keeping as well as cleaning up the site on completion of the work as directed by the Engineer-in-charge.

ix All other incidental/auxiliary /ancillary/accessory or any enabling work/materials not specifically mentioned in the specifications but necessary for the execution and completion of work as envisaged in the tender document.

x Any damage to painting during transportation or due to any other cause shall be made good by the contractor. The OWNER/ STEP specification for painting shall be followed in such cases.
7.1.3.6.2 Contractor shall supply the following for carrying out painting jobs

- All primers and finish paints.
- All equipments required for surface preparation.
- All consumables required for surface preparation.
- All equipments for paint application like Brushes, Spray nozzles, Spray Pumps, Blowers etc.
- All equipments like dust collector, protection shield etc. for conducting the job.

7.1.3.7 LIST OF ATTACHMENTS

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**NOTE:**

All above-mentioned attachments are same for three sites (Madhuban, Baghjan & Chabua. All the common attachments are enclosed with Madhuban package.
EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA

PIPING

DESIGN BASIS
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
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7.1.4.1 SCOPE

This specification covers the general design requirements with respect to layout and detailed design for piping systems.

7.1.4.2 REFERENCE CODES & STANDARDS

The following codes and standards (Latest edition) shall be followed unless otherwise specified.

- ASME B31.3 Process Piping.
- ASME SEC.VIII Rules for construction of Pressure Vessels.
- API Std. 610 Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Service.
- API RP 520 Sizing, Selection and Installation of Pressure Relieving Devices in Refineries.
- API Std. 619 Rotary Compressors for Petroleum, Chemical and Gas Industry Service.
- API Std. 617 Centrifugal Compressors for Petroleum, Chemical and Gas Industry Service.
- OISD-118 Layouts for Oil and Gas Installations.
- API Std.661 Air cooled heat exchanger.
- API Std.618 Reciprocating compressor for General Refinery Service.

7.1.4.3 DESIGN CRITERIA

7.1.4.3.1 Equipment Layout

7.1.4.3.1.1 Basis of Equipment Layout

Equipment layout shall be developed based on the following data:

- P& IDs / PFDs.
- Process / Equipment Data Sheets.
- Overall Plot Plan.
7.1.4.3.1.2 Development of Equipment Layout

The following aspects shall be considered during the development of equipment layout:

a) Process Requirement-i.e. proper flow sequence between equipment as per P&IDs to achieve the intended process parameters.
b) Economy of Piping material-Minimize the quantity of costly piping.
c) Erection & Construction requirement:-Erection scheme and delivery schedule of all equipment must be considered during equipment layout to have smooth erection.
d) Safety Requirements
   - OMR’84 & OISD Std. 118 shall be followed.
   - Fire fighting facilities as per TAC & OISD/NFPA norms.
e) Operation and Maintenance Requirements
   - Overhead and side clearances for pumps.
   - Provision of indirect water bath heater tube bundle pulling area.
   - Horizontal & overhead clearances for easy movement of working personnel.
   - Provision of monorail for pumps (and prime movers).
   - Provision of monorail for compressors.

f) Similar equipment grouping – columns, exchangers, pumps etc. should be grouped together (in separate groups for similar equipments) for convenience of maintenance and safety wherever feasible.

g) The technological structures should be interconnected for easy movement of operational personnel.

NOTE:- Accessibility to pump/compressor shed for replacement of major Equipment in the form of approach road, adequate space for operation of Mobile cranes, vehicles and equipments to facilitate repair, Replacement job is required.

7.1.4.3.1.3 Pipe-rack

In general, equipment layout shall be prepared considering straight pipe rack, however other shapes like L/T/U/H/Z etc can be considered based on area available.

The total width of pipe rack shall include 25% extra space initially to cater for the modifications in unit at later stages of design.

The width of the rack shall be 6M, 8M or 10M for single bay and 12M, 16M or 20M for double bay having 4 tiers maximum. The spacing between pipe rack portals shall be taken as 6M in general. However it can be increased to 8M depending on the size of the pumps to be housed below pipe rack.

- Clearance beneath pipe rack shall be 3M minimum.
• Road clearance shall be 7M minimum for main pipe rack and 5M for secondary rack.
• Flare lines shall be routed to highest level. Instrument and electrical cable trays shall be planned at the top tier with walkways.

7.1.4.3.1.4 **Towers and Vertical Vessels**

Towers and vertical vessels shall preferably be arranged in a row with common centerline, decided by the largest vessels, placing O.D. of the equipment minimum 4M away from the pipe rack. A minimum clearance of 3M shall be allowed between tower shells, but in any case adjacent towers shall be checked so that platforms and foundations do not overlap (minimum 100mm gap shall be provided between platform of adjacent towers) and that a minimum 900mm is left between tower plinths. Also the gap between vertical vessels shall allow full opening of manhole covers without restriction. To handle heavy items (like relief valves, blinds etc.) a davit is usually needed. The davit shall be on the side of the vessel away from the rack. The area at grade shall be kept clear for dropout.

7.1.4.3.1.5 **Horizontal Vessels**

The horizontal vessels shall be laid perpendicular to pipe rack and shall be placed minimum 4M away from the pipe rack. The clearance between horizontal vessel shells shall be minimum 2M or 900mm clear aisle whichever is higher.

7.1.4.3.1.6 **Pumps**

Whenever practicable pumps shall be arranged in rows with the centerline of the discharge on a common line. Pumps shall be kept outside the pipe rack. Gap between each pump base plate and columns of technical structure should be sufficient for easy access of equipment after piping. The foundation of pump shall not overlap the foundation of the technological structures/pipe rack. Clearance between two adjacent pumps shall be such that clear 900mm aisle is available. Wherever this is not feasible, common foundation for a pair of pumps may be considered with 300mm gap between two the base plates. However each pump is to be provided proper access from at least one side.

All pumps not open to sky with motor rating >=75KW shall be provided with monorail. No monorail should normally be provided for pumps outside rack and sufficient space below rack shall be available for removal of pumps for maintenance.

7.1.4.3.1.7 **Compressors and their Prime Movers**

Two major types of compressors are used in process plants:

- Centrifugal compressors
- Reciprocating compressors
Compressors shall be located to keep suction lines as short as possible. Drivers for compressor may be electric motor, gas engine, gas-fired turbine or steam turbines as per P&ID. The gas compressors shall be located downwind side of furnace so that leaks are not blown towards furnace. In general compressors are kept under shed, sides are fully open for the low shed or partially closed from top for high shed to avoid accumulation of heavier gases in the shed. In case of a turbine drive compressor, if exhaust steam is condensed, turbine and compressor to be located at an elevated level and condenser to be located below turbine. A major consideration in centrifugal compressor location is the lube and seal oil console. It must be accessible from a road, must be lower than the compressor to allow gravity drain of oil to the consoles oil tank. Inter-coolers are placed near compressor and are kept within shed. Knockout pots and after coolers may be kept outside the shed but near compressor house.

7.1.4.3.1.8 Clearance and Accessibility

7.1.4.3.1.8.1 TUBE BUNDLE PULLING

All exchanger tube bundles shall be “jacked out” against shell. A clear space for tube bundle removal shall be provided. Dropout bay may be considered for exchangers at elevated structures.

7.1.4.3.1.8.2 ACCESS TO PUMPS

Clear access of 3M both vertically and horizontally shall be provided centrally under main pipe ways for small mobile equipment to service pumps, wherever these are put under pipe ways with prior specific approval. Pumps outside rack shall be approachable by small cranes etc. from under the pipe rack/from roadside as applicable.

7.1.4.3.1.8.3 ACCESS TO LOWER ITEMS TO GRADE (LOWERING AREA)

Clear access shall be provided at grade on the access side for lowering external and internal fittings from tall elevated equipment/structures by providing pipe davits/monorails/hoist as required.

7.1.4.3.1.8.4 LAYOUT & ACCESS REQUIREMENTS FOR PLATFORMS LADDERS AND STAIRS

For providing platform ladder & staircase following guidelines shall be following:

- Two means of access (i.e. two ladders or one ladder and one staircase) shall be provided at any elevated technological structure, which serves three or more vessels.
- Platforms, ladders and stairways shall be minimum, consistent with access and safety requirements.
• Stairways for tanks to be provided on upstream of predominant wind direction.

(i) Platform at elevated structure
   a) Dual access (i.e. one staircase and one ladder) shall be provided at large elevated structure if any part of platform has more than 22.65M (75 ft) of travel.
   b) For inter-connecting platforms between towers, consideration for expansion of towers should be taken care of.

(ii) Platforms with stair access shall be provided only for:
   c) Location at which normal monitoring is required or where samples are taken (once a day or more).
   d) Locations where vessels or equipment items have operator attention such as compressors, heater, boilers etc.

(iii) Platforms with ladder access shall be provided for:
   a. Points which require occasional operating access including valves, spectacle blinds and motor operated valves, heater stack sampling points.
   b. Man ways above grade on equipment.

7.1.4.3.1.8.5 CLEARANCES

Minimum clearances shall be as indicated in Annexure-E.

7.1.4.3.2 Unit Piping

7.1.4.3.2.1 Basis of Unit Piping

• Piping & Instrumentation Diagram
• Equipment layout
• Equipment Data sheet & Setting plan
• Line list
• Instrument data sheet
• Structural & building drawing
• Topography of the plant
• Piping material specification
• Overall plot plan

The following objective shall be ascertained during piping layout:

• Proper access to all operating points including valves, and for all orifice tapping points, safety relief valves and instruments in particular (refer Annexure-B).
- Proper access to inter related operating points for specific purpose and for maintenance.

7.1.4.3.2.2 Pipe Ways / Rack piping

- Predominantly process lines are at lower tier and, utility & hot process line on upper tier.
- Generally the top tier is to be kept for instrument ducts & electrical cable trays (if located above ground). Cable tray laying to take care of necessary clearances. Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.
- for the fire proofing of structure.
- Generally the hot lines and cold lines shall be kept apart in different groups on a tier.
- Generally the bigger size lines shall be nearer to the column.
- Min. Spacing between adjacent lines shall be decided based on O.D. of bigger size flange (minimum rating 300# to be considered), O.D. of the smaller pipe, individual insulation thickness and additional 25 mm clearance, preferably. Wherever even if flange is not appearing the minimum spacing shall be based on above basis only.
- Actual line spacing, especially at 'L' bend and loop locations, shall take care of thermal expansion / thermal contraction / non-expansion of adjacent line. Non-expansion / thermal contraction may stop the free expansion of the adjacent line at 'L' bend location.
- Anchors on the racks are to be provided on the anchor bay if the concept of anchor bay is adopted. Otherwise anchors shall be distributed over two to three consecutive bays.
- Anchors shall be provided within unit on all hot lines leaving the unit.
- Process lines crossing units (within units or from unit to main pipe way) are normally provided with a block valve, spectacle blind and drain valve. Block valves are to be grouped and locations of block valves in vertical run of pipe are preferred. If the block valves have to be located in an overhead pipe way, staircase access to a platform above the lines shall have to be provided. Provision of block valves, blinds etc. shall be as per P&IDs.
- All small-bore piping shall be designed in a way so as to ensure adequate supporting from adjacent large bore lines to minimize the requirement of intermediate beams in the pipe rack.
- No vertical piping should be routed along pipe rack column in order to Facilitate any type fixing on to columns.

7.1.4.3.2.3 Vessel Piping / Control valves

- Piping from vessel shall preferably drop or rise upon leaving the nozzle and run parallel as close as practicable to column to facilitate supports from vessel.
- Piping shall be grouped as far as possible for the ease of supports and shall run on the rack side of the vessel.
• Manholes shall be kept on the road side of the vessel and approachable from the platform. Platform width shall be such that minimum 1M space is available beyond manhole for movement.
• Piping shall be supported from cleats welded on the vessels as far as possible. Supports from welded platforms need to be avoided as far as possible.
• Proper guides at intervals shall be provided for long vertical lines.
• Access platforms/ladders shall be provided along the vessel for valves and instruments. Minimum width of platform shall be 750mm clear.
• For ease of operation and maintenance, vessels, which are grouped together, shall have their platforms at the same elevation interconnected by walkways. However each vessel shall have an independent access also.
• Vessel platforms should be designed in such a way so that all the nozzles should be approachable from platforms.
• Unless specifically indicated in P&IDs control valves shall preferably be kept at grade instead of platform.
• Piping support cleats shall be designed for safety valve considering impact loading during popping off.
• Davit cleat should not foul with nozzles/ manhole opening.

7.1.4.3.2.4 Pump Piping

• Pump drives shall have clear access.
• Pump suction piping shall be as short as possible & shall be arranged with particular care to avoid vapour pockets.
• Reducers immediately connected to the pump suction shall be eccentric type flat side up to avoid the accumulation of gas pocket. For slurry lines reducers will have flat side bottom.
• For side suction pumps elbows shall not be directly connected to the suction flange. A straight piece minimum 3 times the line size shall have to be provided at the suction nozzle.
• Pump discharge check valve if installed in vertical lines shall be fitted with a drain connection as close as possible downstream of the valve.
• When a suction vessel operates under vacuum, the vent connection of the pump has to be permanently connected to vapour space of the suction vessel to allow possible filling of the pump with liquid before it is started.
• Unless otherwise specified T-type strainer shall be used on pump suction piping for sizes 2" & above.
• Y-type strainer to be used for all sizes in steam services and for pump suction lines 1 1/2" and below.
• All small-bore piping connected to pump (drain to OWS & CBD, seat and gland leak drain) shall have provision for break up flanges for removal of pumps.
• Piping shall be so arranged that forces and moments imposed on the pump nozzle do not exceed the allowable values.
• Pump discharge should preferably be routed away from the pump rather than towards the motor side.
- Pump cooling water connection shall be taken from the top of circulating cooling water header.
- Pump suction and discharge block valves shall be located such that both the valves can be operated from the same place.
- Elevation of pump foundation should be decided in such a way that suction piping bottom should be 500mm above grade level and in case of jacketed pipe, it should be 600mm above grade level.

7.1.4.3.2.5 Compressor Piping

- Suction lines shall be as short as possible.
- Suction piping shall have adequate flanged joints for ease of erection and maintenance.
- Lube oil cooler space shall be provided and in a way as to facilitate tube bundle removal.
- All operating valves on main suction and discharge piping shall be lined on one side as far as possible.
- A minimum straight length of suction pipe is to be provided as per manufacturer's recommendation.
- Piping shall be designed so that forces & moments imposed on the compressor do not exceed the manufacturer's recommendation.
- Compressor suction lines between the knockout drum and the compressor shall be as short as practicable.
- Where the line between knockout drum and the compressor can not be routed without pocket, low point in compressor line shall be provided with drains to remove any possible accumulation of liquid.

- Low points in the discharge line from an air compressor shall be avoided because it is possible for lube oil to be trapped and subsequently ignited. If low points are unavoidable, they shall be provided with drains.
- In case of reciprocating compressor, piping shall be suitably supported to avoid vibrations due to pulsation flow. Unless specific requirements of no pocket is there from the licensor, all the piping shall run at 500mm above grade level so that supports can be provided from grade independent of structure to minimize vibrations. Analog study shall be carried out for complete compressor piping including suction / discharge piping as per P&IDs and the study recommendations if any, shall be implemented.
- Reciprocating compressor piping should not be supported from compressor shed /platform structure.

7.1.4.3.2.6 Relief system / Blow down system piping

- Relief of liquids and easily condensable hydrocarbon are usually discharged to a closed system.
- Wherever the inlet line size is higher than the safety valve inlet size, reducer shall be installed adjacent to inlet of safety valve.
- Relief valve discharging steam, air or other non-flammable vapour or gas directly to atmosphere shall be equipped with drain and shall be suitably piped to prevent accumulation of liquid at valve outlet.
- Liquid-phase blow down system piping connected to a closed system shall be self-draining to the blow down drum. Closed blow down header shall be sloped towards the CBD drum to assure free drainage.
- Liquid vapor phase relief valves shall discharge into the flare header at an angle 45 degrees in the direction of header flow, to minimize the effect of kinetic energy and to avoid accumulation of liquid.
- Pockets in the flare header and blow down system shall be prohibited.
- Relief valve discharge piping to atmosphere shall be taken to safe location as per the following:

  3M - above top platform of column or structure and 8M for hydrocarbon / toxic discharge.

- Inlet and outlet piping of pressure relief valve shall be adequately supported to take care of the thrust induced by the relief valve during popping.
- Reaction forces including both momentum & static pressure effects due to safety valve popping shall be ascertained in the connected piping according to API RP 520(part-II, Fourth edition, 1994). The effect of these forces on the piping supports and the anchors of the piping system shall be calculated to ascertain that the allowable limits at these locations are not exceeded. The supporting structure also shall be adequately designed so that when subjected to these reaction forces the supporting elements connected to piping as well as the basic supporting structure i.e. structure members etc. are capable of withstanding them. System stresses in the inlet and outlet piping portions at safety valves also shall be kept within the allowable limits, inclusive of the distribution branching points in the inlet portions. These reactive forces shall not lead to any leakage at the flanged joints present in the system. To ascertain this the necessary calculations for checking leakage at the flanged joints shall be performed.

Relief discharge valve position shall be as per OMR’84 & API RP 520.

7.1.4.3.2.7 Utility Stations

Requisite number of utility stations shall be provided throughout the unit for the utility requirement. Utility stations shall have two connections one for Plant Air (AP), and one for Service Water (WS) each of 1” unless otherwise specified in P & ID. Air and water lines shall have quick type hose connection. All connections shall be directed downwards. All connections shall have globe valve for isolation purpose or as per client requirement. Inert gas hose, when required, shall have built-in non-return valve in quick connection coupling of piping end.

Number of utility stations shall be such that the related equipments shall be approachable from at least one utility station. The approach of utility station shall be considered 15M all around the station location. The utility stations shall generally be located adjacent to pipe-rack column. The utility stations shall also be provided on elevated structures like technological structure, operating
platforms of vertical equipments etc. Columns/towers shall be provided with utility service (air).

7.1.4.3.3 Flare Piping

Flare header shall be sloped towards flare knockout drum. Only horizontal loop shall be provided as per requirement to accommodate thermal expansion. The desired slope shall be ensured throughout including flat loop. Flare header shall be supported on shoe of height ranging from 100mm to 300mm.

Proper thermal analysis temperature shall be established including the possibility of temperature gradient along the line before providing expansion loops. Efforts shall be made to minimize the number of loops.

Flare line between knockout drum and water seal drum shall be designed for pressure fluctuations and adequately supported to avoid vibrations.

7.1.4.3.4 Flexibility Analysis and Supporting

7.1.4.3.4.1 Pipe supporting Criteria & General Guidelines.

Piping System shall be properly supported taking into account the following points:

- Load of bare pipe + fluid + insulation (if any).
- Load of bare pipe + water fill.
- Load of valves and online equipment and instruments.
- Thermal loads during operation.
- Steam-out condition, if applicable.
- Wind loads for large diameter piping at higher elevation, e.g. transfer lines, column over headlines, flare headers etc.
- Forced vibration due to pulsating flow.
- Vibration due to two-phase slug flow.
- Loads due to internal pressure.
- Any external loads / concentrated loads and cold loads of springs.

Pipe supporting shall preferably follow the basic span as given in Annexure–A except for flare line in offsite on trestles, in which case the basic span shall preferably be restricted to maximum 18.0 meters. For sizes not covered in Annexure-A, basic span shall be established based on project requirement. For piping on rack or sleeper, as a minimum, providing resting support on every grid of pipe rack / sleeper is mandatory. Depending on the pipe size, as a rule, guides shall be provided on straight run of pipes at intervals as specified in Annexure–C, unless specifically becomes non-viable due to flexibility problems.

Additional supports, guides, anchors, special supports like spring supports and sway braces shall be provided after detailed analysis of piping system to restrict the forces experienced on nozzles of critical items like pumps, compressors, turbines, exchangers, air fin coolers etc. For lines which do not
need any support otherwise but become unsupported by opening of flange, etc. during maintenance and thereby may transfer the total load on a small branch or other equipment nozzle, a permanent support shall suitably provided which may be a spring support also.

Bare pipes of size 12” and above shall be supported with pad or shoe. Adequate care shall be taken for small (1 1/2” and below) branch from piping. As a rule for all lines of 600# & above classes, lines having two phase flow and lines having pulsating flow such as discharge of reciprocating compressors, & reciprocating pumps, all small bore branches of size 11/2” and below, e.g. vents, drains, orifice taps, pressure tappings, temperature tappings, sample connections, PSV inlet, TSV inlet and small bore line etc. shall be provided with 2 number stiffeners at 900 to each other from the main pipe to impart adequate stiffness to the branch connection. The stiffeners shall be made of 6mm thick flats of material equivalent to the pipe material. Further irrespective of line rating, the stiffeners shall be provided for all orifice taps, all small bore tappings from PSV inlet/ outlet lines and all small bore tappings from Control Valve manifolds. For pulsating flow lines, detailed thermal and vibration analysis by analog study shall be done to decide on location of anchor supports and guides etc. Wherever two-phase flow in piping is expected, piping design shall be checked by dynamic analysis to prevent vibrations.

Pipe support design shall be such that deflection in piping systems due to sustained loads shall not exceed 15mm (max.), in any case between two adjacent supports.

As far as possible long trunion types of supports (more than 0.5 mtr.) are to be avoided. In case long trunion support is unavoidable in straight length of pipe, trunion height is to be restricted to 0.5m and balance height to be made up by providing extended structure.

In the heaters, where steam air decoking is there, the main lines and the decoking lines should be supported in a way that either of the lines should not be in the hanging position while connected to other one.

Piping passing through the technological structure or passing near the concrete column etc. should have adequate annular space to avoid restriction of line movement during thermal expansion. The gap should take care of thermal expansion along with insulation thickness.

High-density PUF blocks shall be considered for cold piping supports. Use of wood blocks shall be minimized.

All pipe supports shall be so designed that there is no undue loading on equipment flanges.

7.1.4.3.4.2 Flexibility Analysis Criteria & General Guidelines.
Piping shall be analyzed for expansion, contraction, differential settlement, relief, valve reaction and effects mentioned in CL 3.2.6.

- The design of piping systems shall take into account the different conditions expected during operation, start up, shut-down, cold branch in case of stand by pump, tracing etc. Hydrocarbon lines shall be designed for steam-out conditions, if specified in line schedule.
- System where combination of different conditions is envisaged shall be analyzed for all possible combinations.
- The use of expansion joints shall be considered only when space or pressure drop limitation does not permit pipe bends. Expansion joint of axial type shall generally be avoided.
- Forces and moments due to weight, thermal loads and other imposed loads on the equipment nozzle must not exceed the allowed loads for the equipment.
- In case of special requirement, surge effects (loads generated by overpressure in pipes due to water hammer effect) will be analyzed based on process data. An equivalent static stress analysis will be performed in which the force due to pressure surge will be applied at appropriate locations (changes of direction). Supports (piping supports and structures) will be designed to withstand these loads. Force spectrum dynamic analysis will be performed when high surge pressure fluctuations and high stress level or high loads on supports are obtained from the static stress analysis. Concerned lines will be identified on Piping Line List by Process Group.
- Pipe subjected to slug flow shall be identified by Process Group and indicated on Piping Line List. Slug force will be applied at changes of direction to determine stresses and pipe support loads. Supports (piping supports and structures) will be designed to withstand these loads. First natural frequency of such piping shall be kept in the range of 4 to 8 Hz.

7.1.4.3.4.3 Method of Analysis

- Following lines shall be considered critical and shall mandatorily require formal analysis. Other lines may also need analysis, if required.
- All process lines to and from fired heaters and steam generators.
- All process lines to and from centrifugal compressors and blowers.
- All lines to and from turbines.
- All pump lines and air cooler lines (6” and above and analysis temp.>600°C & less than -600°C).

All lines as below:

4” to 6” analysis temp. above 3000°C & less than -1000°C
8” to 14” analysis temp. above 1500°C & less than -800°C
16” & above analysis temp. above 800°C & less than -800°C

All other critical lines (connecting to sensitive equipments).
The package used shall be CAESAR II. All lines shall be analyzed at operating / analysis temperature. In the absence of analysis temperature, lines may be analyzed at design temperature. However in case of wide difference in design and operating temperatures, the temperature for analysis shall be established based on consultation with the process department. (e.g. while doing the analysis of flare line or calculating expansion of long columns.)

All non-critical lines may be analyzed using other methods. Special analysis methods shall be followed for lines involving pulsating flow such as those connected to reciprocating pumps and compressors. Analog and mechanical vibration study of entire system along with piping/equipments will be entrusted to agencies with proven track record.

7.1.4.3.5 Materials.

Basic material selection of particular line depending on its service temperature and corrosivity shall be spelt in process package.

For additional technical requirements refer Annexure–D.

7.1.4.3.6 Painting

7.1.4.3.6.1 Scope of Painting

7.1.4.3.6.1.1 The following surfaces and materials shall require painting.

a) All uninsulated C.S & A.S piping, fittings, valves, columns, vessels, drums, storage tanks, heat exchangers etc. including identification marks on insulated lines.
b) Identification colour bands on all piping as required including insulated aluminium clad, galvanized, SS and non-ferrous piping.
c) Pipes, fittings & valve surfaces under insulation of carbon steel and alloy steel insulated piping system.
d) Pipes, fittings, valve surfaces under insulation of stainless steel insulated piping system.
e) All structural steel works, supports, walkways, handrails and platforms.

7.1.4.3.6.1.2 The following surfaces and materials shall not require painting:

a) Uninsulated austenitic stainless steel and higher alloy piping.
b) Plastic and plastic coated materials.
c) Non-ferrous material like aluminium galvanized steel, brass, bronze piping etc.

7.1.4.3.6.2 Colour Coding

All painting and colour coding shall be as per STEP Specification (9473-03-TS-012), which is as per codes followed by OIL. For clarification reference code is IS: 2379.
7.1.4.3.6.3 **Surface Preparation**

All surfaces to be painted shall be blast cleaned either by air blasting or water blasting using steel grit to finish SA 2.5 as per SIS-055900 / ISO-8501-1. Only repair painting of shop primed piping shall be done with mechanical tools to surface finish ST-3 as per SIS-055900 / ISO-8501-1.

7.1.4.3.6.4 **Painting Application**

7.1.4.3.6.4.1 All blast surfaces shall be primed within four hours upon completion of blasting.

7.1.4.3.6.4.2 No surface shall be coated in rain, wind or in environment where injurious airborne element exists, where surface temperature is below 50°F above dew point, where relative humidity is greater than 90% and temperature is below 400°F.

7.1.4.3.6.4.3 No coat shall be applied unless the preceding coat is dried. Forced drying shall be avoided to avoid cracks, wrinkles and blister formation.

7.1.4.3.6.4.4 Paint application shall follow the strict instruction of the Paint Manufacturer Whose Paint is Being Employed.

7.1.4.3.6.4.5 All procedures from surface preparation to finish painting, including testing shall be well documented through a quality procedure approved by engineer-in-charge.

7.1.4.3.7 **Welding**

7.1.4.3.7.1 **Applicable Codes & Standards**

All welding works, equipments for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following accepted standards and procedures.

a) Process Piping - ASME B 31.3

In addition, the following codes and specifications referred in the code of fabrication shall be followed for the welding specifications, consumable qualifications and non-destructive test procedures.

i) Welding & Brazing Qualifications - ASME BPV Sec.IX

ii) Non-Destructive Examination - ASME BPV Sec.V

iii) Material Specifications: Welding rods, electrodes and filler metals - ASME BPV Sec II- Part C.

The additional requirements mentioned in this specification, over and above those obligatory as per codes, shall be followed wherever specified.
## TABLE OF BASIC SPAN

### PART-I

<table>
<thead>
<tr>
<th>Nom. Pipe Size (Inches)</th>
<th>SCH / THK (Inches)</th>
<th>PIPE-VAPOUR INSULATION</th>
<th>PIPE-LIQUID INSULATION</th>
<th>BARE PIPE EMPTY</th>
<th>BARE PIPE WATER-FILLED</th>
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### Examples
- **3/4”**
  - SCH 40: 3.5 m, 3.5 m, 2.5 m, 3.5 m, 3.0 m, 2.0 m, 1.68 kg/m³, 4.0 kg/m³, 2.04 kg/m³
- **1”**
  - SCH 40: 4.5 m, 4.0 m, 3.0 m, 4.5 m, 3.5 m, 3.0 m, 5.0 kg/m³, 4.5 kg/m³, 3.07 kg/m³
- **1-1/2”**
  - SCH 40: 5.5 m, 5.0 m, 4.5 m, 5.0 m, 4.5 m, 3.5 m, 6.5 kg/m³, 5.5 kg/m³, 7.65 kg/m³
- **2”**
  - SCH 40: 6.5 m, 6.0 m, 5.0 m, 6.0 m, 5.5 m, 4.5 m, 7.5 kg/m³, 6.5 kg/m³, 11.79 kg/m³
- **2-2 1/2”**
  - SCH 40: 7.5 m, 6.5 m, 5.5 m, 6.5 m, 6.0 m, 5.5 m, 8.0 kg/m³, 6.5 kg/m³, 16.15 kg/m³
- **3”**
  - SCH 40: 8.0 m, 7.5 m, 6.5 m, 7.5 m, 7.0 m, 6.0 m, 9.0 kg/m³, 7.5 kg/m³, 24.45 kg/m³
- **4”**
  - SCH 40: 10.0 m, 9.5 m, 8.5 m, 9.0 m, 8.0 m, 7.5 m, 10.5 kg/m³, 9.0 kg/m³, 46.7 kg/m³
- **6’**
  - SCH 40: 12.0 m, 11.0 m, 10.0 m, 10.0 m, 10.0 m, 9.0 m, 12.0 m, 10.0 kg/m³, 111.9 kg/m³
- **8’**
  - SCH 40: 13.0 m, 12.5 m, 12.0 m, 11.5 m, 11.0 m, 10.5 m, 15.0 m, 11.5 kg/m³, 172.0 kg/m³
- **10”**
  - SCH 40: 14.5 m, 13.5 m, 13.0 m, 12.5 m, 12.0 m, 11.5 m, 18.0 m, 11.5 kg/m³, 258.3 kg/m³
- **12”**
  - SCH 40: 16.0 m, 15.0 m, 14.5 m, 14.0 m, 13.5 m, 13.0 m, 20.0 m, 12.0 kg/m³, 307.5 kg/m³
- **14”**
  - SCH 40: 17.5 m, 16.5 m, 16.0 m, 15.5 m, 15.0 m, 14.5 m, 22.0 m, 14.0 kg/m³, 418.2 kg/m³
- **16”**
  - SCH 40: 19.0 m, 18.0 m, 17.5 m, 17.0 m, 16.5 m, 16.0 m, 24.0 m, 14.0 kg/m³, 541.5 kg/m³
- **18”**
  - SCH 40: 20.5 m, 20.0 m, 19.5 m, 19.0 m, 18.5 m, 18.0 m, 26.0 m, 14.0 kg/m³, 674.8 kg/m³
- **20”**
  - SCH 40: 22.0 m, 21.5 m, 21.0 m, 20.5 m, 20.0 m, 19.5 m, 28.0 m, 14.0 kg/m³, 808.1 kg/m³
- **24”**
  - SCH 40: 24.0 m, 23.5 m, 23.0 m, 22.5 m, 22.0 m, 21.5 m, 30.0 m, 15.0 kg/m³, 941.4 kg/m³
### DESIGN BASIS

For MADHUBAN, BAGHJAN & CHABUA  

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<th>No. m.Pipe Size (Inches)</th>
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<tr>
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<td>10.5</td>
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<td></td>
<td></td>
<td></td>
<td>65.10 8”</td>
</tr>
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<td></td>
<td></td>
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<td>82.20 10”</td>
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<td></td>
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<td>98.13 12”</td>
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<td>13.5</td>
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<td></td>
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<td>108.1 14”</td>
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<tr>
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<td>15.0</td>
<td>15.0</td>
<td>13.0</td>
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<tr>
<td>18” ½” w</td>
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<td>17.0</td>
<td>16.0</td>
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<td>14.0</td>
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<td></td>
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<td>140.2 18”</td>
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<td>20” ½” w</td>
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<td>157.5 20”</td>
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<td>24” ½” w</td>
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<td>16.0</td>
<td>15.0</td>
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<tr>
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<td>188.2 24”</td>
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## PART- III

<table>
<thead>
<tr>
<th>No. Pipe Size (Inches)</th>
<th>SCH/THK Size (Inches)</th>
<th>PIPE-VAPOUR INSULATION</th>
<th>PIPE-LIQUID INSULATION</th>
<th>BARE PIPE EMPTY</th>
<th>BARE PIPE WATER-FILLED</th>
<th>No. Pipe Size (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BASIC SPAN (L) M</td>
<td>BASIC SPAN (L) M</td>
<td>Upto 175°C</td>
<td>Upto 175°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Up to 175°C</td>
<td>Up to 175°C</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>176°C to 315°C</td>
<td>316°C to 400°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upto 175°C</td>
<td>Upto 175°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>176°C to 315°C</td>
<td>316°C to 400°C</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPAN (L) M</td>
<td>SPAN (L) M</td>
<td>Weight (kg/m³)</td>
<td>Weight (kg/m³)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upto 175°C</td>
<td>Upto 175°C</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>176°C to 315°C</td>
<td>316°C to 400°C</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Examples

- **1"**
  - SCH/THK Size: 10 S
  - Pipe Size: 1" (1"
  - Basic Span (L) M: 4.0
  - Span (L) M: 3.5
  - Thickness: 3.0
  - Weight: 4.0

- **1-1 ½"**
  - SCH/THK Size: 10 S
  - Pipe Size: 1-1 ½"
  - Basic Span (L) M: 5.0
  - Span (L) M: 4.5
  - Thickness: 3.5
  - Weight: 5.0

- **2"**
  - SCH/THK Size: 10 S
  - Pipe Size: 2"
  - Basic Span (L) M: 5.0
  - Span (L) M: 4.5
  - Thickness: 4.0
  - Weight: 5.0

- **2-2 ½"**
  - SCH/THK Size: 10 S
  - Pipe Size: 2-2 ½"
  - Basic Span (L) M: 6.5
  - Span (L) M: 5.5
  - Thickness: 5.0
  - Weight: 6.0

- **3"**
  - SCH/THK Size: 10 S
  - Pipe Size: 3"
  - Basic Span (L) M: 7.0
  - Span (L) M: 6.0
  - Thickness: 5.0
  - Weight: 6.0

- **4"**
  - SCH/THK Size: 10 S
  - Pipe Size: 4"
  - Basic Span (L) M: 7.5
  - Span (L) M: 7.0
  - Thickness: 6.0
  - Weight: 7.0

- **6"**
  - SCH/THK Size: 10 S
  - Pipe Size: 6"
  - Basic Span (L) M: 9.5
  - Span (L) M: 9.0
  - Thickness: 8.0
  - Weight: 8.0

- **8"**
  - SCH/THK Size: 10 S
  - Pipe Size: 8"
  - Basic Span (L) M: 11.0
  - Span (L) M: 10.5
  - Thickness: 9.5
  - Weight: 9.5

- **10"**
  - SCH/THK Size: 10 S
  - Pipe Size: 10"
  - Basic Span (L) M: 12.5
  - Span (L) M: 12.0
  - Thickness: 10.5
  - Weight: 10.5

- **12"**
  - SCH/THK Size: 10 S
  - Pipe Size: 12"
  - Basic Span (L) M: 14.0
  - Span (L) M: 13.0
  - Thickness: 11.0
  - Weight: 11.0

- **14"**
  - SCH/THK Size: 10 S
  - Pipe Size: 14"
  - Basic Span (L) M: 15.5
  - Span (L) M: 14.5
  - Thickness: 12.0
  - Weight: 12.0

- **16"**
  - SCH/THK Size: 10 S
  - Pipe Size: 16"
  - Basic Span (L) M: 17.5
  - Span (L) M: 16.5
  - Thickness: 13.5
  - Weight: 13.5

- **18"**
  - SCH/THK Size: 10 S
  - Pipe Size: 18"
  - Basic Span (L) M: 19.0
  - Span (L) M: 18.0
  - Thickness: 14.5
  - Weight: 14.5

- **20"**
  - SCH/THK Size: 10 S
  - Pipe Size: 20"
  - Basic Span (L) M: 20.5
  - Span (L) M: 19.0
  - Thickness: 15.5
  - Weight: 15.5

- **24"**
  - SCH/THK Size: 10 S
  - Pipe Size: 24"
  - Basic Span (L) M: 24.0
  - Span (L) M: 23.0
  - Thickness: 16.5
  - Weight: 16.5

---

**Saipem Triune Engineering Pvt. Ltd., New Delhi**

**DESIGN BASIS FOR MADHUBAN, BAGHJAN & CHABUA**

**Document Number:** 9473-03-DB-001

**Sheet 69 of**
### Annexure-B

#### Accessibility for valves and instruments

<table>
<thead>
<tr>
<th>Valves, instruments, equipment to be operated</th>
<th>Centerline of item to be operated, located less than 3.6 m above grade, 2.75 m above floor or platform or 1.8 m above wing platform</th>
<th>Centerline of item to be operated, located more than 3.6 m above grade, 2.75 m above floor or platform or 1.8 m above wing platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchanger heads</td>
<td>Nl</td>
<td>Platform</td>
</tr>
<tr>
<td>Manually Oper. Valves 2&quot; &amp; smaller</td>
<td>Fixed ladder</td>
<td>Fixed ladder</td>
</tr>
<tr>
<td>Manually Oper. Valves 3&quot; &amp; above</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Motor operated valves</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Control valves</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Relief valves 2&quot; &amp; smaller</td>
<td>Fixed ladder</td>
<td>Fixed ladder</td>
</tr>
<tr>
<td>Relief valves 3&quot; &amp; above</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Block valves 2&quot; &amp; smaller</td>
<td>Portable ladder</td>
<td>Platform</td>
</tr>
<tr>
<td>Block valves 3&quot; &amp; above</td>
<td>Platform note-1</td>
<td>Platform note-1</td>
</tr>
<tr>
<td>Battery limit valves</td>
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<td>Platform</td>
</tr>
<tr>
<td>Pressure instruments</td>
<td>Fixed ladder if above 2.2m height</td>
<td>Fixed ladder</td>
</tr>
<tr>
<td>Temperature instruments</td>
<td>Fixed ladder if above 2.2m height</td>
<td>Fixed ladder</td>
</tr>
<tr>
<td>Sample points</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Gauge glasses</td>
<td>Fixed ladder</td>
<td>Fixed ladder</td>
</tr>
<tr>
<td>Level controllers</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Process blinds and spades 2&quot; &amp; smaller</td>
<td>Portable ladder / platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Process blinds and spades 3&quot; &amp; above</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Man ways / manholes</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Hand holes / inspection holes</td>
<td>Platform</td>
<td>Platform</td>
</tr>
<tr>
<td>Nozzles</td>
<td>No access required (Note-2)</td>
<td>No access required (Note-2)</td>
</tr>
<tr>
<td>Vessel vents</td>
<td>Portable ladder</td>
<td>Fixed ladder</td>
</tr>
<tr>
<td>Line drains &amp; vents</td>
<td>Portable ladder</td>
<td>Portable ladder</td>
</tr>
<tr>
<td>Orifice flanges</td>
<td>Portable ladder</td>
<td>Portable ladder</td>
</tr>
</tbody>
</table>

**Notes:**

1. Centerline of block valves located above 2.0 meter from the operating floor, which are required for normal operation, shall be provided with portable platform or chain for operation of valves.
2. Temporary arrangement for access should be feasible.
### Vertical and Horizontal Guides Spacing

<table>
<thead>
<tr>
<th>Nom. Pipe size (Inches)</th>
<th>Guide spacing (in meters)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal</td>
<td>Vertical</td>
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<tr>
<td></td>
<td>Note –2,3</td>
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<td>12</td>
<td>6</td>
</tr>
<tr>
<td>2 ½</td>
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<td>3</td>
<td>12</td>
<td>6</td>
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<td>4</td>
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<td>14</td>
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<td>16</td>
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<td>18</td>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>20</td>
<td>36</td>
<td>14</td>
</tr>
<tr>
<td>24</td>
<td>36</td>
<td>16</td>
</tr>
</tbody>
</table>

**Notes:**

1. The guide spacing given in the above table are indicative only.
2. The above spacing is valid for all lines unless otherwise specified by stress group.
3. For horizontal long straight runs of pipe inside units, given that pitch is between 3m & 7.5m, guide all lines 2” & under on every frame & all lines 3” to 8” inclusive on alternative supports lines 10” & above need not be guided unless required by stress group.
4. These spacing may be varied to suit column spacing of rack. The above spacing is for straight runs of pipes and does not include guides, which are used for control of thermal movements as would occur as expansion loops etc.
Annexure – D

Technical Requirements of Piping Material

Ends

Unless otherwise specified, the end shall be to the following standard:

- **SW / SCRD** : ASME B16.11
- **BW** : ASME B16.25
- **FLANGED** : ASME B16.5 and ASME B 16.47 SERIES'B'
- **THREADING** : ASME B1.20.1 (NPT, Taper threads)

Face Finish

This shall be to MSS-SP-6 / ASME B 46.1/ASME B 16.5. The interpretation shall be:

- **Stock Finish** : 250-1000 µ in AARH
- **Serrated Finish** : 125- 250 µ in AARH
- **Smooth Finish / 125 AARH** : 63- 125 µ in AARH
- **Extra Smooth Finish/ 63 AARH** : 32- 63 µ in AARH

Austenitic Stainless Steel

- All items / parts shall be supplied in solution-annealed condition.
- For all Austenitic Stainless Steels, Intergranular Corrosion (IGC) Test shall be conducted as per following:
  - ASTM A262 Practice 'B' with acceptance criteria of 60 mils/year (max.) for casting.
  - ASTM A262 Practice 'E' with acceptance criteria of 'No cracks as observed from ‘20 X Magnification’ & microscopic structure to be observed from ‘250 X magnification’ for other than casting.
- For IGC test, two sets shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and other set corresponding to the highest rating / thickness.

ITEM SPECIFIC NOTES:

Pipes

- Unless specifically exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding.
- Double seam 180 deg. apart is allowed for sizes 36” and larger only.
- Galvanized Pipes shall be only Hot Dip galv. To ASTM A53.

Fittings

- All fittings shall be seamless in construction unless otherwise specified.
- For reducing BW fittings having different wall thickness at each end, the greater one shall be employed and the ends shall be matched to suit respective thickness.
- All welded fittings shall have maximum negative tolerance equivalent to pipe selected.
- All welded fittings shall be double welded. Inside weld projection shall not exceed 1.6mm, and the welds shall be ground smooth at least 25mm from the ends.
- For fittings made out of welded pipe, the pipe itself shall be of double welded type, manufactured with the addition of filler material made employing automatic welding only.
- All welded fittings shall be normalized for CS, normalized & tempered for AS; and 100% radio graphed by X-ray for all welds made by fitting manufacturer as well as for welds on the parent material.
- Bevel ends of all BW fittings shall undergo 100% MP/DP test.
- Those used in fire-fighting facilities shall be marked.

Flanges

- For Ring Joint Flanges, Blinds and Spacers, the hardness shall be as follows:

<table>
<thead>
<tr>
<th>Flange material</th>
<th>Min. Hardness of Groove (BHN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Steel</td>
<td>120</td>
</tr>
<tr>
<td>1% Cr to 5% Cr, ½ Mo</td>
<td>150</td>
</tr>
<tr>
<td>9% Cr, 1 Mo</td>
<td>215</td>
</tr>
<tr>
<td>Type 304, 316, 347</td>
<td>180</td>
</tr>
<tr>
<td>Type 304L, 316L</td>
<td>140</td>
</tr>
</tbody>
</table>

- For RTJ flanges, blinds & spacers, the hardness of the groove shall be specified on the test report.
- Bore of weld neck flange shall correspond to the inside diameter of pipe for specified schedule/thickness. Ends shall be bevelled to suit the specified schedule/thickness.
- For RTJ flanges, only octagonal section ring joint flanges shall be used.

Valves

- Valves of class 900 & above shall be pressure-sealing type. Threaded and seal welded or welded bonnet may be employed up to sizes 1½".
- All flanged valves (except forged) shall have flanges integral with the valve body.
- Valve Castings / Forgings purchased from India or Indian vendors shall be from approved foundries / forging shop.
- Yoke material shall be at least equal to body material.
- Forgings are acceptable in place of Castings but not vice-versa.
- No Cast Iron valves to be used in firewater or any other service except in drinking water service.
VALVE STANDARD (API):-

Following API standard (Latest edition) for valve shall be applicable.

- API 6D : Specification for Pipe line Valves (Gate , plug, Ball & check valves).
- API 6A : Fire test for valves.
- API 598 : Valve inspection & testing.
- API 600 : Steel gate valve flanged and butt weld ends.
- API 602 : compact carbon steel gate valve.
- API 607 : Fire test for soft seated quarter turn valve.
- API 6FA : Fire test for Valves.

Valve standards are also mentioned in ‘Piping material specification’ as well as ‘Valve material specification’ specified for this project.

Dimensions

- Face-to-Face / End-to-End dimension shall be as per ASME B 16.10. In case the same is not covered under B16.10, the dimension shall be as per BS 2080 / Mnf Std.
- Valve under cryogenic service (temp. below – 45°C) shall be as per BS-6364 and shall be procured from prequalified vendor.

Operation

- Generally the valves are hand wheel or lever operated. However, suitable gear operator in enclosed gear box shall be provided for valves as follows:
Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on each side. Effort to operate shall not exceed 35 kgf at hand wheel periphery. However, failing to meet the above requirement, vendor shall offer gear operation.

Quarter-turn valves shall have “open” position indicators with limit stops.

**By Pass**

A globe type valve (size as per ASME / ANSI B 16.34) shall be provided as by-pass for the following sizes of gate valves:

<table>
<thead>
<tr>
<th>Class</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>26” &amp; above</td>
</tr>
<tr>
<td>300</td>
<td>16” &amp; above</td>
</tr>
<tr>
<td>600</td>
<td>6” &amp; above</td>
</tr>
<tr>
<td>900</td>
<td>4” &amp; above</td>
</tr>
<tr>
<td>900</td>
<td>4” &amp; above</td>
</tr>
<tr>
<td>1500</td>
<td>3” &amp; above 4”</td>
</tr>
<tr>
<td>2500</td>
<td>3” &amp; above 4”</td>
</tr>
</tbody>
</table>

By-pass Piping, Fitting and valves shall be of compatible material and design. Complete fillet welds for by-pass installation shall be DP / MP tested. NDT of by-pass valve shall be in line with main valve.

**Radiography of Cast Valves**

a) The minimum requirement of radiography shall be as under:
b) Additional radiography requirement for casting sizes for special / critical piping classes [Over and above the requirements covered in clauses (a) above] shall be as follows:

I. For hydrogen / hydrogen bearing, oxygen, NACE, stress relieved amine services:

<table>
<thead>
<tr>
<th>Class</th>
<th>Size</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>upto 24&quot;</td>
<td>50%</td>
</tr>
<tr>
<td>300</td>
<td>upto 16&quot;</td>
<td>50%</td>
</tr>
</tbody>
</table>

II. For LT / CRYO services:

<table>
<thead>
<tr>
<th>Class</th>
<th>Size</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>upto 24&quot;</td>
<td>20%</td>
</tr>
<tr>
<td>300</td>
<td>upto 16&quot;</td>
<td>20%</td>
</tr>
</tbody>
</table>

III. For alloy steel & stainless steel castings [Not covered in paras a, b (i) & b (ii)]:

<table>
<thead>
<tr>
<th>Class</th>
<th>Size</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>upto 24&quot;</td>
<td>10%</td>
</tr>
<tr>
<td>300</td>
<td>upto 16&quot;</td>
<td>10%</td>
</tr>
</tbody>
</table>

- Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME / ANSI B 16.34.
- All casting in Class 300 & below shall be of radiographic quality. This requirement is to be ensured by sample radiography before proceeding with the actual production.

**Ball/Plug/Butterfly Valves**

- Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves.
- Soft- seated Ball, Plug & Butterfly valves shall be supplied with antistatic devices.
- The ball of Ball valves shall not protrude outside the end flanges.
- Ball valves shall be floating ball type/ trunion mounted type as per following:
<table>
<thead>
<tr>
<th>Class</th>
<th>Floating ball</th>
<th>Trunion mounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>8&quot; &amp; below</td>
<td>10&quot; &amp; above</td>
</tr>
<tr>
<td>300</td>
<td>4&quot; &amp; below</td>
<td>6&quot; &amp; above</td>
</tr>
<tr>
<td>600 &amp; above</td>
<td>1½ &quot; &amp; below</td>
<td>2&quot; &amp; above</td>
</tr>
</tbody>
</table>

- Use of soft-seated Ball/Plug/Butterfly valves shall be suitably selected based on temperatures handled.
- Butterfly valves shall be suitable for throttling application.

**Strainer**

- Allowable pressure drop when specified shall be certified by vendor along with the offer. If asked specifically, vendor shall furnish pressure drop calculations.
- All 2" & higher sized Y type strainers shall be provided with ¾" threaded tap and solid threaded plug as drain connection. For less than 2", this shall be ½" size.
- For fabricated strainers, all BW joints shall be fully radiographed and fillet welds shall be 100% DP / MP checked.
- All the strainers shall be hydrostatically tested at twice the design pressure, subject to flange rating limitations.

**Traps**

- Vendor shall also furnish the performance curve indicating the capacity in mass/hour at various differential pressures across the trap.
- Parts subject to wear and tear shall be suitably hardened.
- Traps shall function in horizontal as well in vertical installation.
- Trap shall have integral strainers.
- All traps shall be hydrostatically tested to twice the design pressure.

**Hoses**

- Manufacturer shall guarantee suitability of hoses for the service and working conditions specified in the requisition, if the material is not specified in the Material Requisition for any particular service.
- All hoses shall be marked with service and working pressure as a minimum at both ends clearly.
- Hoses shall be resistant to ageing, abrasion and suitable for outdoor installations.
- Complete hose assembly shall be tested at at least two times the design pressure.

**Expansion joints**

- The applicable codes are ASME B 31.3 and EJMA (Expansion Joint Manufacturer's Association).
Bellows shall be formed from solution annealed sheet conforming to the latest ASTM Spec. Any longitudinal weld shall be 100% radiographed. The finished longitudinal weld must be of the same thickness and same surface finish as the parent material. Circumferential welds are not permitted. Bellows are to be hydraulically or expansion (punched) formed. Rolled formed bellows are not acceptable. Noticeable punch or die marks resulting from expansion operation are not acceptable.

- No repairs of any kind are allowed on the bellows after forming. Deep scratches and dents are not acceptable.
- The out of roundness shall be limited to + / -3mm. This is the max. deviation between the max. & min. diameter.
- The actual circumference of the welding end shall be maintained to + / -3mm of the theoretical circumference.
- Apart from the usual requirements, the vendor shall also furnish:
  - Design calculations to justify stiffness and fatigue life.
  - Axial, lateral stiffness, angular stiffness, effective pressure thrust area.
  - Installation/ maintenance manual.

**Supports & Spring Assemblies**

- The Material, Design, Manufacture and Fabrication shall be generally as per MSS-SP-58 / MSS-SP-89 and / or BS 3974.
- Testing of springs shall be as per BS 1726.

**Gaskets**

- Grafoil filler for spiral wound gasket shall not have any colour or dye.
- Full-face gaskets shall have bolt holes punched on it.

Non-metallic ring gaskets as per ASME / ANSI B16.21 shall match flanges to ASME / ANSI B16.5 upto 24”, and ASME / ANSI B 16.47 or AWWA for sizes greater than 24’ unless otherwise specified. Spiral wound gaskets as per ASME B 16.20 shall match flanges to ASME / ANSI B 16.5 upto 24”, and ASME B 16.47 series “B” for sizes >24” unless otherwise specified.

Inner rings’ requirements for spiral wound gaskets shall be as given below:

Inner ring shall be provided for the following:

- a) As per code (B 16.20) requirement.
- b) For sizes 26” & above in all classes.
- c) For vacuum, cryo and hydrogen service.
- d) For SS 321,SS 347 and H-grade SS classes.
- e) For classes where temperature is higher than 427°C.
- f) For 900# rating and above classes.

In case of RTJ gaskets, only octagonal section ring gaskets shall be used and shall have proper marking stamped. Material certificate shall be available for
the gasket. Hardness of RTJ gaskets shall be 20 BHN (min.) less than the corresponding flange groove hardness.

**Stud, Bolts, Nuts and Jack Screws**
- All bolting shall be as per ASME / ANSI B 18.2.1 for Studs, M/C Bolts and Jack Screws, and ASME/ ANSI B 18.2.2 for nuts.
- Threads shall be unified (UNC for <= 1” dia. and 8UN for > 1” dia.) as per ANSI B 1.1 with class 2A fit for studs, M/C Bolts and Jack Screws and class 2B fit for nuts.
- Stud bolts shall be full threaded full length with heavy hex nuts. Length tolerance shall be in accordance with the requirement of table F2 of Annexure F of ASME B 16.5.
- The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process.
- The length of the studs / bolts should be such that minimum two threads should be out of the nut on either side.
- All the stud / bolt should have metallurgical certificates in case of alloy / SS metallurgy with identified colour marking at the stud ends / bolt side face.
- In corrosive atmosphere like acid chemical storage area, cooling towers area, where SS flanges are provided, fasteners should also be SS.
- Heads of jackscrews and M/C bolts shall be heavy hexagonal type. Jackscrew end shall be rounded.
- Wherever bolt tensioning is specified, stud bolt length shall be longer by minimum one diameter to suit bolt tensioner. Excess threads shall be protected by a threaded cap.

**Special Service Requirements:**

**NACE & Sour Service**
- For items under this category, NACE MR-01-75 and / or any other applicable standards shall also be followed. Hardness shall be below BHN 200 for C.S material. Carbon Equivalent (CE) shall be limited to 0.43.

**CRYO & Fire Safe**
- For items to be used under cryogenic conditions, temperature below –45°C and those required to be fire safe, special designs and tests would be applicable. Pre-qualification criteria need to be specified before execution of job.

**Impact Tests**
- Welded Pipes and Fittings used below temp. –29°C shall be impact tested as per requirement of ASME B31.3.
Hydrogen & other demanding services

- Vendor quality plan shall include the special quality checks and inspection requirements of these services.
- Impact Test and normalizing of CS/AS materials shall be prescribed.

INSPECTION & TESTING:

- All items and their parts shall be subjected to all mandatory as well as supplementary (wherever specified) tests and checks called for in the respective codes/standards/datasheets.
- All critical service valves shall be hydrotested at site for leak test before installation. All facilities for testing shall be arranged by the contractor.
- The examining personnel shall have the requisite qualification and experience.
- Client and its authorized representative reserve the right to vet and suggest changes in vendor’s procedures.
- Vendor’s works and facilities shall be accessible to the Client/Representative at all reasonable times.
- Test reports for all mandatory as well as supplementary tests wherever specified shall be furnished.
- All items of low alloy, alloy and exotic material shall be subjected to Positive Material Identification (PMI) Test before despatch as well as at site before fabrication/erection.

MARKING

- All items shall be marked (stamped/etched) in accordance with the applicable code/standard/specification. In addition, the item code if available, shall also be marked.
- For ease of identification, the colour of the painted strip (wherever required) shall be as per the applicable standard.
- Paint or ink for marking shall not contain any harmful metal or metal salts which can cause corrosive attack either ordinarily or in service.
- Special items/smaller items shall have attached corrosion resistant tag providing salient features.
- Colour coding for all the materials shall be as per owner’s specifications.

DESPATCH

- All items shall be dry, clean and free from moisture, dirt and loose foreign materials of all kinds.
- All items shall be protected from rust, corrosion, and mechanical damage during transportation, shipment and storage.
- Rust preventive on machined surfaces to be welded shall not be harmful to welding and shall be easily removable with a petroleum solvent.
- Ends shall be suitably protected, and the protectors shall be securely and tightly attached.
- Each variety and size of item shall be supplied in separate packaging marked with the purchase order no.; item code (if available) and the salient specifications.
- Carbon steel, LTCS, and low alloy steel valves shall be painted with one coat of inorganic Zinc silicate primer.
### OVERHEAD CLEARANCES:

Equipment, Structure, Platforms, Piping & its Supports shall be arranged to provide the following clearances overhead:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Over rail tracks, top of rail to bottom of any obstruction</td>
<td>7 m</td>
</tr>
<tr>
<td>2</td>
<td>Over Plant roads for major mobile equipment</td>
<td>7 m</td>
</tr>
<tr>
<td>3</td>
<td>Over secondary roads (Bottom of pipe) access ways for mobile equipment</td>
<td>5 m</td>
</tr>
<tr>
<td>4</td>
<td>Over grade and bottom of pipe (inside battery limit)</td>
<td>3.0 m</td>
</tr>
<tr>
<td>5</td>
<td>Over walk-ways, pass-ways &amp; platforms to nearest obstruction and inside building</td>
<td>2.2 m</td>
</tr>
<tr>
<td>6</td>
<td>Over Exchangers at Grade, shell cover channel end</td>
<td>1.5 m</td>
</tr>
</tbody>
</table>

### HORIZONTAL CLEARANCES:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Between Exchangers</td>
<td>0.9 m clear aisle or 2 m centre to centre whichever is higher</td>
</tr>
<tr>
<td>2</td>
<td>Around pumps (Aisles between piping)</td>
<td>0.9 m</td>
</tr>
<tr>
<td>3</td>
<td>Fired heaters to pumps handling flammable stock</td>
<td>16 m</td>
</tr>
<tr>
<td>4</td>
<td>Fired heaters to other flammable containing equipment not closely associated with heaters</td>
<td>16 m</td>
</tr>
<tr>
<td>5</td>
<td>At driver ends of pumps where truck access is required</td>
<td>3 m</td>
</tr>
<tr>
<td>6</td>
<td>At driver ends of pumps where truck access is not required</td>
<td>1.8 m</td>
</tr>
<tr>
<td>7</td>
<td>At shell cover end of exchangers at grade, for access way</td>
<td>1.3 m</td>
</tr>
<tr>
<td>8</td>
<td>Between shells of adjacent horizontal vessels</td>
<td>2.0 m or 0.9 m clear aisle whichever is higher</td>
</tr>
</tbody>
</table>

### EQUIPMENT SPACING

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Small Pumps (3.7 KW &amp; less)</td>
<td>Mount on common foundations with suitable centre to centre distance</td>
</tr>
<tr>
<td>Column</td>
<td>Description</td>
<td>Measurement</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Middle Pumps (22.5 KW &amp; less)</td>
<td>900 mm clear Aisle beyond associated piping</td>
</tr>
<tr>
<td>3</td>
<td>Larger Pumps (Above 22.5 KW)</td>
<td>900 mm clear Aisle beyond associated piping</td>
</tr>
<tr>
<td>4</td>
<td>Exchangers and other equipments on structures</td>
<td>900 mm clear Aisle beyond associated piping</td>
</tr>
</tbody>
</table>

### D. PLATFORMS

#### 1) TOWERS, VERTICAL & HORIZONTAL VESSELS:

<table>
<thead>
<tr>
<th>i.</th>
<th>Distance of platform below centerline of manhole flange-side platform</th>
<th>750mm – 1050mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii.</td>
<td>Width of manhole platform from manhole cover to outside edge of platform</td>
<td>1000mm</td>
</tr>
<tr>
<td>iii.</td>
<td>Platform extension beyond centerline of manhole-side platform</td>
<td>1000mm</td>
</tr>
<tr>
<td>iv.</td>
<td>Distance of platform below underside of flange – head platform</td>
<td>175mm</td>
</tr>
<tr>
<td>v.</td>
<td>Width of platform from three sides of manhole-head platform</td>
<td>750mm</td>
</tr>
</tbody>
</table>

#### 2) HORIZONTAL EXCHANGER:

<table>
<thead>
<tr>
<th>i.</th>
<th>Clearance in front channel or Bonnet flange</th>
<th>1300mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii.</td>
<td>Heat exchanger tube bundle removal space</td>
<td>Bundle length +1.5 m</td>
</tr>
<tr>
<td>iii.</td>
<td>Min. clearance from end of flanges</td>
<td>100mm</td>
</tr>
</tbody>
</table>
### 3) VERTICAL EXCHANGER:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Distance of platform below top flange of channel on bonnet</td>
</tr>
</tbody>
</table>

### 4) FURNACES:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Width of the platform at side of horizontal and vertical tube furnace</td>
</tr>
<tr>
<td>ii.</td>
<td>Width of the platform at ends of horizontal tube furnace</td>
</tr>
</tbody>
</table>
7.2 SCOPE OF WORK FOR MECHANICAL
BLANK SHEET
CLIENT : OIL INDIA LTD., DULIAJAN.
PROJECT : IMPLEMENTATION OF 1NO. FGS, 1 NO. CGGS & O.T.POINTS

DISCIPLINEWISE SCOPE OF WORK AND DESIGN BASIS

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DOCUMENT NO.</th>
<th>REV. NO.</th>
<th>DESCRIPTION</th>
<th>NO. SHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>MECHANICAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>9473-02-SOW-001</td>
<td>0</td>
<td>SCOPE OF WORK - MECHANICAL</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>9473-02-DB-001</td>
<td>0</td>
<td>DESIGN BASIS – MECHANICAL</td>
<td>7</td>
</tr>
</tbody>
</table>
EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA
MECHANICAL
SCOPE OF WORK
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
CONTENTS

1. INTRODUCTION
2. APPLICABLE CODES, STANDARDS AND SPECIFICATIONS
3. SCOPE OF WORK
   3.1 STATIC EQUIPMENT
      3.1.1 VESSELS
      3.1.2 SKID MOUNTED EQUIPMENT
      3.1.3 TANKS
   3.2 ROTATING EQUIPMENTS
   3.3 INTERNALS
4. SPARES
5. INSPECTION AND TESTING
6. GUARANTEE
7. LIST OF ATTACHMENTS
7.2.1.1 INTRODUCTION

The Scope of work of Mechanical Equipment shall consist of design, detailed engineering, procurement of materials, fabrication / manufacturing, PWHT / stress relieving, inspection, testing, insulation, refractory, fire proofing as applicable, chemical cleaning, surface preparation and painting, supply and erection and commissioning of all the equipment as per equipment list, P&IDS enclosed in basic engineering package and in accordance with Design basis for Mechanical.

7.2.1.2 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS

The design, manufacture, fabrication, material of construction, inspection, & testing of all the equipment shall as a minimum, comply with the requirements specified in the following International Codes, Standards and Practices as amended/supplemented by STEP Specification / Standard.

7.2.1.2.1 Vessels

Following codes for design and construction (including referred standards and codes there in) shall be applicable

- ASME SEC VIII DIV .1 FOR UNFIRED PRESSURE VESSELS (INCLUDING SEPARATORS (U-STAMP))
- ASME SEC II PART A FOR FERROUS MATERIAL
- API 12 K FOR INDIRECT WATER BATH HEATER
- API 12 J FOR SEPARATORS
- API 650 FOR ATMOSPHERIC STORAGE TANKS
- IS –875 PART 3 FOR WIND LOADS
- IS- 1893 FOR SEISMIC DESIGN
- 02-TS-001 FOR PRESSURE VESELS
- 02-TS-101 FOR STORAGE TANK
- STEP CONSTRUCTION STANDARDS
  02-CS-001 FOR TOLERANCES
  02-CS-002 FOR SUPPORTS (SADDLES)
  02-CS-006 FOR MANHOLE DAVIT
  02-CS-007 FOR LADDER RUNGS FOR MANHOLE / DEMISTER
  02-CS-008 FOR NOZZLE REINFORCEMENT AND PROJECTION
  02-CS-009 FOR BOLT HOLE ORIENTATION
  02-CS-011 FOR VORTEX BREAKER
02-CS-017 FOR INSULATION SUPPORT
02-CS-018 FOR NAME PLATE
02-CS-019 FOR EARTHING LUG
02-CS-023 FOR TYP. WELD DETAIL
02-CS-024 FOR LIFTING LUG
02-CS-025 FOR NOZZLE STIFFENER
02-CS-026 FOR MANHOLE WITH HINGED COVER
02-CS-027 FOR ALLOY LINER DETAIL
02-CS-030 FOR DEMISTER SUPPORT
02-CS-103 FOR NAME PLATE OF TANK
02-CS-104 FOR EARTHING LUG OF TANK
02-CS-105 FOR ANCHOR CHAIR
02-CS-106 FOR GAUGE HATCH WITH COVER
02-CS 108 FOR DRAIN OUTLET

7.2.1.2.2 Rotating Equipment

- API 610 FOR PROCESS CETRIFUGAL PUMP
- ANSI B 73.1 FOR CENTRIFUGAL PUMP – GENERAL PURPOSE
- API 674 FOR RECIPROCATING PUMP
- BS5514/ISO 3046/IS 10000 FOR DIESEL/ GAS ENGINE DRIVER
- STEP STANDARDS:-
  02-TS-610 FOR PROCESS CETRIFUGAL PUMP
  02-TS-608 FOR CENTRIFUGAL PUMP– GENERAL PURPOSE (WATER SERVICE)
  02-TS-674 FOR RECIPROCATING PUMP
  02-TS-606 FOR DIESEL ENGINE DRIVER

7.2.1.3 SCOPE OF WORK

The Scope of work and supply shall include but not be limited to all the equipment as shown in P &ID’s attached with Basic Engineering Package. Any additional equipment / facility including material handling equipment as deemed necessary by LSTK Contractor for making smooth and efficient operation of the plant shall also be included in the scope of LSTK contractor.

7.2.1.3.1 Static Equipments
Applicable Codes and Standards and General design criteria shall be as mentioned in clause 2.0 above.

7.2.1.3.1.1 Vessels

a) The extent of bidder's scope of supply/work shall include, but not be limited to, the following.

- Complete design calculations of vessels, including nozzle load analysis as per WRC107/297, if required, by validated international software, like PV-elite.
- Preparation of fabrication drawings.
- Materials procurement with test certificate.
- Fabrication and supply of vessels with all attachments in accordance with approved fabrication drawings.
- Vendor data, drawings, and documents as specified in the Vendor Documentation Requirement.
- Welding procedures & welder's qualification as per ASME Sec IX.
- Inspection & Testing by STEP/OIL Authorized inspector.
- Design & supply of all internals, if any, for the vessels to meet the specified performance.
- All external cleats including fireproofing cleats, insulation cleats, if applicable.
- Cleaning, Rust Prevention, Protection coating and Final Painting etc.
- Marking, Packing, and preparation for shipment.
- Holding down bolts as applicable.

b) All the vessels shall be procured from approved Vendors, list of which shall be indicated in the bid.

c) Dished ends shall be 2:1 ellipsoidal unless otherwise specified in Mechanical data sheet. Construction shall be seamless up to 2000 mm. diameter. Larger dished ends shall have one weld seam located at no closer than one third ID from the dished end centerline, or shall be of crown and petal construction. The weld seams shall be fully radiographed.

d) Flanges shall be Weld Neck Type, as per ANSI B16.5.

e) Repair of defects by welding or otherwise of any pressure part material is not permitted.

f) Long Weld Neck Nozzles shall be used up to 3" NB in SS cladded type of construction. Nozzles shall have full reinforcements. Metal area available from shell shall not be considered in mechanical calculation.
g) Cladding thickness shall not be included in mechanical strength calculations.

h) Minimum clad thickness after machining shall be 3 mm of undiluted chemistry.

i) Manhole (MH) shall be provided with hinge / davit & Jack Screw.

j) Mill test certificates for all materials used for construction shall be furnished.

k) Minimum Nozzle size shall be 1½” NB. For lower size, forged couplings shall be provided unless otherwise specified in equipment data sheet.

l) Nuts used for pressure parts fasteners shall be of heavy series.

m) Corrosion allowance (CA) for fixed and removable internals shall be one half of vessel CA, on each exposed surface.

n) Bolts / Nuts for internal components shall be SS 316 & shall be furnished with lock nut.

o) All cladded surfaces shall be fully scanned for UT testing.

p) Spot radiography shall be specified as minimum. Full radiography shall be used where required as per code, or stated in Mechanical data sheet.

q) Lifting lugs shall be provided and duly designed by vendor.

r) Post Weld Heat Treatment (PWHT) shall be carried out as per code requirement. Vendor shall specifically check and report dish end thinning, fiber elongation and other requirements and perform PWHT accordingly.

s) Vendor shall check in advance before fabrication that nozzles and other attachments do not clash with main circumferential welds, longitudinal welds and other fittings.

t) Material classification shall be in general as per Mechanical data sheet.

u) Nozzles other than Instrument nozzles, manhole, inspection openings, shall be checked for piping loads, as per WRC 107 / WRC 297.

Piping load shall be considered as follows:

Forces
Radial Force, Fa = K x 67.5 x D Kgf
Longitudinal Force, FL = K x 100 x D Kgf
Circumferential Force, Fφ = K x 100 x D Kgf

Moments
Torsional Moment, Mt = K x 12.5 x D^2 Kgf.m
Longitudinal Force, ML = K x 10 x D^2 Kgf.m
Circumferential Force, Mφ = K x 7.5 x D^2 Kgf.m

K = 1 for 150 # and 300 #
K = 1.25 for 600 # and above class.

Where D is nominal size of Nozzle in inches.
v) Nozzles

- Nozzles shall be set in type with full penetration weld construction.
- Nozzles necks fabricated from plate shall be fully radiographed for long seam on nozzle neck.
- All internals shall pass through manhole.

w) Complete design of demister pad, support rings/cleats, grids/major beams as applicable shall be carried out. All tie-wires/clamp bolts required for demister installation shall be supplied by LSTK contractor. Demister shall be installed at shop.

7.2.1.3.2 SKID MOUNTED EQUIPMENTS

Each separator as per list mentioned in Annex. –I will be supplied as installed on adequately sized separate skid with all interconnecting piping, valves, control valves, instruments, junction boxes, cabling, tubing, ladder-platforms as required. The limit of supply for each skid shall be as marked in P&ID enclosed elsewhere in bid document. A common spreader bar with sling/shackles for lifting of all skids is to be provided.

7.2.1.3.2.1 SKID DESIGN

i) Skid shall be sized and designed to accommodate the equipment, piping, instruments/junction box and other consideration of operation & maintenance aspect.

ii) Skid shall be rigid and designed for static load, wind load, seismic load etc. It shall also be designed for adequacy during lifting/transportation.

iii) Skid shall be provided with 4 nos. lifting lugs, 2 Nos. on each side.

iv) If the holes drilled in beam flange or holes cut on web of members reduces the net section to the extent that stresses in the members exceed the allowable stresses, the member shall be reinforced with welded plate with sufficient thickness to provide additional required area.

v) Skid shall be designed for single point lift at hook and four point lift at skid. Vendor shall provide necessary spreader bar/sling shackle etc.

vi) Skid dimension shall not exceed 9.0m (L) X 2.5 m (W) X 2.75m (H) for transportation.

vii) Skid should be covered by “Anti Skid” checkered plates to facilitate O & M of the separator.

viii) Skid structural design calculation shall be submitted during detail engineering for STEP/OIL review.
Scope of Supply/ Work:
- Supply of all equipments as per equipment list.
- Supply and installation of demisters and other internals as applicable.
- Supply and application of insulating material, primer & paints, fire proofing materials wherever required.
- Supply of materials/equipment required for blast cleaning/chemical cleaning, if applicable.
- Supply of tools & tackles, equipment, consumable/non-consumable materials required for inspection and testing (i.e. NDT, hydro testing etc.)
- Supply of all other materials whether specifically mentioned or not but required for completion of the job in all respect as per bid package.
- All approach ladders, platforms (independent & interconnecting) for different accessories, instruments, operating valves etc. shall be included in the LSTK contractor’s scope and all layout and design shall be as per requirements of bid package covered elsewhere.
- All materials required for hydro testing of field-erected equipment, if applicable.
- Supply of mandatory spares.
- Statutory clearance/approval of the equipment/package as applicable shall be in the scope of LSTK contractor.

DESIGN REQUIREMENT

a) All vessels shall be designed by bidder as per ASME Sec.VIII, Div.1. Design calculations shall be made considering all loads for erection, operating and hydro test condition.

b) All vertical vessels shall be designed so as to permit site testing of the equipment in vertical condition with test pressure as per code at the top with the vessel completely filled with water plus 25% wind load. The design shall be based on fully corroded condition. Equipment foundation shall be designed for hydro test condition as well as operating condition with seismic/wind loads whichever is governing with equipment in new condition.

c) Horizontal vessels saddle support shall be designed for operating condition (considering full of water) and also transverse seismic force shall be taken as 50% of longitudinal seismic force. Saddles shall be equally spaced from tangent line. Local loads imposed by supports on vessel shall be checked and vessel shall be adequately reinforced.

d) Wind and Seismic requirements shall be as mentioned in Mechanical data sheets attached.

e) For hydro test, gasket specification shall be same as service gaskets.
f) Thickness of heads shall be equal to shell thickness as a minimum requirement in case of ellipsoidal/torispherical heads. All dished ends shall be 2:1 ellipsoidal or as specified on Mechanical data sheet/specifications.

g) All nozzles and reinforcing requirements shall be as per specification and code. However width shall be as per STEP standard as a minimum with thickness and material of reinforcement element shall be same as the minimum width of reinforcement element.

h) All gas filters/vertical separators (KOD) which consists of filter elements/demister pads and require periodic replacement due to clogging shall have body flange and cover with davit arrangement as per STEP standard with adequate capacity.

i) All filter separators installed after KOD which consists of filter element and require periodic replacement due to clogging shall be provided quick opening closure (QOC) with hinge arrangement. QOC shall be procured from reputed manufacturers i.e. G.D Engg. U.K, PECO, USA, TUBE- TURN USA etc.

j) All manholes shall be provided with davit and size of man ways shall be as per Mechanical Data sheet/specification and location shall be checked in all cases by LSTK Contractor.

k) Leg and skirt supports for all vertical vessels shall be provided with fire proofing as applicable.

l) Painting shall be as per bid package requirement. Primer/ paint selection shall be done considering the environment as specified elsewhere in the bid package.

7.2.1.3.3 Tank
Complete mechanical design, including design of fixed roof structure, engineering, procurement of material, fabrication, surface preparation, painting, inspection, testing, supply and delivery to site of the tanks as per equipment list, P & ID. and Design basis for Mechanical doc. No. 9473-02-DB-200. Ladders platforms, cage ladders etc. as required shall be supplied by contractor as per STEP std. attached. Statutory approval as required, shall be included in LSTK Contractor’s scope of work.

7.2.1.3.4 Rotating Equipment
- LSTK Contractor’s scope of supply/work shall include design, engineering, procurement of materials and all accessories, manufacturing, inspection, testing, supply to site, erection, pre-commissioning and commissioning of all the rotating equipment as per equipment lists, P&IDS attached with basic engineering package.
- LSTK Contractor shall comply with the specifications like Design Basis, data sheets of pumps; P& ID’s and process package etc. attached with the bid document and shall carry out the detail engineering.
LSTK Contractor shall procure the pumps along with driver. The pump unit as defined herein means as a minimum the pump, the driver, mechanical seal, coupling, coupling guards, base plates, foundation bolts, local instruments, local start/stop push button and other auxiliaries & accessories as specified in the bid document. All equipment and the auxiliaries shall be procured from approved vendor list attached.

LSTK Contractor shall carry out the following activities for procurement of rotating equipment.

- LSTK Contractor shall prepare the enquiry specifications/documents for each pump including spare parts for erection, commissioning & minimum recommended spare parts for 2 years normal operation.
- Datasheets indicating the basic process & mechanical requirements are attached in the bid document. Contractor shall use only these datasheets for enquiry & purchase.
- LSTK Contractor shall prepare the detailed Purchase Requisition / specification/spare parts/vendor data requirement for all equipment and shall obtain the approval/review of purchase requisition of all the equipment from OIL/STEP.
- LSTK Contractor shall carry out the detailed review, checking and approval of engineering, fabrication drawing and technical data from vendors for equipment and materials to ensure scope adequacy and consistency with the design, safety and operability requirements.

LSTK Contractor shall submit all engineering drawings/documents/data and obtain the approval of OIL/STEP.

LSTK Contractor shall ensure that all inspection and tests are conducted for all equipment at vendor’s shops/site as specified in bid document, basic engineering package, data sheets, codes and standards etc. Contractor shall also submit the schedule of witnessed tests of all equipment in advance.

- Mandatory spares for all rotating equipment for one-year operation shall be provided. As a minimum following mandatory spares shall be provided:
  - Pumps
    1. Set of bearings
    2. Wear rings, if applicable
    3. Shaft Sleeve
    4. Mechanical seal, if applicable
    5. Set of couplings.

For all equipment minimum recommended spares for 2 years normal operation shall be submitted for STEP/Owner’s approval.

LSTK contractor to provide insurance spare as per list furnished by vendor and approved by STEP/Owner.

LSTK Contractor shall include all the commissioning spares as required for the equipment vendor’s scope. Contractor shall procure the same.
from the equipment vendors and make it available well before commissioning of plant/equipment. In case, any additional spares are consumed during commissioning, the same shall be provided by the contractor at no additional cost to the Owner/STEP.

- LSTK Contractor shall furnish a list of special tools/tackles required for assembly and maintenance. Such tools/tackles shall be supplied by the vendor and shall form part of supply by contractor to Owner.
- LSTK Contractor’s scope shall include complete supply, transportation of equipment package from vendor’s shop to site, receipt of material at site. Handling at site and arrange for storage at site.
- LSTK Contractor shall carry out erection of each equipment at the specified location on the properly designed & cast foundation as per requirement.
- LSTK Contractor shall note that consumables, lubricants etc. required during erection, commissioning and performance guarantee run of equipment such as first fill of lubricants etc. shall be in contractor’s scope. A consolidated list for all equipment shall be provided indicating type of lubricant, grease, oil etc. giving specifications, qualities, brand name and their Indian equivalent.
- LSTK Contractor shall supply & install all maintenance facilities sized for handling the heaviest single piece of equipment for maintenance. Contractor shall provide sufficient space for maintenance, dismantling and platforms for maintenance.
- LSTK Contractor shall carry out the pre-commissioning and commissioning activity at site for all equipment.
- LSTK Contractor shall ensure the presence of equipment manufacturers (vendor) at site for supervision of erection and commissioning for equipments, wherever required.

7.2.1.3.5 INTERNALS

- Non-Proprietary internals (like vortex breaker) shall be as per STEP standards forming part of tender. Vessel vendor shall fabricate and install the same.
- Some internals (like weir plate, inlet distributor, anti turbulence/calming, baffles, sand jetting etc.) shall be fabricated by vessel fabricator as per Process design.
- Proprietary nature of internal (coalescer pads, demisters/mist eliminators etc.) shall be as per Process designer or manufacturer’s vendor, to be reviewed by OIL/STEP.
- Supporting arrangement and installation of internals shall be the responsibility of LSTK contractor and his vessel vendor.
- All internals shall be of SS 316 L for stainless cladded and glass flake lined vessels.

7.2.1.4 SPARES
7.2.1.4.1 The following erection, installation & commissioning spares shall be included in vendor’s Supply:
- Gaskets - 200% of the total installed quantity for nozzles with blind flanges.
- Bolts/ Nuts – 10% of the total installed quantity for nozzle with blind flange (Minimum 2 studs / 4 nuts for each size)

7.2.1.4.2 Vendor shall furnish item wise price list for 2 years operation and maintenance.

7.2.1.5 INSPECTION AND TESTING

7.2.2.1 The purchaser’s representative(s) shall have entry to all vendor’s and his sub-vendor’s shop at all times during manufacturing, testing or inspection of the equipment.

7.2.2.2 Pressure containing parts shall not be painted until the specified inspection of the parts is completed.

7.2.2.3 Acceptance of shop tests shall not constitute waiver of the requirement to meet field test under any operating condition, nor does the inspection relieve the vendor and the manufacturer of his responsibilities in any manner.

7.2.1.6 GUARANTEE

LSTK contractor shall guarantee that all the materials and accessories provided for the equipment under his scope shall be new and all work shall be of good quality.

LSTK contractor shall guarantee all work to be free from defect in design, workmanship, materials and equipment. LSTK contractor shall provide mechanical and performance guarantee of the equipment for the period as mentioned elsewhere in the bid document.

7.2.1.6.1 Under this guarantee, the LSTK contractor shall replace (at his expense) all materials, equipment and/or part that are found to be faulty during the guarantee period. The LSTK contractor shall also provide (at his expense) an experienced service representative to supervise the necessary repairs and replacements.

7.2.1.7 LIST OF ATTACHMENTS

- STEP SPECIFICATION FOR PRESSURE VESELS 02-TS-001
- STEP CONSTRUCTION STANDARDS
  02-CS-001 FOR TOLERANCES
  02-CS-002 FOR SUPPORTS (SADDLES)
  02-CS-006 FOR MANHOLE DAVIT
  02-CS-007 FOR LADDER RUNGS FOR MANHOLE / DEMISTER
  02-CS-008 FOR NOZZLE REINFORCEMENT AND PROJECTION
02-CS-009 FOR BOLT HOLE ORIENTATION
02-CS-011 FOR VORTEX BREAKER
02-CS-017 FOR INSULATION SUPPORT
02-CS-018 FOR NAME PLATE
02-CS-019 FOR EARTHING LUG
02-CS-023 FOR TYP. WELD DETAIL
02-CS-024 FOR LIFTING LUG
02-CS-025 FOR NOZZLE STIFFENER
02-CS-027 FOR ALLOY LINER DETAIL
## ANNEXURE-1

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<th>SL. No.</th>
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<th>Equipment Description</th>
<th>Location</th>
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<td>FGGS Baghjan</td>
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<td>3</td>
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<td>5</td>
<td>V-3002 A/B</td>
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<td>6</td>
<td>V-3003 A/B</td>
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EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA

MECHANICAL
DESIGN BASIS
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
CONTENTS

1. SCOPE
2. APPLICABLE CODES, STANDARDS AND SPECIFICATIONS
3. DESIGN CRITERIA
   3.1 STATIC EQUIPMENT (TANKS, VESSELS & WATER BATH HEATERS)
   3.2 ROTATING EQUIPMENTS (COMPRESSORS, PUMPS)
7.2.4.1 SCOPE

This specification is intended to provide minimum guidelines to be used as basis of design and selection criteria of mechanical equipment and its accessories to be selected and used for FGGS at Baghjan & Chabua and CGGS & Off take at Madhuban.

7.2.4.2 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS

The design, manufacture, inspection, testing and supply of equipment shall as a minimum comply with the requirements specified in the following International Codes, Standards and Practices as amended/supplemented by TPPL Specification / Standard.

7.2.4.2.1 Static Equipment

<table>
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<tr>
<th>SL NO.</th>
<th>ITEM</th>
<th>CODE/ STANDARD</th>
<th>TPPL SPECIFICATION/ STANDARD</th>
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<tr>
<td>1</td>
<td>Separators, Gas filters, Slug catchers</td>
<td>ASME Sec VIII Div. 1, (U Stamp)</td>
<td>02-TS-001</td>
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<tr>
<td>2</td>
<td>Instrument Air/Gas Receivers</td>
<td>ASME Sec VIII Div. 1</td>
<td>02-TS-001</td>
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<td>3</td>
<td>Welded steel Storage tank</td>
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<td>Other storage tank</td>
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<td>5</td>
<td>Indirect water Bath heater</td>
<td>ASME Sec VIII Div. 1, API 12 K</td>
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<td>6</td>
<td>Material Specification</td>
<td>ASME Sec II / ASTM</td>
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<td>IS-875/ Project specific code</td>
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<td>8</td>
<td>Seismic loads</td>
<td>IS-1893/ Project specific code</td>
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<tr>
<td>8</td>
<td>Nozzle loads</td>
<td>WRC 107/ 297</td>
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7.2.4.2.2 Rotating Equipment

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<td>Centrifugal Pumps-General Purpose</td>
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<td>HC Condensate transfer Pump</td>
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<td>Gas/Diesel Engine</td>
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7.2.4.3 DESIGN CRITERIA

General

The equipment design in general shall primarily fulfill the desired service requirements and maximum equipment availability for a minimum service life of 20 years. The equipment packages shall be designed for uninterrupted operation of three years without any major overhaul.

The basic design for Pressure Vessels, Heat Exchangers and Atmospheric Refrigerated Tanks shall conform to all applicable clauses of the respective design code requirements and all specified standard constructional requirements, quality details, and other specific job requirements to enable vendor to perform detailed design, manufacture and produce a quality product to fulfill the intended service.

The rotating equipment and packaged equipment shall be of proven design and performance conforming to the respective design code and standards and Vendor’s standard design (proprietary in nature) fulfilling the experience and qualification requirements as specified in respective Purchase specifications.

The design specification shall include supply of spare parts for start-up and commissioning. Vendor’s recommendation for two years normal operating period with itemized prices and list of special tools shall be furnished, for owner’s decision for purchase.

Order of precedence for various documents is as follows:
- Mechanical data sheet
- Design Basis
- Specification & Standards
- Codes of construction.

7.2.4.3.1 Static Equipment (Tanks, Vessels & Water Bath Heaters)

7.2.4.3.1.1 Vessel size and type shall be as per process data sheet. Where internals are involved, the same shall be reviewed and internals of proprietary nature shall be procured separately.

7.2.4.3.1.2 All the vessels & Water bath heaters shall be procured from reputed Vendors as per approved vendor list.

7.2.4.3.1.3 Dished ends shall be 2:1 ellipsoidal. Construction shall be seamless up to 2000 mm. diameter. Larger dished ends shall have one weld seam or shall be of crown and petal construction. The weld seams shall be fully radiographed.

7.2.4.3.1.4 No impact test exemption of UG 20( f) & UCS 66.1 is permitted.
7.2.4.3.1.5 Flanges shall be Weld Neck Type, as per ANSI B16.5.

7.2.4.3.1.6 Long W.N. Nozzles may be used upto 2" NB in high-pressure service. Integrally reinforced nozzles shall be used for sour service.

7.2.4.3.1.7 Water Bath Heater coil shall be made of seamless pipe and bend. Short radius Return bend can be used for multi pass arrangement.

7.2.4.3.1.8 Fire Tube & stack shall be fabricated from plate with weld seam spot radiographed.

7.2.4.3.1.9 Manhole (MH) shall be provided with hinge / davit & jack screw.

7.2.4.3.1.10 Mill test certificate for all materials used for construction shall be furnished.

7.2.4.3.1.11 Minimum Nozzle size shall be 1½ " NB. For lower size forged couplings shall be provided.

7.2.4.3.1.12 Corrosion allowance (CA) for fixed and removable internals shall be one half of vessel CA, on each exposed surface.

7.2.4.3.1.13 Corrosion allowance shall be taken on heating coil. As specified in Water bath heater Data sheet.

7.2.4.3.1.14 Bolts / Nuts for internal components shall be SS 316/304 and shall be furnished with lock nut.

7.2.4.3.1.15 Wherever cladding / lining is provided, same shall not be considered for strength calculation.

7.2.4.3.1.16 Standard flange faces, CA- Nil

7.2.4.3.1.17 Spot radiography shall be specified as minimum. Full radiography shall be used where required as per code, or economy in materials.

7.2.4.3.1.18 Post Weld Heat Treatment (PWHT) shall be carried out as per code requirement.

7.2.4.3.1.19 Material classification shall be in general as per Process/ Mechanical Data Sheet.

7.2.4.3.1.20 Design For External Forces

- Full wind loads shall be considered, applicable during erection and operating conditions.
- 25% wind load shall be considered during Hydrotest.
- Additional loads during transportation of the equipment through sea shall be considered
- Seismic loads
- Local Loads on nozzles due to piping reactions

Nozzles other than Instrument nozzles, MH, inspection openings, shall be checked for piping loads, as per WRC 107/ WRC 297. Piping load shall be considered as follows:

**Forces**

Radial Force, $F_a = K \times 67.5 \times D$ Kgf  
Longitudinal Force, $F_l = K \times 100 \times D$ Kgf  
Circumferential Force, $F_\phi = K \times 100 \times D$ Kgf

**Moments**

Torsional Moment, $M_t = K \times 12.5 \times D^2$ Kgf.m  
Longitudinal Force, $M_l = K \times 10 \times D^2$ Kgf.m  
Circumferential Force, $M_\phi = K \times 7.5 \times D^2$ Kgf.m

- $K = 1$ for 150 # and 300 #  
- $K = 1.25$ for 600 # and above class.

Where $D$ is nominal size of Nozzle in inches.

7.2.4.3.1.21 Nozzles

- Minimum Hand hole size shall be 6”.
- Minimum size of nozzles for cladded vessels shall be 2”.
- Minimum Manhole size shall be 18”.
- Nozzles shall be set in type with full penetration weld construction.

7.2.4.3.2 Rotating Equipment (Compressors & Pumps)

7.2.4.3.2.1 For all rotating equipment, the main equipment together with its driver, auxiliaries and accessories will be purchased from one vendor and the OEM shall be responsible for the performance of complete unit.

7.2.4.3.2.2 The noise level for equipment and packages shall not exceed 85 dBA when measured at 1-m distance from the equipment surface in any direction without acoustic treatment. Noise level for DG set with acoustic enclosure shall be as per CPCB norms Some of the equipment may not meet this criteria for which specific deviations shall be considered on case to case basis.

7.2.4.3.2.3 Equipment nozzles especially at customer interface shall be as per the piping specifications and sizes. Where the use of non-standard nozzles cannot be avoided, the companion flanges along with the gaskets and fasteners shall be procured from the equipment vendor.
7.2.4.3.2.4 All horizontal centrifugal pumps shall have back pull out design.

7.2.4.3.2.5 Pumps shall be selected from standard series in such a way so as to have maximum interchangeability between components to minimize inventory cost.

7.2.4.3.2.6 Suction specific speed for all centrifugal pumps shall be limited within 8500 (USCS unit)

7.2.4.3.2.7 Vertical submerged centrifugal pump shall be provided with gland packing.

7.2.4.3.2.8 Couplings shall be of spacer type for ease of maintenance. Guards for all moving parts i.e. coupling guards belt drive etc shall be of non-sparking material and shall be provided with hole for visual inspection of coupling.

7.2.4.3.2.9 Balanced mechanical seals shall be used.

7.2.4.3.2.10 Pumps fitted with inducers are not acceptable unless approved by the purchaser.

7.2.4.3.2.11 Performance & Complete unit test of critical equipments shall be witnessed by OIL representative preferably together with STEP at vendors premises.

7.2.4.3.3 Packaged Equipment

7.2.4.3.3.1 The packaged equipment shall comply with the respective applicable codes, standards job specification and the requirements stated in this design basis.

7.2.4.3.3.2 Packages shall be as per P&IDs for respective package. P&IDs for package equipment shall be further developed by Vendor and submitted for review and approval by STEP / client.
7.3 SCOPE OF WORK FOR GENERAL CIVIL, ARCHITECTURE & FIRE PROTECTION SYSTEMS
## DISCIPLINEWISE SCOPE OF WORK AND DESIGN BASIS

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# EPMC SERVICES

FOR

CGGS & OFF TAKE AT MADHUBAN

AND

FGGS AT BAGHJAN & CHABUA

GENERAL CIVIL, ARCHITECTURE & FIRE PROTECTION

## SCOPE OF WORK

FOR

OIL INDIA LTD., DULIAJAN (ASSAM)

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Saipem Triune Engineering Pvt. Ltd.,
New Delhi

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7.3.1.1 SCOPE

The scope of General Civil, Architectural & fire protection system works under this contract shall include design, detailed engineering, procurement & supply of all materials, items, equipment transportation to work site, labour, consumables, tools, tackles, etc. and construction of all relevant works, erection, testing, commissioning, trial runs, obtaining approvals etc, as per Scope drawings, Engineering design basis, Standard specifications and Standard drawings attached with this bid document. LSTK CONTRACTOR shall not proceed with construction till those documents, which are specially listed under “Review” category are reviewed by OWNER/PMC.

LSTK CONTRACTOR should ensure good engineering/international standards practice accepted by client in all respect of all the General Civil, architecture & fire protection activities for 1 CGGS & 2 FGS complex. Necessary care shall be taken by the LSTK CONTRACTOR to prevent damage to facilities (if any) or disruptions of daily routine. All cooperation shall be given to the OWNER/PMC in this respect. For all works cold / hot work permits shall be obtained before start of any work.

The scope of works mainly involves as described below but not be limited to the following:

7.3.1.1.1 General

- Contractor to note that site development, underground / aboveground general civil, architectural; fire fighting work etc. shall not be limited to conceptual layouts’ attached with the bid document. These drawings furnished only the minimum requirements and developed for contractor reframe only.
- Any change in standardsii / specificationsiii / design must be got approved from OWNER/PMC. For approval of design, the relevant reference documents shall also be approved by PMC/OWNER prior to the design approval.
- Any temporary activities required must be listed.
- Clearing the site after completion of all types of work.
- Documentation of ’As Built’ details for all types of works.
- LSTK CONTRACTOR to obtain the pollution control certificate from the relevant authority for its disposal or any kind of effluent treatment plant.

7.3.1.1.2 Civil

- Development of plot plan, engineering design & documents
- Setting out of works from the grid benchmarks which shall be established by the LSTK CONTRACTOR as directed by OWNER/PMC.
- Earthwork, leveling, site grading, micro grading of the area, disposal of surplus & unusable earth within 3 Km from the site in the OIL’s land (inside or outside). Contractor to assess the lead by visiting the complex physically.
• Boundary wall
• Ground flare – pit, barricading and hard stand etc.
• New main roads, approach roads, outside patrolling roads, widening/strengthening of roads (if any).
• Road crossings for electrical/instrumentation cabling/storm water/ all types of sewers/ all types of piping with 25 % extra provision for future expansion. It shall be designed for Class A or Class AA IRC loading.
• Approaches to all the facilities.
• Drinking water system- Tube wells, WTP, distribution piping with necessary pipe fittings & valves and support.
• All storm water drains, culverts.
• RCC pavements & foot paths.
• RCC trenches, including RCC covers suitable for hydra-crane movement over them.
• Oil pits, other pits, sumps, and four-pole structure.
• Dykes/walls & tank pads.
• Sleepers, pipe way bridges.
• Fencing & gates around storage, licensed areas etc., and temporary fencing where ever required as per safety requirements.
• All civil works associated with oily water and contaminated rainwater sewer (OWS/CRWS) system and other oil drainage systems.
• Chain barricading of classified roads.
• Rerouting/relocation of above ground/under ground structures, pavements/piping/ manholes/ cable trenches, earth-pits etc. wherever required.
• All civil works associated with the buildings & sheds including plumbing works, roof drainage etc.
• Water proofing and damp-proofing where ever specified/directed by OWNER/PMC.
• Protective lining/coatings wherever required especially in all underground tanks, pits, piping etc.
• Painting of structural steel members.
• Barricading the construction area to protect the works/facilities, including local barricades and water blanketing arrangements.
• Hardstand required for erection of heavy equipments.
• Removal of under ground and over ground obstructions as directed by OWNER/PMC, or wherever required for the installation/construction of new facilities, piping, trenches etc.
• Any other civil and structural works required/directed by OWNER/PMC for the satisfactory and successful completion of the project.
• Preparation of all construction drawings, fabrication drawings for all structural steel works and bar bending schedule for all RCC works.
• Setting up of worksite establishments and LSTK CONTRACTOR’S facilities.
- Any other General civil work required/directed by OWNER/PMC for satisfactory and successful completion of the project including supply of material for the same.

### 7.3.1.1.3 Architectural

Design, Engineering and Construction including preparation of design scheme, basis engineering layout and approval of the same by OWNER/PMC/Statutory authorities for the following Plant and Non-Plant buildings & sheds:

<table>
<thead>
<tr>
<th>MADHUBAN Station code 10</th>
<th>BAGHJAN Station code 20</th>
<th>CHABUA Station code 30</th>
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</thead>
<tbody>
<tr>
<td>• Control room &amp; operator building ref.7.3.1.3.1</td>
<td>• Control room &amp; operator building. ref.7.3.1.3.1</td>
<td>• Control room &amp; operator building. ref.7.3.1.3.1</td>
</tr>
<tr>
<td>• Instrumentation air house. ref. 7.3.1.3.2</td>
<td>• Instrumentation air house. ref.7.3.1.3.2</td>
<td>• Instrumentation air house. ref.7.3.1.3.2</td>
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<td>• Security barrack. ref.7.3.1.3.3</td>
<td>• Security barrack. ref.7.3.1.3.3</td>
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<tr>
<td>• Security cabin. ref.7.3.1.3.4</td>
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<tr>
<td>• Watch towers ref7.3.1.3.5</td>
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<td>• Shift workers cabin ref7.3.1.3.6</td>
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<tr>
<td>• Entrance, exit &amp; wicket gates</td>
<td>• Entrance, exit &amp; wicket gates</td>
<td>• Entrance, exit &amp; wicket gates</td>
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<tr>
<td>• Pump Sheds for Condensate feed pump ref7.3.1.3.7</td>
<td>• Generator room ref7.3.1.3.8</td>
<td>• Generator room ref7.3.1.3.8</td>
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<tr>
<td>• Generator room ref7.3.1.3.8</td>
<td>• Firewater pump house ref7.3.1.3.10</td>
<td>• Firewater pump house ref7.3.1.3.10</td>
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<tr>
<td>• Additional shed for loading bay. ref7.3.1.3.9</td>
<td>• Analyser Shelter</td>
<td>• Analyser Shelter</td>
</tr>
<tr>
<td>• Firewater pump house ref7.3.1.3.10</td>
<td>• Any other building as per requirements of LSTK CONTRACTOR’S package vendor.</td>
<td>• Any other building as per requirements of LSTK CONTRACTOR’S package vendor.</td>
</tr>
</tbody>
</table>
Indicative layouts of above building are attached in the bid. In case any building/Shed layout is not attached, the same shall be developed by the LSTK CONTRACTOR.

- Preparation of all construction drawings, architectural drawings for all architectural works.
- EPCC contractor shall develop the architectural drawings for these buildings, and get it approved from Owner / PMC.
- Within the buildings, provision shall be made for the following.
- Water proofing of RCC building roofs, and damp proofing of building walls.
- Anti-termite treatment for buildings.
- Plumbing systems for buildings for service and drinking water, sanitary drainage, storm water drainage from roofs and building surroundings. Drainage system for battery room floor washing, oil collection system for transformers.
- All related Architectural work for Air conditioning, Pressurisation and ventilation and lighting as per requirements.
- Provision of false flooring / false ceiling / Trenches and covers / wall and floor openings and sealing.
- Provision of Flooring, wall finishes, painting, and special treatments to various elements as specified.
- Fencing, walling and paving as directed in and around the buildings, Gravel paving around transformers in substation.
- Landscaping in the area marked in the scope drawing. (Details will be finalized during detail engineering, like planters, vegetation & plantation, earth mount, grassing, sculptures, sitting arrangement, garden spouts, ponds, pathways, gravel filling, moorum filling, etc.)
- Adequate signage of the facilities, direction & buildings.
- During detailing stage of the work, contractor shall prepare and submit 3D rendered perspective view and walk through with actual material rendering, using ARCHITECTURAL DESKTOP and 3D Studio Viz. software, for approval of the same.

7.3.1.1.4 Fire Protection
- Fire protection systems – Fire water reservoir, fire pump room, fire water piping with all fittings, valves & supports etc.
- Fireproofing of structural steel members and equipment supports as per OISD-STD-164.
- Safety shower & eyewash.
- Obtaining statutory approval from local authorities such as Municipal Corporation, Development authorities, OISD, OMR, Inspector of
factories, CCE, TAC, DGCA, DGMS etc. and any other concerned authorities before starting the work at site, obtaining license from labour commissioner.

7.3.1.5 The Temporary Facilities

The temporary facilities under the LSTK CONTRACTOR’S scope shall include but not limited to:
- Temporary fences, Security fences as per safety requirement. Fencing shall be chain-linked type with RCC post or structural steel post with a minimum height of 2.0 m.
- Material lay-down area
- Fire fighting facilities
- Warehouse facilities for various items e.g. cement etc.
- LSTK CONTRACTOR’S site office
- Workshop facilities
- Fabrication areas including shot blasting and painting areas (for indicative allocated space refer plot plan)
- Maintenance facilities
- Electrical distribution
- Batching plant and aggregate storage
- Construction water receipt, storage and distribution
- Temporary drainage system including that for heavy rains in monsoon
- Labour camps (on land to be arranged & acquired by LSTK CONTRACTOR)
- Canteen, toilet facilities including soak pits, for construction labour
- Laboratory for field-testing of civil/structural items
- Area lighting
- First aid facilities
- Construction power, construction air

7.3.1.2 DETAIL SCOPE OF WORKS FOR GENERAL CIVIL

7.3.1.2.1 Site Information

The information provided below is for bidder’s guidance. He shall independently familiarize / inform himself all geographical, logistical, climatological, commercial, regulatory and others parameters required to prepare his BID and in the event of being selected, execute the work in his scope to the specified schedule without raising any claim whatsoever, for contingencies/conditions.

7.3.1.2.2 Levelling and Micrograding

The area within the battery limit shall be handed over on “as is where is” basis. All areas are generally graded at approximate level as per contour survey drawing, however over a period of time some settlement and level differences may have taken place. Clearing the site of vegetation, scrap, etc. is in the LSTK CONTRACTOR’S scope. Any filling/ grading required to
bring the site up to the required level shall also be in the scope of the LSTK CONTRACTOR. Any extra earth required shall be arranged from the approved area by the LSTK CONTRACTOR at his own cost. Unsuitable material shall be disposed off outside the Complex by the LSTK CONTRACTOR. Suitable sites for collecting approved quality earth and disposal of any surplus/unsuitable earth shall be got approved from ONGC/PMC by LSTK contractor.

7.3.1.2.3 **Boundary Wall**

New boundary wall by brick around new facilities as shown in the scope drawings shall be provided by the LSTK CONTRACTOR.

7.3.1.2.4 **Road, Approach Roads, Patrolling Roads and Storm Water Drains**

New roads around new facilities as shown in the drawing no. (9473-10-04-GC-4006, 9473-20-04-GC-4006, 9473-30-04-GC-4006) shall be provided by the LSTK CONTRACTOR.

Roads shall be suitable for crane movement during construction and maintenance, fire tender movement during emergency and normal vehicular traffic, etc.

Approach roads from main roads for crane movements (whether lying inside or outside of the scope limit) to the units/ paved areas/ various buildings & sheds, for maintenance and operation requirements shall be provided. Sufficient area shall be black topped/paved with proper marking for parking of vehicles in front of the buildings or as directed by OWNER/PMC.

At main/approach roads/patrolling roads LSTK CONTRACTOR shall provide pipe-way bridges for process pipe crossings, RCC box/pipes culverts for process pipe crossings, storm water drain crossings, as required. For electrical/instrument cable road crossings, R.C.C duct bank/box culvert shall be provided. The box culverts and pipe-way bridges shall be designed to suit the type of traffic movement envisaged for operation and maintenance of the units.

Signboards shall be provided on the all roads to units and buildings with the name of the unit or building written on it. The size of the sign shall be suitable to accommodate the text of size 150 mm.

Storm Water Drains (SWDs) shall be generally provided on either side of main roads and approach roads, unless such roads are merged with paved areas in the units, tank farms area, PROCESS AREA unit area. Conceptual layout of storm water drains as per drg.no.9473-04-GC-4002 is enclosed herewith for reference. Storm water drains along with cross drainage works from battery limit area shall be suitably discharged into surrounding storm water drains. Storm water drains in the tank farm area shall be provided with sand trap near the outlet. Provision shall be made for collection of oily water from loading bay area to nearest OWS header.
Box culverts, suitable for moving loads due to maintenance crane and fire tenders, shall be provided where the drains will cross proposed approach roads/ spaces.

At all new/ road crossings SWDs shall be provided with Pipe/RCC box culverts, suitable for operation/ maintenance during traffic movement time over them. All new drains around PROCESS AREA unit shall be covered with heavy duty gratings.

Precast covers on new drains as required for approaching fire hydrants, monitors & foot paths shall be in Contractor’s scope.

7.3.1.2.4.1 Modification of Roads

LSTK Contractor shall do proper survey of the route, within the 1 CGGS & 2 FGS Complex, through which he will be permitted to bring in all machinery, equipment, vehicles, etc. including the roads around the unit, which the LSTK CONTRACTOR will be using for execution of the work. If any measures such as temporary widening/ strengthening of the roads, culverts etc. are required to be taken, the same shall be in the LSTK CONTRACTOR’S scope.

7.3.1.2.5 Drinking Water System

Contractor shall lay the drinking water line underground directly buried but with removable precast concrete cover capable to withstand the heaviest crane movement or on pipe' rack. A minimum dia 2" (exact size of pipes to be ascertained by contractor), drinking water header to safety shower & eye wash units, drinking water post in process unit and drinking & sanitary in building shall be provided. The same shall be hooked up to the main drinking water header available outside the unit battery limit. All above ground header shall be insulated as per specification.

7.3.1.2.6 RCC Paving

RCC pavement shall be provided in the PROCESS AREA project unit area, tank area, manifold area, pump sheds, flare area, inside of dyke wall of tank farm, 4 pole structure for HT cable & security tower.

RCC paving shall be provided for approach road to buildings.

Any drains within paved areas shall be suitably rerouted/ strengthened/ covered with heavy duty gratings so that crane and fire tender movement is possible in this area.

As a minimum requirement, heavy duty RCC paving of Type-I as per details enclosed shall be provided in areas where maintenance crane & fire tender movement is possible. Tube bundle pulling areas shall also be provided with Type-I paving as a minimum requirement. Rest of the areas shall be provided with Type-II RCC paving. Paving inside the tank farm shall be of...
type III. It may be noted that, Type-I and Type-II paving area minimum requirements; LSTK CONTRACTOR to design the paving conforming to IRC:58, suitable for crane movement. Paved areas shall be given appropriate slope towards peripheral storm water drains, or CRWS catch basins, as applicable.

Hardstand and/or RCC pavement for erection of heavy equipment by crane shall be ascertained designed as per erection loads and provided as required by the LSTK CONTRACTOR. Dismantling/ rerouting/ remaking shall also be carried out by the LSTK CONTRACTOR in case of fouling or due to space constraint for other equipment foundation, piping, drains etc. or if directed by OWNER. Maintenance crane load capacity shall be furnished by the LSTK CONTRACTOR prior to starting detail engineering.

After mechanical completion and commissioning, 50 mm thick concrete screed (1:1:5:3 by volume) with non-metallic floor hardener (Nitoflor Hard Top by FOSROC or equivalent) shall be provided over entire paved area except around pump foundations, Hot Oil drum storage shed, where 50 mm thick concrete screed as above with chemical/ abrasion resistant coating (Nitoflor FC170 by FOSROC or equivalent) shall be provided, as per specifications. Paving shall be constructed in alternate panels of approximate size 3 m x 3 m with provision of construction joints, expansion/contraction joints and sealing of joints.

Proper gradient shall be provided for paved areas to quickly drain off the water. Special care shall be taken to drain the areas prone to water spillage, such as areas containing steam trap, cooling water pumps, etc. In no case, water logging shall occur on any part of the paved area.

LSTK CONTRACTOR shall prepare paving layout drawings, showing demarcation between different types of paving and between paving at different levels, thickness, reinforcement details, high points, ridges, valleys, slopes, pedestals, local thickening etc.

7.3.1.2.7 Footpath

Footpaths shall be constructed for non-vehicular approaches by the LSTK CONTRACTORS as shown in the plot plans or advised by ONGC/PMC.

7.3.1.2.8 RCC Trenches

7.3.1.2.8.1 Cable Trenches

Cables shall be laid in covered RCC trenches as indicated in electrical/instruments cable routing drawings. LSTK CONTRACTOR shall provide RCC trenches with inserts or other suitable arrangement to support cables.

Trench floors shall be provided with nominal slope and adequate provisions shall be made, such as providing de-watering sumps at regular intervals if required, for draining out of the accumulated water to nearest storm water
drains. If respective invert levels are not compatible, mobile/permanent dewatering pumps shall be provided.

Cable trenches shall be provided with pre-cast covers having lifting arrangement, etc. seating surface of the covers shall be at least 100 mm wide. Wherever applicable, covers and entire trench cross section shall be designed for anticipated traffic movement across the trench (e.g. maintenance cranes, fire tenders etc.) Joints between covers shall be properly sealed to prevent rain water entry into the trenches. In paved areas, top of trench covers shall overlap walls; joints with paving shall be sealed to prevent water entry into the trenches. Trenches shall be of leak proof construction. Cable trenches shall be filled with sand wherever indicated in relevant electrical drawings.

7.3.1.2.8.2 **Pipe Trenches**

Wherever required, process lines shall be laid in RCC pipe trenches with removable type pre-cast RCC covers. The requirements regarding design and construction of covers and trenches shall be same as that for cable trenches.

7.3.1.2.9 **Tank Pad Foundation & Dyke Walls**

Tank foundation (sand pad / RCC ring beam / pile foundation with pile caps) for all tanks as per equipment layout / plot plan are included in the scope of work including fixing of tank pad foundation, top level and calculation of settlement during hydraulic testing. However, due to soil conditions (as per soil testing report), if any additional soil treatment below tank pad foundation is required, the same shall be carried out by the contractor without any cost implication and schedule impact.

Dyke enclosure of brick confirming to IS:1077 and plastering on both sides. The enclosure shall be designed as per OISD/CCE rules. All the tanks in common enclosure shall be separated by firewall (brick construction) as per CCE’s rules and OISD guidelines. Minimum 600 mm wide walkway over all dyke wall shall be provided.

All dyke enclosures shall be provided with cement concrete pavement type III as per enclosed details.

7.3.1.2.10 **Oily Water System (OWS)**

OWS from all process equipment / tank drains, shall be discharged into OWS funnels & conveyed through OWS underground gravity sewers to the nearest OWS/produced water header, Continuous Oil Contamination (COC) area around the pumps, PROCESS AREA plant etc. indicated in drawing no. 9473-10-04-GC-4003, 9473-20-04-GC-4003, 9473-30-04-GC-4003 generated due to rain / fire water / maintenance / leakage etc. shall be discharged into nearest OWS u/g gravity sewer or separate underground sewers upto ETP if size of sewer is inadequate. Floor wash mixed with oil in the PROCESS AREA unit.
shall be collected in the peripheral storm water drain. The storm water drain shall be provided with double valve pit at the battery limit of unit through which floor wash shall be discharged into nearest storm water drain or oily water sewer when storm water is mixed with oil.

The OWS pits shall be made closed with concrete cover.

7.3.1.2.10.1 Oil drain header

Oil drain header from various process equipments as per process P&ID shall collect the drained oil and be connected to underground drain tank. The flow of oil shall be under gravity.

7.3.1.2.11 Crws System:

CRWS shall be considered for the identified pump areas for the heater areas.

The catchment area for CRWS discharge shall be considered 4.0 m away all around the pump foundations excluding the catchments area inside the curb wall 250mm way from the pump foundations. However, grouping shall be made where the clear distance between the adjacent pump foundations is not more than 8.0M for CRWS discharge.

CRWS discharge from the catchments areas shall be collected through catch basin conveyed to main headers of CRWS system.

CRWS discharge shall be finally routed to CRWS oil skimming pit for segregation of oil. This segregated oil shall be discharged through adjustable weirs to the nearest OWS manholes. One of the discharge lines from double valve pit chamber of storm water drain (collecting the uncontaminated water from inside process unit) shall be connected to this CRWS oil skimming pit through oil catcher. This arrangement shall be controlled by normally closed sluice valve located inside the valve pit only during emergency i.e. when there shall be oil contamination. CRWS oil skimming pit and the oil catcher shall be covered & located in a safe area maintaining the statutory distances outside B/L of process unit.

7.3.1.3 DETAILS SCOPE OF WORK ARCHITECTURE

Design, Engineering and Construction including preparation of at least three architectural design, engineering layout and approval of the same by OWNER/PMC/ Statutory authorities for the following Plant and Non-Plant buildings & sheds-

7.3.1.3.1 Control Room & Operator Building

- Reference drawing no. : 9473-10-04-GC-4009
  9473-20-04-GC-4009
  9473-30-04-GC-4009
- Type of construction: R.C.C.
- C.I. rainwater pipes shall be provided. Rain water stack shall be housed in shafts to match with building architectural look. Exposed rain water stack should be avoided.
- C.I. (IS:3989) pipes shall be provided for Kitchen & Bathroom waste & sewer system.
- All free edges of chajjas and slab projections shall have drip mould in plaster 50 mm wide and 20 mm drop.
- Floor slab in WC areas shall be sunk by 500 mm and toilet slab shall be sunk by 200 mm at all levels.
- All partition walls within toilet kitchen areas shall be 115 mm thick and 2200 mm high.
- All cut outs in slab shall be provided with 200 high curb.
- Groove in plaster, 20 wide x 10 deep shall be provided aesthetically to break extensive areas of plaster.
- Parapet walls shall be at least 900 mm high.
- Roofs of RCC buildings should slope (1:150) towards rain water gutters.
- All electrical & plumbing conduits shall be concealed type.
- All electrical junction box, switch board etc. shall be recessed into the wall.
- Minimum headroom clearance shall be kept at all approachable areas as per the required byelaws and authorities concern.
- Provision of 2nd Floor for Madhuban shall be kept while designing the building.
- F.F.L: 0.45 m above road top level

7.3.1.3.2 Instrumentation Air House
- Type of construction: Steel structure with precoated G.I. profiled sheet roofing.
- Roof slope: 1 : 3
- F.F.L: At road level.
- C.I. rainwater pipes shall be provided.

7.3.1.3.3 Security Barrack
- Reference drawing no.: 9473-10-04-GC-4008
- 9473-20-04-GC-4008
Type of construction : R.C.C.

C.I. rainwater pipes shall be provided. Rain water stack shall be housed in shafts to match with building architectural look. Exposed rain water stack should be avoided.

C.I. (IS:3989) pipes & fittings shall be provided for Kitchen & Bathroom waste & sewer system.

All free edges of chajjas and slab projections shall have drip mould in plaster 50 mm wide and 20 mm drop.

Floor slab in WC areas shall be sunk by 500 mm and toilet slab shall be sunk by 200 mm at all levels.

All partition walls within toilet kitchen areas shall be 115 mm thick and 2200 mm high.

All cut outs in slab shall be provided with 200 high curb.

Groove in plaster, 20 wide x 10 deep shall be provided aesthetically to break extensive areas of plaster.

Parapet walls shall be at least 900 mm high.

Roofs of RCC buildings should 1:150 slope towards rain water gutters.

All electrical & plumbing conduits shall be concealed type.

All electrical junction box, switch board etc. shall be recessed into the wall.

Minimum headroom clearance shall be kept at all approachable areas as per the required byelaws and authorities concern.

F.F.L : 0.45 m above road top level

7.3.1.3.4 Security Cabin

Reference drawing no. : 9473-00-04-GC-4001

Type of construction : R.C.C.

C.I. rainwater pipes shall be provided.

All free edges of chajjas and slab projections shall have drip mould in plaster 50 mm wide and 20 mm drop.

Groove in plaster, 20 wide x 10 deep shall be provided aesthetically to break extensive areas of plaster.

Parapet walls shall be at least 900 mm high.
7.3.1.3.5 Watch Tower
- Reference: Refer drawing no. 9473-00-05-A3-5003.
- Locations: As per plot plan.
- Type of construction: Steel structure, 4 legged, duly braced and placed over the R.C.C.
- Plinth Level: 200mm above nearby Road level.

7.3.1.3.6 Shift Workers Cabin
- Type of construction: R.C.C.
- C.I. rainwater pipes shall be provided.
- All free edges of chajjas and slab projections shall have drip mould in plaster 50 mm wide and 20 mm drop.
- Groove in plaster, 20 wide x 10 deep shall be provided aesthetically to break extensive areas of plaster.
- Parapet walls shall be at least 900 mm high.
- Roofs of RCC buildings should 1:150 slope towards rain water gutters.

7.3.1.3.7 Pump sheds
- Pump Sheds for condensate pumps shall be suitable for housing the respective pumps from operation & maintenance view points.
- Type of construction: Steel structure with precoated G.I. profiled sheet roofing.
- Roof slope: 3
- F.F.L: At road level.

7.3.1.3.8 Generator Room
- Reference drawing no.: 9473-00-04-GC-4002
- Necessary acoustic treatment shall be done for the Generator Room.

7.3.1.3.9 Additional Shed For Loading Bay
- Loading bay shall be located as per the Plot plans.
7.3.1.3.10 Firewater Pump House

- For housing new fire water and jockey pumps.
- **Reference drawing no.**
  - 9473-10-04-GC-4007
  - 9473-20-04-GC-4007
  - 9473-30-04-GC-4007
- **Type of construction**: Steel structure with pre coated G.I. profiled sheet roofing and side cladding, with louvers monitors.
- **Monorail lifting**: shall be provided with 1.5 T (To be confirmed)
- **Roof slope**: 1 : 3
- **Top of intermediate platform**: as per drawing
- **C.I. rainwater pipes shall be provided.**

Paved platform for skid mounted new standby D.G. set of approximate area of 2.5m x 7.0m as shown in the plot plan.

Any other building as per requirements of LSTK CONTRACTOR’S package vendor.

7.3.1.3.11 Furniture & Furnishing

All window / door / ventilators for all buildings shall be provided with pelmets, curtain rods, blinds matching with the internal colour schemes.

Furniture/appliances shall be provided as per following:

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Locations</th>
<th>Items</th>
<th>Quantity</th>
<th>Model</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operators cabin</td>
<td>Table</td>
<td>1</td>
<td>Model T-107</td>
<td>Godrej</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chair</td>
<td>3</td>
<td>Model CHR-7B</td>
<td>Godrej</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral Water Dispenser</td>
<td>1</td>
<td></td>
<td>Reputed manufacturer</td>
</tr>
<tr>
<td>2</td>
<td>Control Room</td>
<td>Table</td>
<td>1</td>
<td>Model T-107</td>
<td>Godrej</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chairs</td>
<td>3</td>
<td>Model PCH 7000</td>
<td>Godrej</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Book Shelf</td>
<td>1</td>
<td>4 Partition shelf with glass doors</td>
<td>Godrej</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel rack</td>
<td>1</td>
<td>165 ltrs.</td>
<td>Godrej Reputed manufacturer</td>
</tr>
</tbody>
</table>
### SCOPE OF WORK

**FOR**

MADHUBAN, BAGHJAN & CHABUA

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<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 PMCC room</td>
<td>Table</td>
<td>1</td>
<td>Model T-107</td>
</tr>
<tr>
<td></td>
<td>Chairs</td>
<td>2</td>
<td>Model CHR-7B</td>
</tr>
<tr>
<td></td>
<td>Book Shelf</td>
<td>1</td>
<td>3” x 3” x 12”</td>
</tr>
<tr>
<td></td>
<td>Work bench with vice fitted industrial steel rack</td>
<td>1</td>
<td>6” x 3” 12”</td>
</tr>
<tr>
<td>5 General</td>
<td>Steel racks (almirah)</td>
<td>1</td>
<td>Store well plain with 4 shelves</td>
</tr>
<tr>
<td></td>
<td>Sofa set with center table</td>
<td>2 sets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Book shelf</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

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### FIRE PROTECTION SYSTEM

The scope of work for fire protection system shall include design of fire protection system; detailed engineering of fire protection system; preparation of relevant drawings, documents, etc. and submission to OWNER/PMC for review and approval; obtaining statutory approvals from TAC and other statutory body as the case may be; procurement of all fire protection equipment, materials, items, consumables, tools, tackles, accessories, etc. and transportation to the work site; arrangement of supervisors, technicians and labors and their mobilization to the work site; construction/erection of all relevant works as per layout drawings, design basis, data sheets, specifications, drawings, standards, OISD, TAC, NFPA requirements including obtaining TAC approval of the complete fire protection system. LSTK CONTRACTOR shall submit the test reports to OWNER/PMC, trial run and commissioning of fire protection system; and handing over of the fire protection system to the owner.

The scope of work mentioned below shall be in general but not limited to the following:

- Construction of firewater tanks (RCC static firewater reservoir)
- Fire water pumps;
- Laying of fire water network above ground on sleeper and underground at road crossing with hydrants, water/foam monitors and spray system as per OISD/TAC;
- Installation of medium velocity water spray system and fixed foam system (semi-automatic type) for protection of Condensate Test Tanks in FGSs and Condensate Storage Tank in CGGS and alternate foam pouring arrangement through fire tender.
7.3.1.4.1 Details Scope Of Work Fire Protection System

Fire water network shall consist of fire water tanks, pumps & jockey pumps for all sites. The fire water system has been designed to fight single largest fire in the installation as per OISD 117. Hence as per above, with minimum changes in the fire protection system, new fire water system shall be designed & provided as per OISD & TAC. The new system shall have the additional fire water system around proposed facilities, integrated with the fire water system, including but not limited to following :-

7.3.1.4.1.1 Fire Water Storage

Easily accessible surface reservoir of RCC (without top cover) having following minimum features:

i. **Capacity**: Capacity of firewater storage tank shall be at least 850 m³ on the basis of two hours’ aggregate pumping capacity.

ii. **Facility** for cleaning and repair: Storage reservoir shall be in two equal interconnected compartments to facilitate cleaning and repairs.

iii. **Emergency**: The installation shall have facilities for receiving and diverting all the water coming to the installation to fire water storage tanks in case of an emergency.

7.3.1.4.1.2 Fire Water Distribution Network

Design and providing fire water system for a minimum residual pressure of 7kg/cm² at the hydraulically remotest point of application at the designed flow rate around the facility with following features:

7.3.1.4.1.3 Looping

The fire water network shall be laid in closed loops as far as possible to ensure multi-directional flow in the system. Isolation valves shall be provided in the network to enable isolation of any section of the network without affecting the flow in the rest. The isolation valves shall be located normally near the loop junctions.

7.3.1.4.1.4 Above/ Underground Network

The fire water network of suitable material as per relevant standards shall mainly be laid above ground at a height of 300 mm to 400 mm above finished
ground level. However, the fire water network piping shall be laid below ground level at the following places:

- Road crossings.
- Places where the above ground piping is likely to cause obstruction to operation, vehicle movement and places where the above ground piping is likely to get damaged mechanically.

The above ground pipes shall be protected as follow:

- The mains shall be supported at regular intervals not exceeding 6 mtrs having point support.
- The system for above ground portion shall be analyzed for flexibility against thermal expansion and necessary expansion loops where called for shall be provided.

For the protection of underground pipelines following measures shall be taken:

- Underground firewater pipings shall be protected as per the norms specified in relevant OISD standards / TAC.
- The mains shall have at least one-meter earth cushion in open ground and 1.5 meters cushion under the roads. In case of crane movement areas, pipe may be protected with concrete/steel encasement.
- The mains shall be provided with protection against soil corrosion by suitable coating/wrapping.

In case of poor soil conditions it may be necessary to provide concrete/masonry supports under the pipe.

7.3.1.4.1.5 Sizing of Ring Main

Firewater distribution ring main shall be sized for 120% of the design water rate. The analysis of network shall be preferably done through a computer programme.

7.3.1.4.1.6 Hydrants, Monitors and Accessories

Hydrants, monitors and accessories shall have minimum following features:

- Hydrants and accessories shall be IS marked.
- Water/foam monitors shall be UL/FM/TAC approved type.
- Hydrant and monitors shall be located along roadside at appropriate distance from storage or equipment to be protected.
Double-headed hydrants with two separate landing valves on 100 mm standpost shall be provided with outlet situate 1.2 mtrs. above ground level.

Connection for fixed water monitors shall be provided with independent isolation valves.

Adequate nos. of hydrants, water/foam monitors shall be provided as per relevant OISD standards / TAC or STEP/ Owner’s requirements.

7.3.1.4.1.7 **Hose Pipes/Branch Pipe/Nozzles**

Adequate nos. of hoses (Type B) of 63 mm diameter as per IS Standard shall be provided at least at the rate of two lengths (15m each) per hose box. All coupling of hose pipe shall be of instantaneous spring-lock type and nozzle shall not less than 16mm. All coupling branch pipes and nozzles shall be of gunmetal or stainless steel and comply with IS: 903. Number of hose, branch pipes and nozzles shall be as per the requirement of TAC.

7.3.1.4.1.8 **Accessories, Consumables & Spares**

Fire hoses, hose boxes, water and foam nozzles, spares, consumables, etc. required on the basis of number of hydrants, types of expected fires, etc. shall be procure and supplied. The quantity and quality of these items shall meet requirements of OISD/TAC. Where standards are moot in this regard, the directives of STEP/owner will prevail.

7.3.1.4.1.9 **Foam System**

Mobile Foam System

One no. of portable (trailer) foam monitor shall be provided for pool fire anywhere in the facility. The system should be able to throw water also as the need arises for fighting fire or exposure protection.

7.3.1.4.1.10 **Fixed Foam System & Foam Tanks**

Fixed foam system of semi-automatic type shall be provided along with alternate provision for injecting foam with fire tender, for FGS Condensate Test Tanks and Condensate Storage Tank in CGGS. Foam compound storage tank dedicated to the fixed foam system shall be of SS material having capacity of 2 (two) KL.

In diesel unloading/storage areas (FGSs & CGGS) foam/water monitor shall have SS foam tank (one KL capacity) with pick tube connected to the foam monitor.

7.3.1.4.1.11 **Quality of Foam Compound**
Foam compound supplied for the above foam system shall be AFFF type and UL/FM/TAC approved or listed.

7.3.1.4.1.12 **Water Spray System**

In addition to the fixed foam system, FGS Condensate Test Tanks and Condensate Storage Tank in CGGS shall also be protected with medium velocity fixed water spray system and water monitor coverage.

7.3.1.4.1.13 **Fire Water Pumps**

**Main Fire Pumps**

Diesel engine driven fire water pumps (1 working + 1 standby) to be provided in FGSs and CGGS will be of 410 m3/hr capacity and the connected firewater storage tank’s capacity will be approximately 850 m3 based on minimum 2 hours’ aggregate pumping capacity. This will satisfy the firewater requirements for FGSs and CGGS as laid down in OISD-STD-189 and TAC for High Hazard (A) occupancy.

Firewater pumps shall be TAC/BIS approved type.

**Jockey Pumps**

1 working (Electric Motor Driven centrifugal pump) + 1 Standby (Electric Motor centrifugal pump) with capacity 12.3 Cum/hr (3% of designed fire water rate) at network pressure not less than 3 kg/cm2.

7.3.1.4.1.14 **Fuel Tanks**

Independent fuel tank (with appropriate type of level gauge) for each engine, sized for 8 (eight) hours’ continuous running of the pump shall be provided. The tank with feed line/funnel shall be connected to respective engine fuel tank to deliver the fuel without spillage. The tank shall have proper level gauge.

7.3.1.4.1.15 **Pump Room**

Well ventilated pump room (meeting the requirement of TAC) to house pumps and electric/instrument panels. It will offer minimum obstruction to the convenient handling and hoisting of equipment therein.

The pump room shall have provision for lifting, lowering and handling of firewater pumps, diesel engine, etc. placed therein.

7.3.1.4.1.16 **First-Aid Fire Protection and Hose Boxes**

7.3.1.4.1.16.1 **FIRE EXTINGUISHERS**

Fire extinguishers of suitable types and capacities shall be provided strategically and fixed on hangers in all buildings and hazardous areas; and
near electrical installations, or any other hazardous locations. Types, capacities and distribution of these fire extinguishers shall conform to the requirements of OMR-84, OISD-189, TAC, NFPA, IS-2190, etc.

7.3.1.4.1.16.2 **HOSE BOX**

Hose pipes and nozzle shall be installed near each hydrant in glass fronted hose boxes of suitable design as per relevant standard.

7.3.1.4.1.16.3 **STORAGE FACILITY**

Appropriate facility (15’ x 10’ approximately) shall be provided for storage of foam jerrycans/drums, additional fire hoses & other fire fighting appliances and parking of portable (trailer) monitor, adjacent to the firewater pump house of each station.

7.3.1.4.1.17 **Drawings and Documents**

**Schematic layout/plan of fire water system**

i. Layout/plan shall be clear, contain all required details including scale and compass and shall be dated.

ii. Plans should show the entire compound, all buildings (with details) therein, details of arrangements of fire water system, location of fire extinguishers, and other fire fighting appliances.

iii. Plan/layout shall fulfill all the norms required by regulatory and statutory bodies so that this is readily acceptable by them for approval.

7.3.1.4.1.18 **Process and Instrumentation Diagrams (P&ID)**

P&ID for the fire water system shall be developed showing all instrumentation and control.

The above are the minimum drawings and documents, which are to be prepared conforming to TAC/OISD or requirements of STEP/Owner and submitted to STEP/Owner for approval.

7.3.1.4.1.19 **List of materials**

A consolidated list of details of major items (pipes, valves, etc.), equipment (pumps, drivers, etc.), accessories (nozzles, hoses, etc.), Fire Extinguishers, spares (for pumps, valves, hydrants, extinguishers, etc.) and consumables (foam, chemical powder, etc.) that will be required in the proposed fire protection system.

7.3.1.4.1.20 **Miscellaneous**

Contractor shall design the entire fire protection system to obtain maximum rebate on insurance premium.
The schematic layout for fire water system or any information/data described in the present document are only indicative and should be used for reference only.

Hydrants/monitors shown on the layout are indicative only. Hydrants shall be provided on all headers long roadsides at all locations. Contractor shall finalize the exact location and nos. of hydrants and monitors etc. as per OISD/ TAC requirements and STEP/Owner requirements.

The hydraulic calculations for hydrant system spray system and foam system shall be furnished in PIPENET or equivalent internationally accepted computer programme or any programme acceptable by STEP/Owner along with detail layout drawings.

The contractor shall obtain approval of the complete fire protection system of units from TAC or any other statutory body. This includes preparation of all documents, write ups and drawings. Any change/alternations required to be made to meet the requirements of OISD, TAC, etc. shall be done by the contractor without any extra time and cost implication.

In addition to requirements described in previous paragraphs, the following minimum requirements are also to be fulfilled by the contractor:

i. Any other specific fire protection system required or identified during detailed engineering.

ii. Approval of all specifications for fire fighting equipment, accessories, materials, etc. form STEP/Owner before procurement.

iii. All fire fighting equipment, appliances and materials to be procured from OIL approved vendors.

iv. All the equipment of fire water system shall be TAC approved or ISI marked preferably FM/UL approved or listed.

v. Provision of suitable restriction orifice in hydrant system as per TAC requirements.

vi. Provide suitable strainer at each tapping point of spray cooling system.

Flushing arrangements for firewater mains at various locations.

7.3.1.4.1.21 Radiography

At least 10% of all welded joints of firewater piping shall be radio graphically tested and shall be found in order as per TAC requirements. At least 50% of welded joints selected for radiography shall be field joints.

7.3.1.4.1.22 Fire proofing

As per OISD-164 requirement and as per specification as defined in structural requirement enclosed in the tender document.

7.3.1.4.1.23 Safety shower & eye wash
Contractor shall provide safety shower and eyewash where either caustic or other chemicals are handled or toxic chemicals may be present No. of SS & EW to be provided shall be as per process P&IDs and equipment layout and hazardous area requirements. Water shall be fed from service water line. Discharge from safety shower/eye wash unit shall be connected to nearest OWS produced water header.

7.3.1.4.1.24 Fencing & Gates

LSTK CONTRACTOR shall dismantle the fencing on west side of tank farm I to provide areas for dyke walls & roads. The LSTK Contractor shall provide new chain link fence & gates on fence as shown in drawing no. 9473-GC-04-4001.

7.3.1.4.1.25 Barricading

LSTK CONTRACTOR shall do barricading of construction area to prevent damage to facilities. The minimum extent of barricade shall be as outlined in the scope drawing 9473-04-GC-4002 barricading required at other locations, if any, shall also be provided. The height of the barricade shall be; minimum two meters above the highest point of active work. In PROCESS AREA plant area, barricaching sheets shall go 150 mm below ground level. The barricade shall be made out of steel frame work with galvanised iron sheets. Steel frame work and its foundations shall be properly designed/ constructed as per BIS codes. The barricade shall also be provided with suitable piping arrangement to be connected to a pressurized water source to provide necessary water blanketing. Any hot work above the point of barricade shall be as per approved special hot work procedure which shall be developed by the LSTK CONTRACTOR in line with the practice followed in the oil & gas installation. After completion of the work, barricading including its foundations shall be removed and the site made good by the LSTK CONTRACTOR. Safety rules shall be strictly adhered to while working in running plant, failing the same will have punitive action by OWNER/ PMC. Any work within 1 CGGS & 2 FGS by LSTK contractor shall comply with OISD-105 work permit system w.r.t Hot & Cold work permit.

7.3.1.4.1.26 Display Boards

Ten numbers safety display boards of size 2m x 1.5m shall be installed at suitable places. The board shall be vinyl / co flex or superior material. Adequate number of caution signboard 60cm x 30 cm shall be installed at suitable location. P&ID, plant layout, SLD, fire water network, fire fighting equipment layout, loading procedures, product material safety data sheet shall be displayed at suitable places.

7.3.1.4.1.27 Tubewell

Design and construction of a tubewell and providing pumps having yield of 50 m3/hr
7.3.1.5 DETAILED ENGINEERING BY LSTK CONTRACTOR

LSTK CONTRACTOR shall take this basic Engineering package to Approved for Construction (AFC) status, taking due account of the detailed requirements as specified in the Engineering Design Basis, Job Specifications, Standard Specifications and Standard drawings for General Civil, Architectural & fire protection works covered under this LSTK Contract.

7.3.1.5.1 Specifications and Design

The LSTK CONTRACTOR shall:-

Prepare and submit list of all codes/ standards, including local codes/ standards and regulations, to be followed, which are related to General Civil, Architectural Design, and fire protection system whether or not stated in the list of codes in this package, to ensure a functional, safe and economic structure/ facility.

Prepare and submit design philosophy/ design basis along with the bid.

Prepare, review and finalize engineering/ construction specifications for each system based on design basis and related codes and specifications.

Prepare building specification for architectural works in accordance with Architectural Design Basis and job specifications, which shall be submitted for OWNER/ PMC’S approval prior to detail engineering.

Select material of construction, conforming to relevant codes and standards, in such a way so as to protect the structures and foundations against any harmful effect of chemicals, fumes etc. present in the plant or its vicinity or in the ground and/ or subsoil water.

Design and Detail the requirements for fire protection of structural steel work and equipment. LSTK CONTRACTOR shall ensure that his proposed fire protection system meets with the requirements of the Bid Specifications.

Design of barricading structures around the PROCESS AREA unit area including design of any local barricading and water blanketing for hot work at high levels.

Design temporary construction facilities like site multipurpose shelters, site cabins, site office for OWNER/PMC if instructed, laboratory, temporary drainage system, construction site access roadways, barricades and fencing, tanks for storage/ handling of construction water and other liquids like preparation of slurries, chemical mixing etc. batching plants, etc.

Prepare specifications, drawings etc. for getting statutory approvals, submitting and getting approvals from the concerned authorities.
Design all new/modified roads and prepare layout and detail drawings keeping in view the present and future facilities, likely vehicular movement, soil strength, maintenance and construction requirements. This shall highlight rerouting of roads, if any. Various components shall be given in details.

Design storm water drainage system consisting of storm water drains, box / pipe culverts etc. Layouts shall show the drains from which / to which the new drains are getting connected etc.

Design RCC paving; provide surface finishing keeping in view normal operation and maintenance, erection, etc. Design hardstands required for the erection/ maintenance of equipment and plants as per the approved erection and maintenance scheme of the LSTK CONTRACTOR, which shall have to be issued in advance.

Design of pipe way bridges for road crossings of process piping etc. The pipe way bridges shall be designed for maximum crane load envisaged or class AA loading as per IRC.6, whichever is more.

Design electrical land instrument cable road crossings, cable trenches, cable ducts, pipe/ cable sleepers, anchors and other pipe supports, etc. Prepare layouts of the new cable/ pipe ways/ trenches. RCC details etc.

Design following systems and hook up with the respective systems, if indicated so earlier.

- Storm water drains in operation areas; storm water drains to take care of firewater also.
- OWS system
- Design service water system for safety shower & eyewash etc.
- Design of acid/ alkali lining in chemical handling areas
- Design of fire Protection system.

Prepare detail drawings, general arrangement drawings, area drawings, documents, layouts, design calculations etc.

Furnish Final Documentation and “As Built” drawings.

The design calculations (typed and properly bound), detail drawings and execution drawings for each independent building/ structure shall be submitted by the LSTK CONTRACTOR in one lot so as to facilitate an overall systematic review, Detail design and execution drawings for each building and structure shall be submitted after approval of architectural drawings.
In case the basis of design is changed by the OWNER/ PMC after award of the contract and causes additional cost to the LSTK CONTRACTOR, the latter has to submit his substantiated claim without delay for approval by the OWNER/ PMC, to be dealt with in accordance with the Terms and Conditions of the Contract.

7.3.1.5.1.1 **Architectural Design**

The LSTK CONTRACTOR shall:-

Carry out Basic Design and engineering, including preparation of conceptual/ schematic layouts for buildings/ sheds, etc. (for which preliminary drawings are not provided with the bid)
showing plan,(s) elevations, sections, finishing schedule, perspective view etc. complete with all necessary building services requirements conforming to the specified parameters, relevant codes, standards and bye-laws, architectural design basis, job specifications, attached with the bid etc for OWNER/ PMC’S review and approval. The design, layout, size, occupancy and spatial requirements of buildings not indicated at the bidding stage (if any) shall be discussed and details of such buildings shall be mutually agreed with OWNER/ PMC.

Carry out complete detailed engineering, including preparation of AFC (Approved for Construction) drawings showing all relevant plans, sections, elevations of all the buildings/ sheds.

Indicate following details and schedules building wise wherever applicable:-

- Construction Details
- Door Window Schedule and Details
- Details of Toilet and Staircase
- False Ceiling and False Flooring Layout and Details
- External and Internal Finishing Schedule and Color Scheme
- Schedule of Fittings and Fixtures (for plumbing, sanitary hardware etc.)
- Any other details as required for construction and/ or required by the OWNER/PMC.
- Furniture details

The internal & external finishing and colour scheme of each building shall be finalized jointly with the OWNER/ PMC prior to the preparation of drawings/ documents.
7.3.1.6 CONSTRUCTION

LSTK CONTRACTOR shall supply the materials conforming to the attached specifications and construct the work in accordance with the requirements of 1.1 to 1.5., mechanical completion and commissioning as defined elsewhere herein.

The construction is to be carried out in an 1 CGGS & 2 FGS complex. All care shall be taken to prevent damage to facilities, or disruptions to daily routine. All cooperation shall be given to the OWNER/ PMC in respect to above. All cooperation with new construction shall be located, brought to the notice of the OWNER/ PMC, and rerouted, including supply of materials for such work, or otherwise dealt with as instructed by OWNER/ PMC. Losses arising due to failure on the part of the LSTK CONTRACTOR in the above shall be borne by the LSTK CONTRACTOR. LSTK CONTRACTOR shall give full cooperation to all other agencies, involved in the area where he is working.

LSTK CONTRACTOR shall be responsible for completion of works in all respects whether specifically mentioned or not in the scope.

7.3.1.6.1 General Civil

Work shall include but shall not be limited to:-

Cutting, clearing, grubbing of trees, bushes, vegetation, etc.

Set out the work from worksite and benchmarks, which shall be accurately fixed in position by LSTK CONTRACTOR and in a form approved by OWNER/ PMC.

Earthworks, site clearing, top soil removing, leveling including bund; micro grading including procuring suitable soil from outside if not available locally, and disposing unutilized soil as indicated by OWNER/ PMC (procuring and disposing both) LSTK CONTRACTOR shall confirm lead etc. by visiting site.

Arranging for temporary dewatering using pumps and protection of underground services and foundation by providing temporary supports, shoring/ strutting, rerouting, if required, etc.

Construction of new roads and drains, modifying or repairing or rerouting roads and drains, piping/pits etc in line with the new; requirements. The same shall be tied up with the road and drain network. Laying of access roads to individual blocks, facilities within the plot. Initially, roads may be constructed up to sub-base level, and subsequently, up to finished levels.

Construction of hard stand for equipment erection and dismantling the same, with the consent of OWNER/ PMC, after the work is over.
Providing RCC paving in areas as indicated; including sub grade, reinforcement and joint materials, and other ground treatments if required.

Construction of storm water drains on either side of the approach/diverted road, if any

Modifying SWDs to suit the LSTK CONTRACTOR’S design of new drains, if required.

Constructing the catch pits, manholes, clean outs, valve pits, manholes, sump pits etc for various sewer systems, inside the plot and hooking the same with network.

Construction of box culverts/ cable ducts for road/ drain crossings of cables and pipes.

Construction of sleepers/ racks/ trestles for supporting pipes and cables, including tying them to the network, taking supports from facilities, anchoring etc, as instructed. Construction of miscellaneous crossovers and platforms, not covered elsewhere.

Construction of temporary drainage works, site offices, laboratories, workshops, stores, yards, etc as required.

Removal of all underground and above ground structures, foundations causing obstruction to new structures and foundations, provided removal of the former would not disturb the functions of the plant.

Rerouting/ modifications of underground and above-ground facilities, if required, to avoid fouling with new facilities, without disturbance to routine operations. This shall be done as instructed by the OWNER/PMC.

Storage and maintenance of LSTK CONTRACTOR provided items

Loading, transporting and offloading from storage areas to place of erection

Erection of steel work including the supply of construction equipment, facilities, staging, labour, supervision, safely equipment and consumable materials.

Plumbing, lining, leveling and tightening down

Painting of erected steel work

Touch up painting or galvanizing to erected steelwork where required after erection including painting of erection bolts.

Fire-proofing of steel structures and equipment supports as per OISD-STD-164

Provision of insert plates in RCC structures.
7.3.1.6.2 Architectural

LSTK CONTRACTOR shall obtain necessary approvals for construction of the buildings and sheds from the relevant local/ state authority/ government agency/ statutory bodies, including preparation of necessary drawings/ documents required to be submitted for obtaining such approvals.

All construction shall be as per the AFC drawings conforming to protocol state earlier. The buildings, sheds, and out-door structures/ facilities shall be provided suitable for the purpose for which they are intended, with complete arrangements for all services including all fittings and fixtures, furnishings and outfitting, complete as required by the provision of the bid. Out-door structures shall be suitably tied with the similar facilities wherever required.

LSTK CONTRACTOR shall obtain necessary completion/fit for habitation certificates from the relevant local/ state authority/ govt. agency/ statutory bodies, Tariff Advisory Committee, State Inspector of factories etc. Preparation of necessary drawing/ documents required to be submitted for obtaining such certificates shall be in the scope of LSTK CONTRACTOR.

7.3.1.7 STATUTORY REQUIREMENTS

The Contractor during detail engineering design as well as subsequent construction, shall take into account and comply with various local statutory requirements, standards and codes, as applicable including but not be limited to the following:

1. Factories Act.
2. Indian Petroleum Rules
3. Tariff Advisory Committee (TAC) Guidelines (for insurance purpose).
4. Indian Boiler Regulation Act (IBR)
5. Civil Aviation Rules
6. Indian Railway Authority
8. Indian Electricity Rules
9. Central Electrical Authority (CEA)
10. Director General, Factory Advice Service and Labour Institute, Bombay
11. Central Mines Research Institute (CMRI), Dhanbad, India
12. Department of Atomic Energy
13. Requirement of Chief Controller of Explosives (CCE), Nagpur, India
14. Standards prescribed by Oil Industry Safety Directorate (OISD), Ministry of Petroleum and Natural Gas, Government of India
15. Ministry of surface Transport
16. National Institute of Oceanology
17. Stipulations stated in Environmental clearance granted by Ministry of Environment and Forest, Government of India.
18. Liquid Effluent Discharge as per Minimal National Standards for Liquid Effluents and air emissions confirming to Pollution Control Board Standards.
19. Stipulations of Environmental authorities of the State of Assam.
20. Other legislations relating to Environmental protection such as (but not limited to):

   b) Water (prevention and control of pollution) Act., 1974
   e) Environment (Protection) Act, 1980
   f) Forest (Conservation) Act, 1980
   g) Municipal Byelaws of Urban Development Authority of State Government for Buildings in Township
   h) National Building Code.

21. Pollution Control Board
22. Oil India Safety Directorate (OISD)

7.3.1.7.1 Approvals

Contractors shall take approvals for all facilities within BID package from

1. Factory Inspector Assam.
2. Tariff Advisory Committee (TAC)
3. Chief Controller of Explosives (CCE), Nagpur, India
4. Pollution Control Board
5. Environmental authorities of the State of Assam.
6. Director General of mines & safety.
7. Any other statutory & local authorities.

7.3.1.7.2 Attachments

   a) LIST OF PLOT PLANS
5437-10-04-GC-4001 PLOT PLAN FOR CGGS & OT AT MADHUBAN
5437-20-04-GC-4001 PLOT PLAN FOR GFGS AT BAGHJAN
5437-30-04-GC-4001 PLOT PLAN FOR GGS AT CHABUA

   b) LIST OF STANDARDS
5437-00-04-GC-471 Detail of Septic tank dwg SH 1of 2
5437-00-04-GC-471 Detail of Septic tank dwg SH 2 of 2
5437-00-04-GC-472 Detail of Soak Pit dwg SH 1of 2
5437-00-04-GC-472 Detail of Soak Pit dwg SH 2 of 2
5437-00-04-GC-473 Storm Water Drain details - Rectangular Drain
5437-00-04-GC-474 Detail of Masonry Dyke & Fire Wall
5437-00-04-GC-475 Conc. Pavement dwg
5437-00-04-GC-476 Conc. Platform for Tube Well dwg
5437-00-04-GC-477 Urinal fixing Detail
5437-00-04-GC-478 Dado Details dwg
5437-00-04-GC-479 Skirting Details dwg
5437-00-04-GC-480 Detail of Plinth Protection dwg
5437-00-04-GC-481 Details of Footpath dwg
5437-00-04-GC-482 Funnel for Storage Tank Drain dwg
5437-00-04-GC-483 Floor finish dwg
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<td>OWS Clean Out and Funnel Detail dwg</td>
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<td>Steel Gate at Entrance dwg</td>
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<td>Wash Basin Fixing Detail</td>
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<td>Typical Details Of Buffer Zone Dwg</td>
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<td>Aluminium Window Typical Detail</td>
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<td>9473-00-04-GC-494</td>
<td>Typical Detail Steel Window And Ventilator</td>
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<td>Window Sill and Coping Typical Detail</td>
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<td>Typical Details of Steel Louvers</td>
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<td>Sand trap Outside Tank Farm Area.Dwg</td>
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9473-00-04-GC-552  Typical Adjustable Shelf Dwg
9473-00-04-GC-553  Typical Continuous Wall Mounted Counter For Computer Dwg
9473-00-04-GC-554  Typical Work Table Dwg
9473-00-04-GC-555  Typical Work Table Type-II Dwg
9473-00-04-GC-556  Typical Waste Basket Dwg
9473-00-04-GC-557  Typical Lockers Dwg
9473-00-04-GC-558  Typical Arm Chair Dwg
9473-00-04-GC-559  Typical File Cabinet Dwg
9473-00-04-GC-560  Rolling Shutter Dwg
9473-00-04-GC-561  Typical Steel Door Dwg

c) LIST OF SPECIFICATIONS
9473-00-04-GC-411 Spec. for Concrete Pavement
9473-00-04-GC-412 Spec. for Masonry & Plastering
9473-00-04-GC-413 Spec. for Flexible pavements with premix carpet
9473-00-04-GC-414 Spec. for Misc. civil & Structural work for UG Piping & Other Civil Works
9473-00-04-GC-415 Spec. for RCC Pipe Culverts & ERCS etc.
9473-00-04-GC-416 Spec. for Road and Flexible pavements
9473-00-04-GC-417 Spec. for Stand post type fire hydrant
9473-00-04-GC-418 Spec. for Tank Pads
9473-00-04-GC-419 Spec. for Water Proofing
9473-00-04-GC-420 Spec. for UG Sewer System Pre-cast RCC Pipes
9473-00-04-GC-421 Spec. for C.I. Piping
9473-00-04-GC-422 Spec. for Earthwork underground Piping
9473-00-04-GC-423 Spec. for fabrication and laying of underground piping
9473-00-04-GC-424 Spec. for Hose Cabinet
9473-00-04-GC-426 Spec. for landing valve
9473-00-04-GC-427 Spec. for Floor finishes & Wall tiling
9473-00-04-GC-428 Spec. for Steel doors, windows and ventilators
9473-00-04-GC-429 Spec. for Anti termite Treatment
9473-00-04-GC-430 Spec. for False Flooring
9473-00-04-GC-431 Spec. for False Ceiling
9473-00-04-GC-432 Spec. for Aluminum doors, windows, ventilators & curtain /structural wall glazing
9473-00-04-GC-433 Spec. for Architectural General Trade
9473-00-04-GC-450 Spec. For Lab Equipments
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9473-00-04-GC-466 Spec. for Landscaping
9473-00-04-GC-467 Spec. for Reception Table
9473-00-04-GC-468 Spec. for Painting
9473-00-04-GC-469 Spec. for Door & Window
9473-00-04-GC-470 Spec. For Open Type reservoir with Concrete Lining
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Saipem Triune Engineering Pvt. Ltd.,
New Delhi
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**Saipem Triune Engineering Pvt. Ltd., New Delhi**

**DESIGN BASIS**

**FOR**

**MADHUBAN, BAGHJAN & CHABUA**

**Document Number**

9473-04-DB-001

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1.8 SITE FINISH
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2.5 INSPECTION & TESTING
2.6 STORAGE FACILITY
2.7 SPACING AND LAYOUT
2.8 DRAWING AND DOCUMENTS
2.9 MISCELLANEOUS
2.10 RULES, CODES AND STANDARDS
7.3.4.1 DESIGN BASIS

7.3.4.1.1 Scope

This document covers engineering Design Basis for General Civil Works such as development of plot plan, roads, pavements, storm water drainage, water supply, oily water sewer, tank foundations, dykes, site finishing, fencing, miscellaneous civil works such as barricading, pipe sleepers, pipe way bridges etc. for FGS Chabua, FGS Baghjan & CGGS Madhuvan.

7.3.4.1.2 Codes And Standards

Only latest edition of the codes and standard shall followed. In case of conflict between codes and standards and job specification more stringent requirement shall be prevailed in general. Following codes shall govern:

- OISD-118 Layout for oil & gas installation.
- OISD-189 Stand on firefighting equipment for drilling rigs, work over rigs and production installations.
- OISD-116 Fire Protection Facilities for Petroleum Refineries and Oil/ Gas Processing Plants
- OISD-117 Fire Protection Facilities for Petroleum Depots, Terminals and Pipeline Installations
- OISD-164 Fire Proofing in Oil & Natural Gas Industry
- TAC Tariff Advisory Committee
- OMR Oil Mines Regulations
- IRC-37 Design Code of Flexible Pavement

7.3.4.1.3 Plot Plan

Plot plan shall be developed as per the OISD-118 & OMR inter distances, between process unit, equipment, storage tanks, buildings, boundary wall, flare (ground) and line of adjoining property shall be considered as defined in the above codes & standards.

7.3.4.1.4 Green Belt

5.0m wide green belts inside the plant boundary of the area shall be considered based on local environment for Chabua & Baghjan & 15m wide green belt for Madhuvan.

Height of Fencing : 2 M
Type of Fencing : Wire chain link type with precast
7.3.4.1.5 Roads

5.0m wide space for a road (for maneuvering of jeeps) outside the entire plant boundary shall be provided as buffer zone for security patrolling. Roads shall be provided around (all side) the process area for access & approached for fire fighting (in the event of blockage on one route). Road width, gradient & turning radii at junctions shall be followed as below to facilitate movement of the largest fire fighting vehicle.

**Road Width**

<table>
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<tr>
<th>Location</th>
<th>Roadway</th>
<th>Carriage way</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Main roads for Product movement &amp; Approach to Site.</td>
<td>6.00 M</td>
<td>4.00 M +1.0m wide shoulders on either side</td>
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<tr>
<td>2. Other Roads</td>
<td>6.0 M</td>
<td>4.0 M +1.0m wide shoulders on either side</td>
</tr>
<tr>
<td>3. Foot path</td>
<td>1.0 M</td>
<td></td>
</tr>
</tbody>
</table>

**Design Parameters**

- Camber: 1 in 50
- Radius of curve: 12.0 m for 6.0 m roadway
- Refer standard 9473-00-04-GC-512 ROAD CURVES DETAILS.
- Ruling Gradient: 1 in 30 (in plain terrain) 1 in 20 (in hilly terrain)
- Design of Road crust thickness: As per IRC-37, 2001 for 2.0 msa
- Finish: Bituminous carpet with seal coat of minimum 50 mm thickness.
- Road level above FGL: Min. 0.6 M above F.G.L.

7.3.4.1.6 Entry/ Exit Gate

The width of the gate shall be 5.2 m and height shall be 3.0 m, i.e. matching with the boundary wall height. One wicket gate of 1.5 m width shall also be provided.
7.3.4.1.7  Footpath

1.0 m wide pedestrian walkway & shall be provided all around the boundary wall for security use & 100 thk. PCC 1:3:6 footpath shall be provided.

7.3.4.1.8  RCC Pavements

Pavement Slope : 1 in 100
Type
Vehicular movement area : Type-I (200 mm thick RCC);
Non vehicular movement areas : Type-II (150 mm thick RCC);
Offsite pumps station : Type-III (100 mm thick RCC).
Refer standard
Pavement shall be constructed in panels with provision of construction, expansion / contraction and sealing joints.

7.3.4.1.9  Site Finish

Sites are already graded/developed by owner along with boundary wall. All around the proposed site & following FGL & HPP level shall be indicated by client.

Graded site shall be provided by the Owner any local cut and fill if required shall be done to obtain desired level.

Finished grade levels:

<table>
<thead>
<tr>
<th>Area</th>
<th>R.C.C</th>
<th>Asphalt</th>
<th>PCC</th>
<th>Gravel or stone chips</th>
<th>Compacted earth surface</th>
<th>Stone pitching</th>
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<tr>
<td>CGGS &amp; OT site at Madhuban</td>
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<td>FGS site at Baghjan</td>
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<td>GGS site at Chabua</td>
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<td>CGGS &amp; OT site at Madhuban</td>
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<td>GGS site at Chabua</td>
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</table>

Area as given below shall be provided with top finish.

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<tr>
<th>Type</th>
<th>R.C.C</th>
<th>Asphalt</th>
<th>PCC</th>
<th>Gravel or stone chips</th>
<th>Compacted earth surface</th>
<th>Stone pitching</th>
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<tbody>
<tr>
<td>Operating area</td>
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<td>Non Operating</td>
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<td>Road</td>
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<td>Approaches</td>
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<tr>
<td>Footpath</td>
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</tbody>
</table>
7.3.4.1.10 **Fencing**

Barbed wire fencing of 2.0 m high shall have to be provided outside the buffer zone to enclose OIL’s land area.  
2.0 m high chain link fence shall be provided for Diesel storage tank above ground as enclosure.  
Fencing around pressurized storages (vessel)  
Type : Chain link Fencing (GI) with precast RCC post (M-25) and foundation block M15.

7.3.4.1.11 **Storm Water Drains**

**STORM WATER DRAINAGE**

Storm water drains shall be sized for the higher discharge arising out of rain water. The design intensity of rainfall shall be 100 mm per hour.

Rain water run-off shall be computed by the formula-  
\[ Q = \frac{KIA}{360} \]

\( K \) is run-off coefficient given below,  
\( A \) is area (hectares) contributing to drain,  
\( I \) is rainfall intensity (mm/hr),  
\( Q \) is the discharge.

Design of drains shall be computed by the formula-  
\[ V = \frac{R^{2/3}S^{1/2}}{n} \]

\( V \) is velocity of flow m/s,  
\( R \) is hydraulic radius m,  
\( S \) is slope,  
\( n \) is roughness coefficient taken as 0.013 for plastered surfaces, 0.015 for cast-in-concrete 0.017 for brick lined.

The following parameters shall be ensured while sizing:-

<table>
<thead>
<tr>
<th>Tank Farm</th>
<th>Between Unit &amp; Roads</th>
<th>Parking</th>
<th>Piping Manifold</th>
<th>Road slope</th>
<th>Pipe ways</th>
<th>Open storage / Main Areas</th>
<th>Sphere area (with kerb wall)</th>
</tr>
</thead>
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</tbody>
</table>
Minimum velocity of drains : 0.6 m/s
Maximum velocity of drains : 2.4 m/s
Minimum depth of drains : 300 mm
Minimum width of rectangular drains : 300 mm (for depth < 500 mm)
Minimum width of drains : 500 mm (depth > 500 mm)

Run off co-efficient 'K'

a. Paved area
   Concrete : 1.0
   Bituminous : 0.9

b. Unpaved areas : 0.7
c. Unusable areas like Green belt : 0.4

Drain details

Drain section : (i) Rectangular type covered by hot dipped galvanized MS gratings in and around units.
               (ii) Rectangular type without cover at other places i.e. roadside around building etc.

Material of construction: Brick work with cement plaster.

Culverts

Storm water drains shall cross the road by suitable pipe culverts or box culverts. Design of culverts shall be for heavy crane loads on crane movement roads. Material of construction of culverts shall be as below:

Pipe culverts : RCC pipe class NP3 as per IS:458.
               Minimum Size-350 mm)
               (Encasement shall be provided if clear cover over pipe from road top is less than 600 mm.)

Box culverts : RCC construction. (Minimum M20 Type)

The culverts shall be designed running 2/3 full conditions with minimum velocities as 0.6 m/sec. & maximum as 2.4 m/sec. based on Manning formula. The min. cover over culvert shall be 1200 mm. In case of less cover on pipe culverts, pipe encasement shall be provided.

7.3.4.1.12 Pipe Way Bridges

RCC pipe way bridges shall be provided for crossing of process pipelines under the roads and the width of crossing shall be based on pipe ways. Selection of the type and the size of bridge shall be based on number of pipe & wheel load on slab.

Design Loads : As per relevant IRC loads for roads or expected crane wheel loads whichever is more.
Material of construction

- Foundations & walls: RCC M30 grade
- Precast cover: RCC M35 grade
- Cross section: As per standard

7.3.4.1.13 Sleepers

The RCC sleepers for process piping and fire water lines shall be designed based on the soil bearing capacity (to be ascertained by the bidder during site survey) and the horizontal/vertical loads of the pipes running full. The sleeper shall confirm to standard (minimum requirement). Firewater piping sleepers shall be independent of process piping sleepers. Design of sleepers shall be done taking into account soil conditions as per soil investigation to be carried out.

7.3.4.1.14 Electrical / Instrumentation Cable Road Crossing

- ERC/IRC road crossing: PVC pipe conformed to IS: 4998 encased in concrete as per STEP standard

RCC / brick masonry cable trenches shall be with pre cast cover designed to sustain the maximum load envisaged. Buried cable trenches shall be made, as per electrical / instrumentation standards. At crossings electrical trenches shall be made below the instrumentation trenches. Wherever, storm water drains crosses the trenches, cable shall be taken below drains with RCC duct.

The cable crossing at roads & pipe way shall be either with group of PVC pipes (Min. dia. 150 mm encased with PCC M15) or RCC ducts. Clear cover over top of PVC pipe shall be 1200 mm. In case of less cover, RCC encasement shall be provided.

7.3.4.1.15 Drinking Water System

General

Drinking water shall be provided in the toilet blocks, kitchens, offices and drinking water points at some specified location (to be defined at detailed engineering stage) from the deep tube well with pumping arrangement & over head tank on roof.

Source: Taping from nearest existing water header. Co-ordinates of tapings as per site location. Water header will feed the water from deep tube well after the treatment of water if required.
Distribution Network: Drinking water piping network shall be laid U/G in a closed loop wherever possible. Isolation valves shall be provided at junctions. Valve pit shall be provided for valves in under ground drinking pipes.

Min. Clear Cover: 600 mm in open areas. 1200 mm below road crossings.

**Design Data**

Water demand Plant Service: 270 Liters/capita/day

**Materials**

Pipes (up to 150 mm NB): G.I. as per IS: 1239, heavy
Valves: C.I. gate valve as per IS: 780
Gun metal valves as per IS: 778

**Drinking Water Header**

Drinking water header shall be provided by the EPC contractor and providing drinking water post including internal plumbing, piping, fittings, design, testing & commissioning as per relevant IS codes & specifications.

Underground GI piping shall be minimum dia 2”. The line inside unit boundaries shall be either laid above ground on pipe rack. Drinking water posts at suitable locations. Drinking water headers on rack shall be insulated.

Water treatment shall be based on tube well water quality and suitable to provide potable water with chlorination. Additionally UV type water purifier shall be provided at all drinking water coolers/points.

7.3.4.1.16 **Sewer System**

Underground sewer system shall be as per following categories:

Sanitary sewer system

Oily waste sewer

7.3.4.1.16.1 **Sanitary Sewer System**

**Source**

Sanitary sewer system shall collect waste from all toilet facilities provided in various plant and non-plant buildings & discharge to septic tank & soak pit. Size of septic tank for 50 person shall be considered.

Acids, caustics, hydrocarbons, rain water or other chemical waste shall not be discharged into the septic tank if any.
Estimate of Quantity

The flow shall be based on the following guidelines:

- No. of users.
- Average daily consumption of water.
- Any exceptional requirement due to simultaneous use of fittings in buildings.
- Generally 90% of water supply may be expected to reach the sewer.

The sewers should be designed for minimum of 240 liters per capita per day considering 270 liters per capita day water consumption.

Cover

The minimum cover over top of sewer pipes shall be 600 mm.

Under road, the sewers shall have a minimum cover of 1200 mm and shall be enclosed in cement concrete.

Sewer Design

i) Flow

The sewers shall be designed to a capacity of 3 times the average daily flow.

From the consideration of ventilation in waste water sewer it shall be designed to run half full up to 400 mm diameter, 2/3 rd full from 401 mm to 900 mm diameter and three fourth full for diameter greater than 901 mm at peak flow.

ii) Velocity

Sewers should be designed for a minimum velocity of 0.75 m/sec. at peak flow.

The maximum velocity in the sewers should be restricted to 2.4 m/sec.

iii) Minimum Size

The minimum size of sewer shall be 150 mm for one building (Toilet Blocks) and 250 mm for two or more buildings (Toilet Blocks).

Manning’s Formula as given below shall be used for sizing of sewers.
\[ V = \frac{1}{n} \times (R)^{2/3} \times (S)^{1/2} \]

- **V** = Velocity in m/s
- **n** = Manning’s Coefficient
- **R** = Hydraulic mean depth (m)
- **S** = Hydraulic Gradient

### iv) Manholes

#### Spacing

<table>
<thead>
<tr>
<th>Dia. Of sewers (mm)</th>
<th>Max. spacing of manholes on straight reaches (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 300</td>
<td>30</td>
</tr>
<tr>
<td>301 to 500</td>
<td>45</td>
</tr>
<tr>
<td>551 to 900</td>
<td>60</td>
</tr>
<tr>
<td>901 and above</td>
<td>as per local conditions.</td>
</tr>
</tbody>
</table>

Apart from manholes on straight runs these shall be provided at:

- Starting of sewers
- Junction of sewers
- Change of direction
- Change of gradient or invert level of sewer
- Change of size
- Dead ends of mains.

### v) Drop Manholes

These shall be provided when the difference in elevation of the invert level of the incoming and outgoing sewers of a manhole is more than 200 mm.

Drop from larger to smaller diameter shall not be made. The crowns of the sewers should be kept continuous. In no case the hydraulic flow line of the larger outgoing sewers shall be higher than the incoming one.

### vi) Material

Sewer up to the first manhole shall be CI(IS: 3989 with concrete encasing)pipes.

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**7.3.4.16.2 Oily Waste Sewer (wherever applicable)**
This covers the basic design parameters of oily waste sewer in offsite and tank farms. Oily waste shall be collected and stored in a sump and subsequently pumped to the Central Static Sump.

Sewer Design

Design of sewer of gravity flow shall be as per as given below:

\[ V = \frac{1}{n} \times R^{2/3} \times S^{1/2} \]

- \( V \) = Velocity m/s
- \( N \) = Manning’s Coefficient
- \( R \) = Hydraulic men depth (m)
- \( S \) = Hydraulic gradient

Sewers shall be designed as flowing full with peak flow taking future requirements or flowing 2/3 full without considering expansion. Minimum size of sewer shall be 150 mm.

Minimum velocity at half full shall be 0.6 m/sec. If sewage consists of large quantities of sediments the minimum velocity shall be 1.0 m/sec. subject to a maximum of 2.4 m/sec.

Sewers shall be designed for the sum of rain water and process water or fire water and process water whichever is more. Storm water quantities within tank farm areas shall not be included.

Fire Water Quantities

Sewer which are to drain fire water shall be designed for the following capacities:

i) 2250 liters / minute entering first catch basin.
ii) 1125 liters / minute entering each of subsequent catch basin.
iii) 4500 liters / minute maximum carried by a lateral sewer.
iv) 9000 liters / minute maximum carried by main sewer.

Minimum Sewer Sizes

Sewer lines serving equipment shall be sized for the anticipated flow with following minimum sizes:

i) Lines serving a single discharge point and less than 10 m long shall be 100 mm.
ii) Lines serving two or more points or over 10 m long shall be minimum 150 mm dia.

Cover

Minimum cover over sewer shall be 600 mm, however the sewer shall have cover of 1200 mm under the roads. In case of less cushion, the pipe shall be encased with 150 mm concrete encasing around.

Sewer Appurtenances

i) Manholes

The manholes shall be spaced as per IS: 1742 and IS: 4111 part I and generally as given below:

For sewers up to 300 mm diameter maximum spacing will be 45 m.

For sewers up to 301-500 mm diameter, max. spacing will be 35m.

For sewers above 900 mm dia. spacing depends on local condition.

ii) Location of Manholes

Manholes shall be Located at

Junction of sewers

Dead end of mains

Change of grade or size of mains.

iii) Location of Sealed Manholes

Sealed manholes shall be provided on oily sewers at the following location.

- At connection manhole of branch sewers to main sewers to isolate each facility, contributing oily waste, from the risk of fire. Such connections may be from unit, tank farms, offsite, pump stations, compressor house etc.

- On main oily sewer lines at suitable points so as to provide fire barriers for segregation of vital hazardous installations from each other, along the sewer alignment.

- All sealed manholes shall have air tight covers and vents.
Sewer In Tankage Areas

Storm water shall be controlled by valve outside the dyke.

Water draw off from crude oil slopes of storage tanks shall be through an underground sewer system controlled by valve just outside the dyke.

Storm water from above areas shall be led to sand trap. The discharge from the sand trap shall be connected to the oily waste sewer (if it contains oil or other contaminants) or to an open drain outside the dykes (if the rain water is uncontaminated) through individual valves on the pipes. For diversion of uncontaminated water to storm water drain, bypass arrangement shall be provided with a valve.

Minimum size of sewer carrying rain water shall be 200 mm dia and that carrying draw off from tanks shall be 150mm dia.

Material of OWS Sewer

CS pipes confirming to piping class A3A.

7.3.4.1.16.3 OILY WATER SEWER (OWS)

Waste from equipment drains etc. shall be collected in funnel points and shall be drained through OWS, while uncontaminated areas (normally at periphery of the unit) shall be drained through ditches covered with Hot Dip Galvanised grating. Oily water sewer shall also collect oily waste / drain from pump, equipment through funnel points and shall be drained through OWS.

OWS shall consist of underground carbon steel sewer with corrosion protection tape coating, funnel points, clean out, RCC manholes, vent pipes, flame arrestor etc.

Open ditches of units shall have a bypass either to the OWS or to storm water drains of offsite.

Discharge Data

Design discharge shall consist of:

i) Process flow

ii) Fire water or rain water whichever is more.

Normal design flow shall be 1.1 times of maximum of above two combinations. A PFD of the system shall be made identifying normal flow and design flow. The normal flow shall be equal to average process flow. After the design flows shall be identified, sewer shall be designed for running full. Velocity at minimum flow shall not be less than 0.3 m / Sec.
Sewer Size

OWS sizes shall generally be governed by firewater flow or rain water flow. For first catch basin the sewer size shall be 200 mm. This is based on a fire water flow of 144 cum / hr. Similarly the min. sewer size from the subsequent catch basins shall be 300 mm based on fire water flow of 216 cum / hr. Each lateral sewer serving 4 or more catch basins shall be based on flow of 288 cum / hr. and the sewer size shall be 300 mm. The main sewer size for one unit shall be based on firewater flow of 600 cum / hr. based on unit of one hectare area.

For larger units, the design shall be accordingly established for sewer sizing. If rain water flow exceeds this flow rate, the sewer size shall be decided based on increased flow rate.

All funnel drain shall be of minimum pipe size 100 mm dia. When 2 or more funnels join together, the OWS size shall be 150 mm.

The main oily waste sewer header shall not be less than 200 mm dia. All connections from funnel points shall be fire sealed.

Velocity

The slopes shall be provided so as to have the following velocities with sewers running full.

Minimum velocity 0.6 m / sec.

Maximum velocity 2.4 m / sec.

Cover

The maximum cover over pipes in unit areas shall be as below:

i) 300mm : For the sewer of sizes up to 150 mm from equipment drain points to nearest main header or manhole.

ii) 450mm : For main headers having size 150 mm and above, when located such that there is no chance of truck movement or crane movement over then.

iii) 750mm : For headers in open paved areas when crane or truck movement can be expected. (pipes shall also be encased with 150 mm thick concrete in this case).

Vent Pipes
Vent pipes shall be located along pipe rack columns of building columns and shall be provided 2 m above the building parapet or top layer of pipe rack.

Requirement of sealed manholes

Sealed manholes shall be provided in the following positions.

- On unit oily sewer / contaminated area sewer at the unit battery limit so that unit area is cut off from any fire in offsite area / sewer.

- Within the unit area, sealed manholes shall be provided in such locations so that each sub-unit within the unit is isolated from the other areas. In case this demarcation is difficult, one sealed manhole for every 30 m length of main sewer in the unit shall be provided.

- At change of direction of the line.

- At entry of branch line to manhole or mainline.

Sealed manhole (with vent pipe) shall be used for CS pipes up to 400 mm diameter. For CS pipes greater than 400 mm diameter double compartment type manhole shall be used.

Future Requirement

During erection of main underground headers, two dummy points with caps shall be left in between two manholes / catch basin for joining left over / future connections.

Material

OWS - CS pipe confirming to piping specification with corrosive protection with coating and wrapping suitable for working temperature.

Manhole - RCC (M-20), with manhole, vent pipe, rungs etc.

Discharge from the catch basin (CB) shall be conveyed to a manhole.

7.3.4.1.17 Fire Proofing

Fire proofing shall be provided as per guidelines laid out in OISD-164 (Fire proofing in Oil & Natural Gas industry).

7.3.4.1.18 Barricade

Barricading shall be provided near construction area to prevent damage to existing facilities. The barricade shall be within the plot plan. The height of the barricade shall be; minimum two meters above the highest point of active work.
Barricading sheets shall be 150 mm below existing ground level. The barricade shall be properly designed/ constructed as per BIS codes. The barricade shall be made out of steel framework with galvanized iron sheets. Steel framework and its foundations shall be properly designed/ constructed as per BIS codes. The barricade shall also be provided with suitable piping arrangement to be connected to a pressurized water source to provide necessary water curtain. Any hot work above the point of barricade shall be done after getting the approval from OIL INDIA. After completion of the work, barricading including its foundations shall be removed and the site made good.

7.3.4.2 GENERAL

This design basis is based on various standards, statutory requirements and good engineering practices, which are essential for the design of a sound fire protection system of the given facilities. Applicable standards or codes shall be of OISD, TAC, NFPA, etc. whereas statutory provisions will be vis-à-vis Oil Mines Regulations, 1984 and The Petroleum Rules, 2003. The requirements of the statutory provisions shall take precedence over all standards and codes in case these are comparatively more stringent.

As regards standards and codes, most stringent requirements of relevant OISD standards and TAC codes shall be followed. In case, these standards and codes are moot on certain issues NFPA codes shall be applicable.

Besides, the minimum requirements given in job specific drawings, standard specifications enclosed with the BID document, etc. shall also form part of the design basis and therefore they shall be also considered binding for designing the system.

7.3.4.2.1 Fire Water System

a) Tubewell

Design and construction of a tubewell and providing pumps having yield of 50 m³/hr

b) Fire Water Storage

Easily accessible surface reservoir of RCC with top cover having following minimum features:

i. **Capacity:** Capacity of firewater storage tank shall be at least 850 m³ on the basis of two hours’ aggregate pumping capacity. However, actual capacity shall be finalized during detail engineering.

ii. **Facility for cleaning and repair:** Storage reservoir shall be in two equal interconnected compartments to facilitate cleaning and repairs.
iii. **Emergency**: The installation shall have facilities for receiving and diverting all the water coming to the installation to fire water storage tanks in case of an emergency.

iv. **Location and shape**: Location and shape of the tank shall be as per plot plan.

v. **Floor level**: Floor level of the tank shall be same as that of existing tank.

c) **Fire Water Distribution Network**  
Design and providing fire water system for a minimum residual pressure of 7kg/cm² at the hydraulically remotest point of application at the designed flow rate around the facility with following features:

d) **Looping**  
The fire water network shall be laid in closed loops as far as possible to ensure multi-directional flow in the system. Isolation valves shall be provided in the network to enable isolation of any section of the network without affecting the flow in the rest. The isolation valves shall be located normally near the loop junctions. Flushing arrangements at various loops shall be provided.

e) **Above/ Underground Network**  
The fire water network shall mainly be laid above ground at a height of 300 mm to 400 mm above finished ground level. Piping material for firewater network piping, fittings, valves etc. shall be of CS construction as per enclosed specifications.

However, the firewater network piping shall be laid below ground level at the following places:

- Road crossings.
- Places where the above ground piping is likely to cause obstruction to operation, vehicle movement and places where the above ground piping is likely to get damaged mechanically.
- The extent of underground and above ground header shall be decided during detail engineering by STEP/ Owner.

Mild steel pipes of conforming to relevant standards or other quality of pipe as per requirements of TAC shall be used for underground piping. The piping should be coated and wrapped as per IS: 10221. MS pipes shall be laid 1 m below ground level.

The above ground pipes shall be protected as follow:

- The mains shall be supported at regular intervals not exceeding 6 mtrs having point support.
- The system for above ground portion shall be analyzed for flexibility against thermal expansion and necessary expansion loops where called for shall be provided.
• Above ground fire water sleepers shall be laid on independent sleepers. 100-mm thick 1:3:6 PCC pavement below and around 500 mm both side of sleepers’ way shall be provided.
• Above ground piping shall be painted fire red paint conforming to shade no. 536 of IS:5.

For the protection of underground pipelines following measures shall be taken:
• Underground firewater pipes shall be protected from corrosion by applying coating and wrapping as per specification enclosed in the tender.
• The mains shall have at least one-meter earth cushion in open ground and 1.5 meters cushion under the roads. In case of crane movement areas, pipe may be protected with concrete/steel encasement.
• The mains shall be provided with protection against soil corrosion by suitable coating/wrapping.
• In case of poor soil conditions it may be necessary to provide concrete/masonry supports under the pipe.
• Under ground firewater headers at road crossings shall be laid in concrete sleeves sealing with bitumen mastic at both the ends.

f) Sizing of Ring Main

Firewater distribution ring main shall be sized for 120% of the design water rate. The analysis of network shall be preferably done through a computer programme.

g) Hydrants, Monitors and Accessories

Hydrants, monitors and accessories shall have minimum following features:
• Hydrants and accessories shall be IS marked.
• Water/foam monitors shall be UL/FM approved type.
• Hydrant and monitors shall be located along roadside at appropriate distance from storage or equipment to be protected.
• Double-headed hydrants with two separate landing valves on 100 mm standpost shall be provided with outlet situate 1.2 mtrs. above ground level.
• Connection for fixed water monitors shall be provided with independent isolation valves.
• Adequate nos. of hydrants, water/foam monitors shall be provided as per relevant OISD standards / TAC or STEP/ Owner’s requirements.
• Suitable restriction orifice shall be provided as per design requirement for hydrants.
• Hydrants/ monitors shown on the layout are indicative only. Hydrants to be provided on all headers along roadsides at all locations.
• Contractor to finalize the exact location and nos. of hydrants & monitors etc. as per TAC/OISD requirements.
• All monitors shall be aqua foam type, Standard specification for monitors enclosed with contract document stand updated accordingly.
• Hydrants and/or water monitors shall be located keeping in view the different risks within the premises, which are to be protected, and ensuring effective coverage
• Number of hydrants shall be based on one hydrant /water monitor for every 30 m of external perimeter of process units.
• Monitors shall be as per IS : 8442

h) Water Spray System

In addition to the fixed foam system, FGS Condensate Test Tanks and Condensate Storage Tank in CGGS shall also be protected with medium velocity fixed water spray system and water monitor coverage. Suitable strainers at each tapping point for the spray system shall be provided.

i) Hose Pipes/Branch Pipe/Nozzles

Adequate nos. of hoses of 63 mm diameter as per IS:4927 or IS:636 or IS:8423 shall be provided at least at the rate of two lengths (15m each) per hose box. All coupling of hose pipe shall be of instantaneous spring-lock type and nozzle shall not less than 16mm. All coupling branch pipes and nozzles shall be of gunmetal or stainless steel and comply with IS:903. Number of hose, branch pipes and nozzles shall be as per the requirement of TAC.

Accessories, Consumables & Spares

Fire hoses, hose boxes, water and foam nozzles, spares, consumables, etc. required on the basis of number of hydrants, types of expected fires, etc. shall be procure and supplied. The quantity and quality of these items shall meet requirements of OISD/TAC. Where standards are moot in this regard, the directive of STEP/owner will prevail.

j) Foam System

Mobile Foam System
One no. of portable (trailer) foam monitor shall be provided for pool fire anywhere in the facility. The system should be able to throw only water also as the need arises for fighting fire or exposure protection.

Fixed Foam System & Foam Tanks

Fixed foam system of semi-automatic type shall be provided along with alternate provision for injecting foam with fire tender, for FGS Condensate Test Tanks and Condensate Storage Tank in CGGS. Foam compound storage tank dedicated to the fixed foam system shall be of SS material having capacity of 2 (two) KL.

In diesel unloading/storage areas (FGSs & CGGS) foam/water monitor shall have SS foam tank (one KL capacity) with pick tube connected to the foam monitor.
Quality of Foam Compound

Foam compound supplied for the above foam system shall be AFFF type and UL/FM approved or listed.

7.3.4.2.2 Fire Water Pumps

Main Fire Pumps

Diesel engine driven fire water pumps (1 working + 1 standby) to be provided in FGSs and CGGS will be of 410 m³/hr capacity and the connected firewater storage tank’s capacity will be approximately 850 m³ based on minimum 2 hours’ aggregate pumping capacity. This will satisfy the firewater requirements for FGSs and CGGS as laid down in OISD-STD-189 and TAC for High Hazard (A) occupancy.

The pump shall be capable of discharge of 150% of its rated discharge and minimum of 65% of rated head. The shut off head shall not exceed 120% of rated head for horizontal centrifugal pump.

Firewater pumps shall be TAC/BIS approved type.

The pumps shall have positive suction and the diameter of the suction pipe/header shall be based upon a rate for flow not exceeding 4m/sec.

The pumps shall have automatic starting devices capable of sequential starting. Each pump shall be provided with a non-return valve on the delivery side. The sluice valve will be shall be installed on the upstream side of the non-return valve with a pressure gauge in-between.

Engine

The engine of the fire pumps shall meet all the requirements of relevant OISD standards and TAC codes. However, following are the basic minimum requirements:

i. Power of the engine should match with the pump as per OISD standards and TAC code
ii. Mechanical direct injection type
iii. Automatic starting through battery powered starter at temperature of 7°C without use of any heating devices
iv. Capable of attaining full load within 15 seconds from the receipt of the signal to start.
v. Capable of running on full load for a period of six hours.
vi. Provided with an adjustable governor to control the engine speed within 10% of its rated speed under any condition of load
vii. Provided with an in-built tachometer in indicate engine’s RPM.
viii. Exhaust system provided with suitable silencer.

Battery charger shall be provided to charge the battery in position.
Jockey Pumps

1 working (Electric Motor Driven centrifugal pump) + 1 Standby (Electric Motor centrifugal pump) with capacity 12.3 Cum/hr (3% of designed fire water rate) at network pressure not less than 3 kg/cm².

Fuel Tanks

Independent fuel tank (with appropriate type of level gauge) for each engine, sized for 8 (eight) hours’ continuous running of the pump shall be provided. The tank with feed line/funnel shall be connected to respective engine fuel tank to deliver the fuel without spillage. The tank shall have proper level gauge.

Pump Room

Well ventilated pump room located 6 m away from all surrounding buildings to house pumps and electric/instrument panels. The construction shall meet the requirements of TAC. It will offer minimum obstruction to the convenient handling and hoisting of equipment therein.

The pump room shall have provision for lifting, lowering and handling of firewater pumps, diesel engine, etc. placed therein.

7.3.4.2.3 First-Aid Fire Protection and Hose Boxes

Fire Extinguishers

Fire extinguishers of suitable types and capacities shall be provided strategically and fixed on hangers in all buildings and hazardous areas; and near electrical installations, or any other hazardous locations. Types, capacities and distribution of these fire extinguishers shall conform to the requirements of OMR-84, OISD-189, TAC, NFPA, IS-210, etc.

Hose Box

Hose pipes and nozzle shall be installed near each hydrant in glass fronted hose boxes of suitable design as per relevant standard.

Hose boxes shall be placed on suitable foundations at appropriate height.

7.3.4.2.4 Spares and Consumables

Spares of all fire protection equipment (pumps, engines, hydrants, valves, firewater piping, etc.) and appliances (hose couplings, nozzles, fire extinguishers, etc.) required for next two years after commissioning of the facilities shall be ascertained based on OISD standards/TAC code and got approved by STEP/Owner, and then supplied.

Foam compound (AFFF or equivalent) shall be supplied along with the fire protection system. The quantity of the foam compound shall be equal to 120%
of the quantity required for fighting a full-scale fire in condensate storage tank at each station.

7.3.4.2.5 Inspection & Testing

Detailed inspection and testing procedures shall be developed on the basis of relevant rules, codes, standards and specifications. Following minimum tests but not limited to shall be carried out after completion of the system.

Radiography

At least 10% of all welded joints of firewater piping shall be radiographically tested and at least 50% of welded joints selected for radiography shall be field joints.

Hydroteting

The system shall be capable of withstanding for two hour a pressure equivalent to 150% of the maximum working pressure.

Haliday Testing

Haliday testing for wrapping and coating of MS pipes used for hydrant mains shall be considered essential.

Radiography test certificate and films for welded joints of mild steel pipes and Haliday Test certificate for coating and warping of underground mild steel piping shall be submitted to STEP as soon as the tests are completed.

7.3.4.2.6 Storage Facility

Appropriate facility (15' x 10' approximately) shall be provided for storage of foam jerrycans/drums, additional fire hoses & other fire fighting appliances and parking of portable (trailer) monitor, adjacent to the firewater pump house of each station.

7.3.4.2.7 Spacing and Layout

Overall plot plan and unit plot plan are developed and attached with bid incorporating major safety issues. The layout shall be developed in accordance with the provisions of The Petroleum Rules, OMR, relevant OISD standards and TAC code.

Fire fighting systems of all the three stations shall be finalized taking all statutory requirements, ease of maintenance, safe approach for fire fighting and emergency escape & routs into account.

7.3.4.2.8 Drawings and Documents

Schematic layout/plan of fire water system
i. Layout/plan shall be clear, contain all required details including scale and compass and shall be dated.

ii. Plans should show the entire compound, all buildings (with details) therein, details of arrangements of fire water system, location of fire extinguishers, and other fire fighting appliances.

iii. Plan/layout shall fulfill all the norms required by regulatory and statutory bodies so that this is readily acceptable by them for approval.

**Process and Instrumentation Diagrams (P&ID)**

P&ID for the fire water system shall be developed showing all instrumentation and control.

The above are the minimum drawings and documents which are to be prepared conforming to TAC/OISD or requirements of STEP/Owner and submitted to STEP/Owner for approval.

**List of materials**

A consolidated list of details of major items (pipes, valves, etc.), equipment (pumps, drivers, etc.), accessories (nozzles, hoses, etc.), Fire Extinguishers, spares (for pumps, valves, hydrants, extinguishers, etc.) and consumables (foam, chemical powder, etc.) that will be required in the proposed fire protection system.

**7.3.4.2.9 Miscellaneous**

Contractor shall design the entire fire protection system to obtain maximum rebate on insurance premium.

The schematic layout for fire water system or any information/data described in the present document are only indicative and should be used for reference only.

Hydrants/monitors shown on the layout are indicative only. Hydrants shall be provided on all headers long roadsides at all locations. Contractor shall finalize the exact location and nos. of hydrants and monitors etc. as per OISD/ TAC requirements and STEP/Owner requirements.

The hydraulic calculations for hydrant system spray system and foam system shall be furnished in PIPENET or equivalent internationally accepted computer programme or any programme acceptable by STEP/Owner along with detail layout drawings.

The contractor shall obtain approval of the complete fire protection system of units from TAC or any other statutory body. This includes preparation of all documents, write ups and drawings. Any change/alternations required to be made to meet the requirements of OISD, TAC, etc. shall be done by the contractor without any extra time and cost implication.
For fire/smoke detectors, manual call points, alarm system etc. electrical and instrumentation specifications attached with the bid document shall be refereed to.

Where STEP or Owner recommendations are specified the same shall be given overriding considerations over other requirements as applicable.

In addition to requirements described in previous paragraphs, the following minimum requirements are also to be fulfilled by the contractor:

i. Any other specific fire protection system required or identified during detailed engineering.

ii. Approval of all specifications for fire fighting equipment, accessories, materials, etc. form STEP/Owner before procurement.

iii. All fire fighting equipment, appliances and materials to be procured from OIL approved vendors.

iv. All the equipment of fire water system shall be TAC approved or ISI marked preferably FM/UL approved or listed.

v. Provision of suitable restriction orifice in hydrant system as per TAC requirements.

vi. Provide suitable strainer at each tapping point of spray cooling system.

vii. Flushing arrangements for firewater mains at various locations.

7.3.4.2.10 Rules, Codes and Standards

The contractor will use at least the following minimum rules, codes and standard for accomplishing this project as stated above.

i. The Oil Mines Regulation (OMR) – 1984

ii. The Petroleum Rules, 202

iii. OISD-STANDARD-189 – Standard for Fire Fighting Equipment for Drilling Rigs, Work Over Rigs and Production Installations

iv. Fire Protection Manual – Published by TAC

v. Rules for Fire Alarm System - Published by TAC

vi. NFPA – 13, Standard for Installation of Sprinkler System

EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA
ARCHITECTURE
DESIGN BASIS
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
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7.3.5.1 GENERAL

7.3.5.1.1 Scope

- This document covers the general requirements for the Design of Buildings, Sheds, (not limited to the building types, covered in this specification) so as to provide enough space for operation, maintenance of machinery and provide for the plant workers good and safe environment.

- The design shall be based on Local Statutory requirements.

7.3.5.1.2 Codes and Standards

The Indian codes and standards are applicable, unless otherwise specified. The codes and standards to be followed are as under:

- National Building code of India 1983
- TAC (Tarrif Advisory Comittee) Recommendations

7.3.5.1.3 Related Engineering Specification

All engineering specifications.

7.3.5.1.4 Units

Unless otherwise specified MKS units shall be applied as the measurement system to the Drawings and Documents.

7.3.5.1.5 Priority of Requirements

In case of any discrepancy among the Codes / Standards, related Design Specification and this document (Design Basis), the priority order shall be as under:

- This Document
- Related Design Specification
- Codes and Standards

7.3.5.2 MATERIALS

7.3.5.2.1 General:

All buildings shall be esthetically designed with modern materials. Materials requirements unspecified in Engineering Specifications shall conform to manufacturer’s standards.
7.3.5.3 PLANNING:

7.3.5.3.1 Layout and Elevation:

7.3.5.3.1.1 Layout of Buildings / Sheds shall be simple rectangular shape in general. Spacing of columns shall be unified as far as practicable and shall be determined in consideration of material of construction viz. R.C.C. or Steel.

7.3.5.3.1.2 Requirements of ceiling height shall be as per functional requirements and applicable factory rules.

The height shall be determined considering the clearance from equipment, bus duct, HVAC duct, lighting fixtures, etc.

However for some of the building areas the following minimum ceiling height requirements shall be followed.

**Table - 1 – Ceiling Height**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Minimum Ceiling Height*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimum height of any habitable room</td>
<td>3000 mm</td>
</tr>
<tr>
<td>2</td>
<td>Industrial work places</td>
<td>3600 mm</td>
</tr>
<tr>
<td>3</td>
<td>False ceiling from False Floor / FFL</td>
<td>3000 mm</td>
</tr>
<tr>
<td>4</td>
<td>Control Room</td>
<td>5000 mm</td>
</tr>
<tr>
<td>5</td>
<td>Compressor Shed</td>
<td>As desired by equipment / crane vendor</td>
</tr>
<tr>
<td>6</td>
<td>Workshop</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Fire Water Pump House</td>
<td></td>
</tr>
</tbody>
</table>

*All height dimensions are to underside of ceiling or beams, whichever is lower. The height shall be determined considering the clearance from equipment, bus duct and lighting fixtures etc.

7.3.5.3.1.3 Width of stair shall be 1000mm minimum, unless otherwise specified.

7.3.5.3.2 Building Plinth Height:

Building Plinth Height shall be minimum +450mm from FGL.

The minimum height of outdoor and indoor pedestals (supporting structures) shall be 300mm and 200mm respectively above the highest paving level/ floor finish level whichever is higher. The projection of pedestals for staircase/ ladder shall be 200mm.

7.3.5.3.3 Main Construction:

7.3.5.3.3.1 Main Structural Construction of buildings, such as R.C.C., Steel, combined R.C.C. / Steel and masonry shall be properly selected by confirming to B.I.S. (Bureau Of Indian Standards).
7.3.5.3.3.2 Typical main construction of buildings are given in the following table.

**TABLE – 2 – TYPICAL MAIN CONSTRUCTION OF BUILDINGS**

<table>
<thead>
<tr>
<th>Building</th>
<th>Main Structural Construction</th>
<th>Roof</th>
<th>External Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control room Building, Security Barrack</td>
<td>RCC (With RCC Stair-case)</td>
<td>RCC</td>
<td>Brick Masonry</td>
</tr>
<tr>
<td>Guard Room</td>
<td>Brick Masonry</td>
<td>RCC</td>
<td>Brick Masonry</td>
</tr>
<tr>
<td>Compressor House Building, Watch Tower</td>
<td>Steel (With Steel Staircase)</td>
<td>Steel + Precoated GI Sheeting (With Roof Monitor)</td>
<td>Precoated GI Sheeting</td>
</tr>
<tr>
<td>Shed for Pits</td>
<td>Steel (With Steel Staircase/Ladder)</td>
<td>Steel + Precoated GI Sheeting</td>
<td>Precoated GI Sheeting</td>
</tr>
</tbody>
</table>

Platform shall be in structural steel with grating floors.

7.3.5.3.3.3 All control rooms, check & change room, operator room, view room shall be blast proof.

**7.3.5.4 BUILDING ELEMENTS**

**7.3.5.4.1 Roof**

7.3.5.4.1.1 In case of reinforced concrete framed building, the roof shall be made of cast-in-situ reinforced concrete and shall be made completely waterproof. Proper slope shall be given towards outlets for drainage purpose.

**7.3.5.4.2 Wall**

7.3.5.4.2.1 Internal / partition walls shall be made of common bricks and shall be of minimum 115 mm thick. Surfaces of common bricks shall be finished by cement mortar.

7.3.5.4.2.2 The external / load bearing wall shall be made of common bricks and shall be of Minimum 230 mm thick.

7.3.5.4.2.3 Fire walls (around transformers) shall be minimum 350 mm thick made of fire bricks.

**7.3.5.4.3 Floor**
7.3.5.4.3.1 Floor on grade:

The floor-on-grade is divided into 3 types viz. Type I, Type II and Type III depending on the facility and type of loading. Type wise floor on grade to be adopted shall be as below:-

Table - 3 - Types of Floor on grade

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Facility Name</th>
<th>Type Of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>For Plant Buildings like</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Building</td>
<td>TYPE – I</td>
</tr>
<tr>
<td></td>
<td>Electrical Main Substation Building</td>
<td>- Floor finish as per architectural requirement.</td>
</tr>
<tr>
<td></td>
<td>Fire Water Pumps Building</td>
<td>- Flooring shall be granite type.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 150 mm thick concrete slab(M15) with single layer of 8 mm dia.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tor reinforcement bar @ 200 mm c/c (bothways) at the center of slab.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 50 mm thick Levelling Concrete (1:5:10) below concrete slab.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 150 mm thick compacted sand below Levelling Concrete.</td>
</tr>
<tr>
<td>2</td>
<td>For Buildings like</td>
<td>TYPE - II</td>
</tr>
<tr>
<td></td>
<td>Ware House Shed</td>
<td>- Floor finish as per architectural requirement.</td>
</tr>
<tr>
<td></td>
<td>Workshop Building</td>
<td>- 150 mm thick concrete slab (M15) with layer of 8 mm dia.</td>
</tr>
<tr>
<td></td>
<td>Fire Station Building</td>
<td>- Tor reinforcement bar @ 200 mm c/c (bothways) top &amp; bottom</td>
</tr>
<tr>
<td></td>
<td>Compressor Sheds</td>
<td>- 50 mm thick Levelling Concrete (1:5:10) below concrete slab.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 150 mm thick compacted sand below Levelling Concrete.</td>
</tr>
<tr>
<td>3</td>
<td>For Non-Plant Buildings like</td>
<td>TYPE-III</td>
</tr>
<tr>
<td></td>
<td>Administration Building</td>
<td>- Floor finish as per architectural requirement.</td>
</tr>
<tr>
<td></td>
<td>Laboratory Building</td>
<td>- Flooring shall be granite type</td>
</tr>
<tr>
<td></td>
<td>Security Office/Booth</td>
<td>- 100 mm thick concrete slab (M15)</td>
</tr>
<tr>
<td></td>
<td>Earth Station</td>
<td>- 50 mm thick Levelling Concrete (1:5:10) below concrete slab.</td>
</tr>
<tr>
<td></td>
<td>Canteen</td>
<td>- 150 mm thick compacted sand below Levelling Concrete.</td>
</tr>
</tbody>
</table>
**Note:** - Structural concrete slab shall be cast in alternate panels and no dimension of the panel shall exceed 7.5 m.

Toilets, Kitchens, pantry & dining shall be ceramic tiles finish.

7.3.5.4.3.2 False / Cavity Floor:
Material for false floor shall be made of 35 mm thick unviniard 3 layers flat pressed teak wood particle board with Antistatic PVC tile flooring finish supported by 30 mm Galvanized mild steel seamless pipe.

7.3.5.4.4 Damp Proof Course
Plain cement concrete of mix 1: 1 1/2: 3 of minimum 40 mm thickness (using 100 mm & down size graded aggregates) shall be provided as damp proof course at plinth level of all masonry walls.

Waterproofing compound shall be added to the damp proof course to prevent percolation of water to superstructure.

7.3.5.4.5 False Ceiling:

7.3.5.4.5.1 False ceiling shall be provided in areas wherever air conditioning is required.

7.3.5.4.5.2 False ceiling shall be of 84C aluminum pre coated.

7.3.5.4.5.3 Suitable space shall be kept to enable suitable arrangement of service duct cable, piping and lighting fixtures.

7.3.5.4.6 Doors / Windows / Ventilators:
Following general guidelines shall be applied:
(1) External doors shall be made to open outwards.
(2) Wooden windows / ventilators shall not be used.

7.3.5.4.6.1 Room-wise requirement of door is stated as in the following table.

**TABLE – 4 - DOORS**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Room / Area</th>
<th>Finish</th>
</tr>
</thead>
</table>
3. Toilet, Drinking Water Area, Pantry.  
   Single Shutter PVC Panelled door with Aluminium Frame.

4. Office, Cabins.  
   Single Shutter Anodized Aluminium Glazed door & frame

7.3.5.4.6.2 Pressed Steel Doors  
The pressed steel doors shall conform to IS: 4351.

7.3.5.4.6.3 Aluminum Doors:  
All aluminium doors shall be glazed anodized aluminium doors with closing devices. Doors shall have heavy duty locks and vertical Venetian blinds.

7.3.5.4.6.4 Windows / Ventilators:  
All windows / ventilators for buildings shall be Anodized Aluminium windows / ventilators of industrial type conforming to IS: 1038 / IS: 1285.

7.3.5.4.6.5 Requirement for windows / ventilators is as stated below:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Room / Area</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Windows and Ventilators.</td>
<td>Anodized Aluminium Windows / Ventilators with 5.5mm thick toughened glass.</td>
</tr>
</tbody>
</table>

7.3.5.4.6.6 Fly mesh shutters shall be provided for Kitchen, Pantry, Dining hall windows / ventilators.

7.3.5.4.6.7 Rolling Shutters:

1. Rolling shutters shall be provided wherever area requirement of openable shutters exceed 2500 mm x 2500 mm such as A.C. Plant, Switch gear Room etc.

2. For opening width from 2500 mm to 3000 mm, it shall be manually operated if the opening height is less than or equal of 2500 mm. In case opening height is more than 2500 mm, mechanically operated rolling shutter shall be used.

3. For opening sizes more than 9 m² (or opening width more than 3000 mm), it shall be mechanically operated type, irrespective of the height of the door.
7.3.5.4.6.8 **Partitions:**

Glazed aluminium partitions shall be provided for Console Area, Rack Room, EC/PLC Room, and Operator Room etc. The partition shall be consisting of Anodized aluminium sections for framework and bothside laminated (1 mm thick) MDF board (12 mm thick) lower panels up to 900-1000 mm. Partitions for office areas shall be of 18 SWG MS framework of 52 mm x 38 mm sections @ 600 mm bothways & 12 mm thick Gypsum board panels on both sides finished with plastic emulsion paint.

7.3.5.4.6.9 **Glazing:**

All glazed partitions, doors, windows / ventilators shall be provided with 5.5 mm thick toughened glass.

Toughened tinted glass (5.5mm thick) shall be provided for Doors/ windows in Administration building.

Front Facia of Administration Building shall be provided with 12mm thick Toughened Tinted Glass

7.3.5.4.7 **Hardwares:**

All hardware fittings and fixtures for doors, windows and louvers (e.g. hinges, bolts, locks, latches, stays, door-stops, door closers, floor springs) shall be heavy type matching to the size and weight of the door/ window/ ventilator shutters. These shall operate easily without hindrance secure properly without jamming; require nominal maintenance durable under prevailing site / weather conditions.

7.3.5.4.8 **Steps / Ramps:**

Steps / Ramps shall be provided for access to buildings, sheds for pedestrian / vehicular, equipment entry. Minimum 1000 mm wide platform shall be provided between Entrances door and ramps. Following dimensions of steps / ramps shall be followed:

(a) Tread: 250 mm (Minimum)
(b) Riser: 150 mm (Maximum)
(c) Slope of ramp: Not steeper than 1:6
(d) Ratio of tread and riser
   (i) Non-plant buildings: Riser + tread = 420 to 450 mm
   (ii) Other buildings: 2 Riser + tread = 600 to 648 mm
(e) Minimum width of steps / ramp: 1000 mm

All the flat roofs shall be accessible either by ladder or staircase for maintenance.

7.3.5.4.9 **Canopy / Overhangs / Shading Devices:**
7.3.5.4.9.1 Canopy / Overhangs:

Canopy / overhangs shall be provided at all entries and exits for rain and sun protection as per following requirements.

(a) For all type of buildings such as Laboratories, Administration, Canteen, Control Room, Substation, Security office, Earth Station building etc. Canopy shall be provided to all entrances.

(b) Canopy shall also be provided for stores / warehouses / storage sheds where regular movement of vehicle is anticipated.

(c) Size of canopy / overhang shall be decided based on vehicle parking, covered access to buildings / sheds, movement around the vehicle and aesthetics of building / shed.

(d) Overhangs shall be provided over all exits. Minimum 900 mm overhang shall be provided.

7.3.5.4.9.2 Shading Devices:

Shading devices over windows / ventilators such as chajja shall be provided for rain / sun protection. These devices shall be in the form of horizontal projection, vertical projected fins or combination of both as per building facade treatment. Minimum projection of chajja shall be 600mm.

7.3.5.4.10 Parapet:

Parapets shall be minimum 300 mm high for non-approachable roof and 900 mm high for approachable roof. Parapet upto 600 mm high shall be of R.C.C. In case of future expansion, GI/MS removable railings shall be provided.

7.3.5.4.11 Plinth Protection:

All buildings / sheds shall be provided with 1000 mm wide plinth protection (100 mm thick concrete of grade M15 over 150 mm thick compacted sand layer) all around buildings sheds.

7.3.5.4.12 Roof gutter:

Roof gutter with rain water pipes shall be provided for all the buildings and sheds, shelters for roof water drainage. Gutters shall be of R.C.C. or MS sheet metal type depending on type of structure.

7.3.5.4.13 External Finishes:

(1) Plastering

External surfaces of brick walls shall receive 16 mm thick (1:6) sand faced cement plaster.
(2) Painting

External plastered surface of buildings shall be painted with cement based paint (SNOWCEM or equivalent)

(3) Portico Columns in Administration building and control Room shall be covered with black granite cladding.

7.3.5.4.14 Internal Finishes:

(1) Plastering

For internal surface plastering of concrete and walls shall be done as per schedule given in the following table.

**TABLE – 6 – WALL FINISHES (PLASTERING SCHEDULE)**

<table>
<thead>
<tr>
<th>Building</th>
<th>Room</th>
<th>Floor</th>
<th>Wall</th>
<th>Ceiling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub – Station</td>
<td>General</td>
<td>Surface hardening compound (Nitoflor hard top) over 40mm thick artificial patent stone.</td>
<td>Plastic emulsion paint.</td>
<td>Plastic emulsion paint.</td>
</tr>
<tr>
<td>Battery Room</td>
<td>Acid resisting tiles.</td>
<td>Acid resisting tiles upto 1.0m and Plastic emulsion paint above.</td>
<td>Plastic emulsion paint.</td>
<td>Plastic emulsion paint.</td>
</tr>
<tr>
<td>Compressor House</td>
<td>Inside Area</td>
<td>Surface hardening compound (Nitoflor hard top) over 40mm thick artificial patent stone.</td>
<td>Precoated GI sheeting.</td>
<td>Pre-coated GI sheeting.</td>
</tr>
</tbody>
</table>

- Exterior Finishing of Buildings.

<table>
<thead>
<tr>
<th>Building</th>
<th>Element</th>
<th>Finishing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub – Station</td>
<td>Roof.</td>
<td>Polyurethane Waterproofing.</td>
</tr>
<tr>
<td></td>
<td>All external surfaces and soffit of chajjas.</td>
<td>Exterior Acrylic Emulsion Paint.</td>
</tr>
</tbody>
</table>

(2) Painting

All internal plastered ceilings shall be painted with White Wash.
All internal plastered surfaces of AC Plant, Battery Room, Cable Cellar, Switch gear Room, Blower Room shall be painted with White Wash.

All other internal plastered surfaces shall be painted with Plastic Emulsion Paint.

Note:-

1. 100 mm high skirting shall be provided in all areas.
2. Cement plaster skirting shall be provided in areas having cement concrete, granolithic / heavy duty flooring.
3. For other areas, skirting shall be provided of same material as that of flooring.

7.3.5.5 PLUMBING

7.3.5.5.1 Materials

7.3.5.5.1.1 Water Supply:
‘C’ class galvanized mild steel pipes conforming to IS: 1239 (Part-1:1990) and (Part-2:1992) shall be used for water supply.

7.3.5.5.1.2 Rain water pipes:
Rain water pipes shall be provided to drain off the rain water accumulating on roof efficiently. Nos. and dia. shall be decided on area of roof, slope and rainfall intensity. Rain water down take pipes shall be of PVC (Class -1). Rain water pipes shall be embedded in concrete / brick for administration building, control room, laboratory building, and sub station etc. For other building rain water pipe may be exposed. GI spouts shall be used for drainage of chajjas and small canopies of ground floor only.

7.3.5.5.1.3 Sewage System:
(1) Sand cast iron pipes conforming to IS: 1729-1979 with lead joint shall be used for sanitary / sewage above ground.

(2) Stoneware glazed pipes shall be used for sanitary sewer pipes below ground.

(3) Domestic sewer collected from buildings shall be directed towards septic tank for treatment. Treated water from septic tank shall be discharged to soak pit. Number and capacity of septic tank and soak pit shall be decided based on number of users. Flow from one or more buildings may be combined to common septic tank and soak pit.

7.3.5.5.1.4 Drainage System:
(1) Rain Water from the buildings shall be discharged into the storm water drain through roof gutters and down take pipes.

(2) Unless otherwise specified, the oil contaminated water from buildings shall be connected to the oily sewer system of the plant.

7.3.5.6 OTHERS

Underground pits, drains, cable & pipe trenches and sewer system shall be made water tight as water table during monsoon rises substantially.
7.4 **SCOPE OF WORK FOR STRUCTURAL**
### CLIENT
OIL INDIA LTD., DULIAJAN.

### PROJECT
IMPLEMENTATION OF 1NO. FGS, 1 NO. CGGS & O.T.POINTS

## DISCIPLINEWISE SCOPE OF WORK AND DESIGN BASIS

<table>
<thead>
<tr>
<th>S. NO.</th>
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<th>REV. NO.</th>
<th>DESCRIPTION</th>
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EPMC SERVICES

FOR

CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA

STRUCTURAL

SCOPE OF WORK

FOR

OIL INDIA LTD., DULIAJAN (ASSAM)
CONTENTS

1.0 SCOPE
2.0 DRAWINGS
3.0 SPECIFICATIONS
4.0 CONCEPTUAL DRAWINGS
5.0 REPORTS
6.0 CONSTRUCTION STANDARDS
7.4.1.1 SCOPE OF WORKS

The scope of structural works for the contractor under this contract shall include design & detailed engineering, procurement & supply of materials, items and construction, erection and painting of all relevant works as per specification enclosed with the bid document. The scope as defined herein shall be read in conjunction with scope drawing, Plot plan drawing, Job specifications, Structural design basis, Soil investigation report, Standard specifications, Construction Standards etc attached elsewhere in the bid document.

At the beginning of the project, Contractor shall furnish list of deliverables for OIL/STEP’s approval.

All structural analysis must be done on the basis of Structural Design Basis Doc. No. 9473-05-DB-5001 Latest revision. Licensed STAAD PRO – 2004/2005 software shall be used for the analysis of framed structure.

Soft copies of native files of STAAD PRO and AutoCAD drawings in addition to hard copies shall be submitted to OIL/STEP for review/approval of documents. Deliverables, as required, shall be submitted for OIL/STEP’s approval, before taking up procurement/execution. As built drawings should be submitted to OIL/STEP for record purpose.

Where ever required, proper work permits shall be obtained before start of any work.

Major works involved shall include but not be limited to the following:

Madhuban
Processing Area, Fire Water Reservoir, Fire Water Pump House, Security Barrack, Security Cabin, Watch Tower, Communication Tower, Control Room & Operator’s Cabin, Condensate Tank, Tube Well, Generator Room, Main Gate (Closed With Steel Plate), Wicket Gate (Closed With Steel Plate), Instrumentation Air House, Condensate & Water Separator Facility (Future), Dehydration Facility(Future), Truck Loading Bay, Tank Farm, Process Water Tank, Potable Water Tank, OWS Drain Pit, Effluent Water Tank, Pipe Racks, Cable Trenches, Pipe Bridges, Culverts, Pipe sleepers as indicated in plot plan drawing and as required for the completeness of the job.

Foundations/supports for:

Stationary Equipments

Rotating Equipments
Condensate Loading Pump, Condensate Recycle Pump, Oily Water Pump, Skimmed Oil Recycle Pump, Raw Water Pump, Effluent Discharge Pump

Packages
Ground Flare Package, Instrument Air Package, Water Treatment Package

Baghjan
Processing Area, Fire Water Reservoir, Fire Water Pump House, Security Barrack, Security Cabin, Watch Tower, Control Room & Operator’s Cabin, Tube Well, Generator Room, Main Gate (Closed With Steel Plate), Wicket Gate (Closed With Steel Plate), Instrumentation Air House, Process Water Tank, Potable Water Tank, OWS Drain Pit, Effluent Water Tank, Effluent Treatment
Plant, Pipe Racks, Cable Trenches, Pipe Bridges, Culverts, Pipe sleepers as indicated in plot plan drawing and as required for the completeness of the job Foundations/supports for:

**Stationary Equipments**

**Rotating Equipments**
- Test Condensate Pump, Test Water Pump, Condensate Recycle Pump, CBD Oil Recycle Pump, Oily Water Pump, Skimmed Oil Recycle Pump, Raw Water Pump, Effluent Discharge Pump

**Packages**
- Ground Flare Package, Instrument Air Package, Water Treatment Package, Atmospheric Gauge Tank, Data Header, Water Bath Heater

**Chabua**
Processing Area, Fire Water Reservoir, Fire Water Pump House, Security Barrack, Security Cabin, Watch Tower, Communication Tower, Control Room & Operator’s Cabin, Tube Well, Generator Room, Main Gate (Closed With Steel Plate), Wicket Gate (Closed With Steel Plate), Instrumentation Air House, Process Water Tank, Potable Water Tank, OWS Drain Pit, Effluent Water Tank, Effluent Treatment Plant, Pipe Racks, Cable Trenches, Pipe Bridges, Culverts, Pipe sleepers as indicated in plot plan drawing and as required for the completeness of the job Foundations/supports for:

**Stationary Equipments**

**Rotating Equipments**
- Test Condensate Pump, Test Water Pump, Condensate Recycle Pump, CBD Oil Recycle Pump, Oily Water Pump, Skimmed Oil Recycle Pump, Raw Water Pump, Effluent Discharge Pump

**Packages**
- Ground Flare Package, Instrument Air Package, Water Treatment Package, Atmospheric Gauge Tank, Data Header, Water Bath Heater

Any other structural work required as directed by OIL / STEP for satisfactory and successful completion of the project including supply of material for the same.

For other works viz. Gen Civil, Mechanical, Piping, Electrical, Instruments and Vessels (Fabricated Equipment) scope of work, scope drawings and job specifications, shall also be referred to.

Following drawings are enclosed for reference purpose only.

**7.4.1.2 DRAWINGS**

7.4.1.3 SPECIFICATIONS

i) 9473-05-TS-5001, Rev 0 Geotech Investigation
ii) 9473-05-TS-5002, Rev 0 Reinforced Cement Concrete
iii) 9473-05-TS-5003, Rev 0 Structural Steelwork Fabrication
iv) 9473-05-TS-5004, Rev 0 Structural Steelwork Erection
v) 9473-05-TS-5005, Rev 0 Civil & Structural Works-Materials
vi) 9473-05-TS-5006, Rev 0 Civil & Structural Works-Earth Work
vii) 9473-05-TS-5007, Rev 0 Civil & Structural Works-Misc. Steel Work
viii) 9473-05-TS-5008, Rev 0 Civil & Structural Works-Misc. Items
ix) 9473-05-TS-5009, Rev 0 Structural Design Basis

7.4.1.4 CONCEPTUAL DRAWINGS

i) 9473-00-05-A3-5001, Rev 0 Communication Tower of height 30.0 M.
ii) 9473-00-05-A3-5002, Rev 0 Foundation for Horizontal Vessel
iii) 9473-00-05-A3-5003, Rev 0 Watch Tower with straight height 5.0 M
iv) 9473-00-05-A4-5004, Rev 0 Foundation for rectangular skid mounted equipment
v) 9473-00-05-A4-5005, Rev 0 Foundation for circular skid mounted equipment.
vi) 9473-00-05-A3-5006, Rev 0 Foundation for CBD vessel.
vii) 9473-00-05-A4-5007, Rev 0 Foundation plan for circular steel tank above ground.
viii) 9473-00-05-A4-5008, Rev 0 Rectangular RCC tank
ix) 9473-00-05-A4-5009, Rev 0 Circular RCC tank.

7.4.1.5 REPORTS

Geotechnical Investigation Report

7.4.1.6 CONSTRUCTION STANDARDS

001. RCC works general notes 9473-00- 05-CS-5001 Rev.0
002. Details of non suspended ground floor slab 9473-00- 05-CS-5002 Rev.0
003. Standard hooks and lap splices 9473-00- 05-CS-5003 Rev.0
004. Pedestal details for stair, ladder 9473-00- 05-CS-5004 Rev.0
005. Construction joint details 9473-00- 05-CS-5005 Rev.0
006. Edge details for concrete structures 9473-00- 05-CS-5006 Rev.0
007. VOID
008. VOID
009. Standard lintels 9473-00- 05-CS-5009 Rev.0
010. Reinforcement details at circular cut-out in slab 9473-00-05-CS-5010 Rev.0
011. Reinforcement details at SQ, Rect cut-out in slab 9473-00-05-CS-5011 Rev.0
012. Chequered plate support details 9473-00-05-CS-5012 Rev.0
013. Grating support details 9473-00-05-CS-5013 Rev.0
014. Reinforcement details for pit in RCC slab 9473-00-05-CS-5014 Rev.0
015. Handrail fixing details to concrete structure 9473-00-05-CS-5015 Rev.0
016. VOID
017. Reinf. Curtailment details for cantilevered slab 9473-00-05-CS-5017 Rev.0
018. VOID
019. Details of MS rungs for concrete structures 9473-00-05-CS-5019 Rev.0
020. Cable Trench Details 9473-00-05-CS-5020 Rev.0
021. VOID
022. Structural steel works general notes 9473-00-05-CS-5022 Rev.0
023. Standard grating details 9473-00-05-CS-5023 Rev.0
024. Splicing details for rolled sections 9473-00-05-CS-5024 Rev.0
025. Metal Insert plates general notes 9473-00-05-CS-5025 Rev.0
026. Steel Stair 9473-00-05-CS-5026 Rev.0
027. Standard lugs 9473-00-05-CS-5027 Rev.0
028. Anchor Bolt Details 9473-00-05-CS-5028 Rev.0
029. Crane rail fixing details 9473-00-05-CS-5029 Rev.0
030. Crane bracket details 9473-00-05-CS-5030 Rev.0
031. Beam to beam & beam to column connection details 9473-00-05-CS-5031 Rev.0
032. AC sheeting details 9473-00-05-CS-5032 Rev.0
033. Details of steel ladder 9473-00-05-CS-5033 Rev.0
034. Purlin connection and side runners 9473-00-05-CS-5034 Rev.0
035. Hand Rail 9473-00-05-CS-5035 Rev.0
036. Base plate for angles 9473-00-05-CS-5036 Rev.0
037. C.G.I. Sheeting Details. 9473-00-05-CS-5037 Rev.0
EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA

STRUCTURAL DESIGN BASIS
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
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<tr>
<th>SR.NO.</th>
<th>DESCRIPTION</th>
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<tr>
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<td>LOADS</td>
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<td>3.0</td>
<td>DESIGN METHODS</td>
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<td>MATERIALS OF CONSTRUCTION</td>
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<td>REINFORCED CONCRETE WORKS</td>
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<td>STRUCTURAL STEEL WORKS</td>
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</tr>
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<td>8.0</td>
<td>FIRE PROOFING OF STEEL STRUCTURES</td>
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ANNEXURE I - LIST OF INDIAN CODES & ITB STANDARDS / SPECIFICATIONS TO BE USED

7.4.1 Scope of Work Madhuvan
7.4.2 Scope of Work Chabua (Blank)
7.4.3 Scope of Work Baghjan (Blank)
7.4.4 Design Basis Madhuvan
7.4.5 Design Basis Chabua (Blank)
7.4.6 Design Basis Baghjan (Blank)
7.4.4.1 GENERAL

7.4.4.1.1 Scope

This design basis is intended to be an overview of information for the preparation of designs and detailed drawings of all relevant structural works in Separator, Flare System, Gas Dehydration Unit, Pipe Rack, Water Storage Tank, Condensate Storage and Loading, etc.

All designs shall be carried out as per Job Specifications, Engineering Design basis, Standard Specifications, Standard Drawings and IS Codes / Statutory regulations.

7.4.4.1.2 Brief Description Of Some Of Works / Structures

In general, most of the superstructures will be made of RCC Structures from corrosion point of view, unless noted different inside.

7.4.4.1.2.1 Compressor House (Optional Item)

Super structure of compressor sheds shall be of Structural steel columns and structural steel roof. Size of the shed shall be as per approved Equipment Layout.

7.4.4.1.2.2 Equipment Foundations

All Equipment foundations shall be in RCC construction. Foundations for fabricated equipment (Horizontal vessels / Exchangers) shall be designed for water full condition (hydro test) with 50% wind load. For stacks, vertical vessels 25% wind load shall be considered for test/hydro test condition. Design concept for Machine foundations shall be followed as described in section 7.0 of this document.

7.4.4.1.2.3 Substation Building

Substation Building shall be designed as per the architectural conceptual layout drawing Building shall be completely of reinforced concrete construction. Substation shall have either all or some of unit like Switchgear Room, Cable Cellar Room, Pressurization Plant Room, Battery Room, UPS Room, Staircases, Passage and storeroom, Toilets, Transformer Bays, and Hardware Room, cellar and access staircases, as per requirement. One staircase shall go up to roof of substation. For design concept, pl. refer section 7.0 of this document.

7.4.4.1.3 Site Information

7.4.4.1.3.1 Wind Data

BASIC WIND SPEED - AS PER IS: 875-1987-(PART-3)

Wind direction - As per Wind Rose.
7.4.4.1.3.2 **Seismic Loads**

Seismic forces shall be as per IS: 1893 –2002 (Part-1) for building & other Structures, Seismic zone -V.

7.4.4.1.3.3 **Geotechnical Data**

Geo-technical data for the site shall be as per Geo-technical Investigation report. Which will be available shortly.

7.4.4.1.3.3.1 **Foundation Type And Depth**

This will be furnished once after the Geo-technical Investigation report is available.

7.4.4.1.3.3.2 **Maximum allowable settlements for foundations shall be as follows:**

   a) Foundations in unit areas, utility areas - 25 mm
   b) Foundations supporting non plant- buildings - 40 mm
   c) Foundation for oil storage tanks (Edge settlement) - 150 mm
   d) Machine foundations and critical equipment With interconnected piping - 25 mm

7.4.4.1.3.3.3 **Coefficient of friction**

Steel on steel: 0.3
Steel on PTFE: 0.08
Concrete on soil: 0.4

7.4.4.2 **DESIGN LOADS**

Design loads shall be considered as per IS: 875 and ITB specifications

7.4.4.2.1 **DEAD LOAD**

7.4.4.2.1.1 **Weights Of Specific Material And Construction:**

In estimating dead loads for purpose of design, the actual weights of materials and construction shall be used. Unless noted otherwise, unit weight shall be taken as follows:

<table>
<thead>
<tr>
<th>Unit Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backfill Soil (above GWT):</td>
</tr>
<tr>
<td>1800 Kg/ m³</td>
</tr>
<tr>
<td>Backfill Soil (below GWT):</td>
</tr>
<tr>
<td>800 Kg/ m³</td>
</tr>
<tr>
<td>Reinforced cements concrete:</td>
</tr>
<tr>
<td>2500 Kg/ m³</td>
</tr>
</tbody>
</table>
d) Plain concrete: 2400 Kg/ m³

e) Brick masonry: 2000 Kg/ m³

f) Structural steel: 7850 Kg/ m³

g) Cement mortar/screed: 2100 Kg/ m³

h) False Ceiling: 60 Kg/ m²

i) Heavy duty tar felting: 30 Kg/ m²

j) Staircase (steel): 140 Kg/ m²

k) Ladder: 40 Kg/ m²

l) Operating floor with grating: 100 Kg/ m²

7.4.4.2.2 LIVE LOAD

7.4.4.2.2.1 LIVE LOAD ON FLOORS:

Live load on floors shall comprise of all loads other than dead loads. The minimum live loads on floors for different uses as applicable shall be as given in Table-1. The loads specified in Table-1 are uniformly distributed static loads in KN/m² on plan area and provide for normal effects of impact and acceleration.

Flat roofs, sloping roofs and curved roofs shall be designed for live loads as given in ITB document / IS: 875, (Part II).

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Occupancy or Use (Types of Floor)</th>
<th>Live Load KN/m²</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Compressor House (Optional item)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating Area</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintenance Area</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ground Floor</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Substation/Control Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Panel floor</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Miscellaneous partition</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other areas</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Roof (Flat, Sloping with slopes up to and including 10 degrees)</td>
<td>See Note 2 below</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access provided</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access not provided except for maintenance</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Services supported from below the floor</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Live loads on floors other than those mentioned above, shall be as per IS: 875 (Part-2).
2. For sloping roof with slope greater than 10 degrees, the live load of 0.75 KN/m² less be reduced by 0.02 KN/m² for every degree increase in slope over 10 degrees.

3. 1.0 KN/SQM allowance shall be made for services supported from below the floor.

7.4.2.2.2 Reduction in floor live loads for design of foundations shall be in accordance with relevant clause of IS: 875 and IS: 1893.

7.4.2.3 Static Equipment Loads

a) Empty Weight

The self-weight of equipment including fireproofing, piping, internals, insulation and platforms supported from equipment.

b) Operating Weight

The operating weight shall be empty weight (as defined above) plus weight of operating fluid.

c) Test Weight

The test weight shall be the empty weight (as defined above) plus the weight of water, which can completely fill up the equipment.

When piping weight is not included in the weight of the equipment, 10% weight of the equipment shall be considered as piping weight.

The equipment loads are considered for the design of the members supporting the equipment. In the case of small equipment, the equipment load shall be considered in addition to the live load. However, in the case of large equipment / vessels, live load in the area occupied by the equipment / vessel shall not be considered along with the equipment load.

SPECIAL CONSIDERATION

7.4.2.3.1 Bundle Pull

Bundle pull for different type of Exchangers shall be considered as under:

<table>
<thead>
<tr>
<th>Type</th>
<th>Bundle Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Type</td>
<td>Nil</td>
</tr>
<tr>
<td>Kettle Type</td>
<td>0.30 x Bundle Weight</td>
</tr>
<tr>
<td>All other types</td>
<td>0.86 X Bundle Weight or 30N/mm of diameter (Whichever is greater.)</td>
</tr>
</tbody>
</table>

Total bundle pull shall be considered on fixed pedestal alone.
7.4.4.2.3.2 **Thermal Expansion**

Horizontal force due to thermal expansion of horizontal vessels/exchangers shall be relieved by using slotted holes and slide plates and remaining force derived from the product of the sliding saddle ‘gravity load’ and the coefficient of friction shall be applied on each support.

7.4.4.2.3.3 **Non-Static Loading**

Foundations and structures supporting vessels subject to surge loading such as Deaerators shall be designed to resist a notional horizontal forces of 10% of Vessel’s operating weight or the given surge load whichever is greater. The force shall be applied at the vessel’s C.G. and acting longitudinally/transversely.

7.4.4.2.4 **Mechanical Equipment Loads**

Complete loading data of mechanical equipment such as Pumps, Compressors, Turbines, Motors, and Engines etc. shall be considered as furnished by Vendor.

7.4.4.2.5 **Impact And Vibratory Loads**

In general, machine foundation will be designed Clause. No: 7.1, Structures subjected to impact or vibratory loads shall be designed as per the provisions of IS: 875 & IS: 2974. The following minimum dynamic factors (multiplying factor for calculating equivalent static load) shall be considered for the static design of structure supporting the under mentioned equipment. However, if the manufacturer’s specifications/foundation design input indicate higher factor or actual load (static & dynamic) disposition, the same shall be adopted.

- **PUMP / MOTOR** - 3
- **Reciprocating Equipment** - 3
- **Crane** - As per IS: 875 or as specified by the Manufacturer whichever is maintained.

The above provisions are for the design of such equipment supporting structures only. For independent foundations of these equipment the provisions of IS: 2974 and Job Specification shall be followed.

7.4.4.2.6 **Wind Loads**

Wind loads shall be as per IS: 875 (Part III)

Design wind pressure Pz in N/m² at height “Z” shall be calculated as follows

\[
Pz = 0.6 \times Vz^2 \quad (IS: 875, \text{ Clause } 5.4) \quad (part – III),
\]
Where $V_z = \text{design wind velocity in m/s at height } \text{“}z\text{“}$

$$V_z = V_b \times k_1 \times k_2 \times k_3 \quad (\text{IS: 875, Clause 5.3})$$

Where, $V_b = \text{Basic wind speed} = 50 \text{ m / sec As per IS: 875, (Part 3)}$

$k_1 = \text{Risk coefficient}$

$k_2 = \text{Terrain, height and structure size factor}$

$k_3 = \text{Topography factor}$

The values of coefficients $k_1$, Terrain Category, and $k_3$ (as in IS: 875, Part 3) shall be as given below:

### Type of Structure

<table>
<thead>
<tr>
<th>K1</th>
<th>K3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open structures</td>
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</tr>
<tr>
<td>Enclosed RCC/Clad</td>
<td>1</td>
</tr>
<tr>
<td>Partially closed/clad</td>
<td>1</td>
</tr>
<tr>
<td>Sheds with monitors</td>
<td>1</td>
</tr>
<tr>
<td>Process Columns, Stacks and Stack like structures with height more than 30m</td>
<td>1.08</td>
</tr>
<tr>
<td>Elevated water tanks</td>
<td>1</td>
</tr>
</tbody>
</table>

Note – louvers to be considered as fully clad.

Design wind pressure at different heights for terrain category 2 are as given below:

<table>
<thead>
<tr>
<th>H (m)</th>
<th>K2 Category 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class A</td>
</tr>
<tr>
<td>10 or less</td>
<td>1.00</td>
</tr>
<tr>
<td>15</td>
<td>1.05</td>
</tr>
<tr>
<td>20</td>
<td>1.07</td>
</tr>
<tr>
<td>30</td>
<td>1.12</td>
</tr>
<tr>
<td>50</td>
<td>1.17</td>
</tr>
<tr>
<td>100</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Following force coefficients ($C_f$) shall be adopted:

<table>
<thead>
<tr>
<th>Type of Structure</th>
<th>Pressure Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Structures</td>
<td>As per Table 7 to Table 14</td>
</tr>
<tr>
<td>Roof</td>
<td>As per Table 29</td>
</tr>
<tr>
<td>Shielding effect</td>
<td>As per Table 29</td>
</tr>
<tr>
<td>Clad / Partially clad structures</td>
<td></td>
</tr>
</tbody>
</table>
### DESIGN BASIS

FOR

MADHUBAN, BAGHJAN & CHABUA

<table>
<thead>
<tr>
<th>One side open</th>
<th>As per Figure 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Internal pressure</td>
<td>As per Table 4</td>
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<tr>
<td>- External pressure</td>
<td>As per Table 4</td>
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<td>Buildings with medium and large openings</td>
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<tr>
<td>- Internal pressure</td>
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<td>- External pressure</td>
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<tr>
<td>Roof</td>
<td>As per Table 5 &amp; 6</td>
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<td>Skylight / Monitor</td>
<td>As per Table 5 &amp; 6</td>
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<tr>
<td>Stacks and stack like structure with height more than 30 m</td>
<td>As per Table 20 (dynamic effects shall also be examined)</td>
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<td>Open Structures</td>
<td>As per Table 20</td>
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<tr>
<td>Parapet Walls and fascia</td>
<td>1.3</td>
</tr>
</tbody>
</table>

To allow for surface area of piping, platforms and other attachments fixed to the equipment, the surface area exposed to the wind shall be increased by 20%. Wherever applicable, frictional drag shall be considered in calculation of wind force.

Total Wind Load (F) on the building / Structure as a whole

\[ F = C_f \times A_e \times P_d \]  
(As per Clause No. 6.3 of IS:875, (Part-III))

Where,
- \( C_f \) = force coefficient (As specified in the table above)
- \( A_e \) = Effective area of the object normal to the wind direction
- \( P_d \) = Design wind pressure

### 7.4.4.2.7 SEISMIC LOADS

Seismic forces shall be as per IS: 1893 -2002 (Part-1) for building & other Structures and min mass participation should be 90%.

Whenever STAAD-Pro software is used, mass will be lumped in such a way that c.g. of the mass remains unchanged in STAAD-Pro modeling.

#### 7.4.4.2.7.1 SRSS method will be used in STAAD-Pro with sufficient nos of mode shapes so that mass participating percentage is greater than or equal to 90% in X and Z direction. In absence of vendor data, C.G. of the equipment will be considered at 2/3rd height from base.

#### 7.4.4.2.7.2 Wind and seismic forces shall not be considered to act simultaneously.

#### 7.4.4.2.7.3 Appropriate ductility details shall be provided for steel structures and reinforced concrete structures. Ductile detailing of steel structures shall be carried out as per the provisions of IS: 4326-1993 and IS: 1893-2002. Ductile detailing of reinforced concrete members shall be carried out as per the provisions of IS: 13920-1993.
7.4.4.2.8 Blast Forces

Where required as per OISD – STD-163 / IS: 4991 provisions, structures subjected to blast forces generated due to accidental blasts from hydrocarbon ignitions shall be designed to withstand a minimum pressure of 2.1 T/m² (3 psi).

7.4.4.2.9 Contingency Loads

7.4.4.2.9.1 RCC Structures

All floor slabs and beams shall be designed for a concentrated load of 1 ton acting simultaneously with the uniform live load but not with actual concentrated loads from equipment, piping etc. This load shall be placed to result in maximum moment and / or maximum shear. It shall not be considered for the design of columns, foundations and in overall frame analysis. For floor slab, the load shall be considered to be distributed over an area of 0.75m x 0.75 m

7.4.4.2.9.2 Structural Steel

For process plants, the following contingency additional loading shall be applied to individual beam elements; these shall be applied as point loads to produce worst shear and bending stresses:

- Platform Walkways 3 kN
- Secondary Floor Trimmers 5 kN
- Primary beams 10 kN

7.4.4.2.10 Load Combinations

Design shall be done to resist the worst combination of the loads

7.4.4.2.10.1 BUILDING

Load combinations for buildings shall be as follows:

CASES:

DL – Dead load

LL – Super imposed loads / Live Loads
WL₁ – Wind load (in longitudinal direction)
WL₂ – Wind load (in transverse direction)
SL₁ – Seismic load (longitudinal direction)
SL₂ – Seismic load (transverse direction)

LOAD COMBINATIONS,
DL + LL
DL + LL ± WL₁
DL + LL ± WL₂
DL + LL ± SL₁
DL + LL ± SL₂
DL ± WL₁ or SL₁
DL ± WL₂ or SL₂

Note: Live load in combination with seismic will be same as considered in seismic load, as per IS: 875 –1987 (Part-V)

7.4.4.2.10.2 FOUNDATION FOR STACKS, COLUMNS TOWERS & VERTICAL VESSELS

1. Self weight of equipment & foundation including fire proofing, piping, all loose internals, Insulation, platforms supported from the Equipment = Empty Weight = a
2. Operating weight of equipment as per above (1) including weight of Operating fluid = Operating Weight = b
3. Test weight of equipment as per above (2) except full of water instead of operating fluid = Test Weight = c
4. Live Load (L.L) – On platforms, for first two Platforms consider 50% L.L. on each platform. For rest of the platforms consider 25% L.L. on Each platform = d
5. Wind Load (100 %) = e
6. Wind Load (25 %) = f
7. Seismic Load = g
8. Erection Load– Temporary loads and Forces caused by erection where specified = h
9. Dynamic loads = i (if any)
10. Thermal loads = j (if any)
11. Pipe stress loading = k (if any)

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<th>Test/Stability</th>
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<td>With E.Q. wind</td>
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<tr>
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<td>Test c</td>
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<td>X</td>
<td>X1</td>
</tr>
<tr>
<td>Wind Load e</td>
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<td>25 % Wind Load f</td>
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<tr>
<td>Earthquake Load g</td>
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<td></td>
</tr>
</tbody>
</table>
7.4.4.2.10.3 FOUNDATION FOR HORIZONTAL VESSELS / EXCHANGERS

1. Self weight of equipment & foundation including fire proofing, piping, all loose internals, Insulation, platforms supported from the Equipment = Empty Weight = a

2. Operating weight of equipment as per above (1) including weight of Operating fluid = Operating Weight = b

3. Live Load (L.L) – On platforms, for first two Platforms consider 50% L.L. on each platform. For rest of the platforms consider 25% L.L. on Each platform = c

4. Wind Load (longitudinal) = d

5. Wind Load (transverse) = e

6. Earthquake Load = f

7. Friction load = \( \mu \times \frac{b}{2} \), to be applied on each support or Thermal load, whichever is more = g

Where \( \mu \) = coefficient of friction
Steel to steel = 0.3
PTFE = 0.08

8. Pipe stress loading = h (if any)

9. Bundle pull = I

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<tr>
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<th>Maintenance</th>
<th>Stability</th>
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</tr>
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<td>Dead Load, a</td>
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<tr>
<td>Operating Load, b</td>
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<td>X</td>
</tr>
<tr>
<td>Live Load, c</td>
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<tr>
<td>Wind Load d/e, (50%)</td>
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</tr>
<tr>
<td>Earthquake Load, f</td>
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<td>X</td>
</tr>
<tr>
<td>Thermal, g</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Note;
X = indicates applicable load case
X1 = Live Load as appropriate to seismic

7.4.4.2.10.4 SHED TYPE BUILDINGS WITH CRANE LOADS

A) For design of Roof Trusses
1) DL + LL on roof
2) DL + WL

B) For design of roof for portals
1) DL + LL on roof + crane load + surge
2) DL + WL

C) For design of roof leg
1) DL + LL + surge
2) DL + LL + Surge + WL (50 %)
3) DL + LL (50 %) + Surge (50 %) + WL

D) For design of columns & foundation
1) DL + LL + Surge
2) DL + LL + Surge + WL (50 %)
3) DL + WL (100 %)

Where
DL = Dead Load
LL = Live Load
WL = wind Load

7.4.4.2.10.5 EARTH / LIQUID RETAINING STRUCTURES

EARTH / LIQUID RETAINING STRUCTURES BELOW GROUND

Earth retaining structures such as retaining walls, dry basements etc. shall be checked for the following combinations:

a) DL + LL + Static earth pressure + Pressure due to ground water.

b) DL + Uplift due to ground water (where applicable). (90% of the dead load shall be considered while checking uplift/overturning)

c) DL + LL + lateral pressure due to earth + Pressure due to ground water + lateral forces due to earthquake.

Underground liquid retaining structure shall be designed for the following load combinations:
a) Tank empty and full lateral pressure from outside due to soil surcharge, ground water.

b) (a) + earth pressure due to earthquake.

c) Tank full with liquid with no relief due to active earth pressure considered.

d) (c) + hydrodynamic pressure due to earthquake.

e) For tanks provided with two or more compartments, combinations a to d shall be considered also with one or more compartments empty.

In both the above cases, coefficient of earth pressure will be considered as 0.33.

**7.4.4.2.11 Stability Criteria**

Factor of safety against sliding shall be 1.5 minimum for Operating Load case with wind or Earthquake (with or without Live loads for worst cases) and 1.75 minimum for Operating Load without wind or seismic load case (Plant operating, with or without Live Loads, for worst cases).

Factor of safety against overturning shall be 1.5 minimums for Operating Load case with Wind or Seismic load case (with or without Live loads for worst cases) and 2.0 minimums for Operating Load without wind and seismic load case (plant operating with or without Live loads, for worst cases).

For stability against uplift, the sum of vertically downward loads shall exceed 1.2 x the sum of all vertically upward loads.

**7.4.4.2.12 Soil And Hydrostatic Pressure**

**Pressure on basement walls:** Basement walls and other vertical structures below grade shall be designed for the lateral pressure due to adjacent soil. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or whole of the adjacent soil is below a free water surface, computations shall be based on the weight of the soil diminished by buoyancy (submerged weight of the soil) plus full hydrostatic pressure.

**Uplift on Floors:** Basement floors and other horizontal constructions below grade shall be designed for the upward pressure of water, if any, and the loading shall be taken as full hydrostatic pressure applied over the entire area. The hydrostatic head shall be measured from the underside of the construction. Factory of safety against uplift shall be 1.2. For purpose of calculating downward load due to over burden, the weight for the same shall be calculated for volume over projected plan area only.


7.4.4.3 DESIGN METHODS

In general, the design shall conform to the applicable latest Indian Codes / Standards and shall be in accordance with sound engineering practice. The major applicable Indian Standards are listed in Annexure I.

7.4.4.3.1 Analyses And Design

a) In general, analysis and design shall be done using STAAD-Pro program version 2005, for both structural steel and RCC framed structures. Equivalent reinforcement or greater than STAAD-Pro output design reinforcement result will be provided during detailing. If required, sample critical members design calculation can be furnished for comparison of STAAD-Pro design result.

b) Design of reinforced concrete members shall be by limit state method as per IS 456. Liquid retaining structures shall be designed as per IS: 3370.

c) Design of structural steel members shall be as per IS 800.

7.4.4.4 MATERIALS OF CONSTRUCTION

The requirements of various materials to be used in civil and structural works shall be as per job specification- structural.

7.4.4.4.1 Cement

Ordinary Portland cement 43 Grade conforming to IS: 8112 shall be used for all concrete works. For masonry application, the use of masonry cement (IS: 3466) may be used.

7.4.4.4.2 Reinforcement Bars

High strength deformed steel bars of minimum grade Fe 415, conforming to IS: 1786 shall be used. All the Re-bars in U/g construction shall be given.

7.4.4.4.3 Structural Steel

Structural steel shall be of yield stress of 250 MPa conforming to grade A of IS: 2062. Tubular steel shall conform to IS: 1161 of grade Yst 240 or higher.

7.4.4.5 REINFORCED CONCRETE WORKS:

Design of reinforced concrete work shall be as per IS: 456-2000. Reinforced concrete conforming to IS: 456-2000 shall be used using 20mm and down size graded crushed stone aggregate.

7.4.4.5.1 Grade Of Concrete

The grade of concrete to be used for various types of structural elements shall be as follows: considering environmental exposure condition as severe as per CL. No. 8.2.2 of IS: 456-2000.
For all structures and foundations except M30 (Fck=30 N/mm²)
Grade slabs / paving
Concrete for ground floor / non-suspended M30 (Fck=30 N/mm²)
Concrete foe encasing (10mm down aggregate) M30 (Fck=30 N/mm²)

Where Fck is the characteristic compressive strength at 28 days of concrete cube specimens as per IS: 456-2000.

75mm thick lean concrete of grade M 7.5 (nominal mix 1:4:8) shall be provided under all RCC foundations except under base slab of liquid retaining structures where 100mm thick concrete of Mix M 10 (nominal mix 1:3:6). The lean concrete shall extend 50 mm beyond the foundation for normal foundations and 75mm under liquid retaining structures
Plain cement concrete (PCC) of grade M 7.5 (nominal mix 1:4:8) of minimum 150mm thickness shall be provided under all masonry wall foundations.

7.4.4.5.2 Minimum Cover To Reinforcement

The minimum clear cover to the steel reinforcement including links for various structural concrete elements shall be as follows unless stated otherwise

Slab (roof & floors, canopy, cantilever, waist slab) 20 mm if bar dia. is less than or equal to 12mm; 20 mm otherwise

Beam (roof, floor & lintel)
45 mm or dia of bar

Whichever is greater.

Column, Pedestal
45mm above FGL
75mm below FGL

Retaining Wall, Basement and Pit Wall
a) Face in contact with earth 75mm
b) Free face 45mm or dia of bar whichever is greater.

Liquid Retaining Structure

a) Face in contact with liquid 30mm or dia of bar

Whichever is greater.
b) Face away from liquid but in contact with earth 75mm
c) Free face 30mm or dia of bar
Whichever is greater.

Foundation Slab, base slab, plinth beam (Top, Side & Bottom) Pile Cap

75mm

a) Bottom face
100mm

b) Top face
75mm

7.4.4.5.3 Minimum Thickness Of Structural Concrete Elements

Footing (All type including raft foundations Without beams)
300mm

(Note: Tapered footings shall not have thickness less than 150mm at the edges. Minimum average thickness shall not be less than 300mm)

Pile Cap
500mm

Slab thickness in Raft foundation with beam & slab construction
225mm

Basement Walls & Base Slab
150mm

Floor / Roof Slab, Walkway, Canopy, Slab resting on beams
125mm

Cable / Pipe Trench / Launder Walls & Base Slab
100mm

Parapet, Cantilevered Canopy Slab
75mm

Louver / Fin
50mm

Pre-cast Trench Cover / Floor Slab
100mm

Pre-cast floor slab/Louver (in contact with liquid)
100mm

Liquid retaining / Leak-proof Structure Walls & Base Slab
150mm

Underground Pit / Reservoir Walls & base slab (Below ground Water table)
250mm

Underground Pit / Reservoir (Above ground Water table) Walls & Base Slab
200mm

Ground Floor Slab (Non-suspended)
150mm
7.4.4.5.4 Minimum Reinforcement

The minimum diameter of reinforcement bar for slab, beam stirrups and column ties shall be 8mm and for foundation slabs and vertical walls it shall be 10mm. The maximum spacing of these bars shall be as per IS: 456 but shall be restricted to 300mm c/c. For other elements, the minimum reinforcement shall be as per IS: 456.

7.4.4.5.5 Minimum Height Of Pedestals

The minimum projection of pedestals supporting equipment/structures above the highest pavement/finished grade/finished floor level shall be as per requirement.

7.4.4.5.6 ANTI-TERMITE TREATMENT

All RCC building shall be provided with anti-termite treatment As per IS: 6313. Material shall be as per IS: 8944.

7.4.4.6 Structural Steel Works

Design of structural steel work shall be as per IS: 800.

7.4.4.6.1 Allowable Deflection Of Steel Structure

The maximum deflections for the structures are limited to the following values:

- Gantry girder for electric overhead crane:
  Span / 750
  (Capacity up to 50 T)

- Gantry girder for electric overhead crane:
  Span / 1000
  (Capacity over 50 T)

- Gantry girder for manually operated crane:
  Span / 500

- Girder beam supporting dynamic equipment hoist: Span / 450

- Grating / Chequered plate:
  Span / 200 or 6 mm

- Purlins supporting any type of roofing material: Span / 200
  Under (dead load – live load) or (dead load-wind load)

- Other structural components:
  As specified in relevant IS codes
Note: The limiting permissible horizontal deflection for multi storied steel structure / building frame shall be height / 325

7.4.4.2 Slenderness Ratio Of Compression Members

Slenderness ratio of members shall be as per IS: 800.

7.4.4.3 Permissible Stresses

The permissible stress shall be as per relevant IS codes.

7.4.4.4 Bolts

Minimum size of bolts shall be 16mm. (10mm & 12mm can be used for misc. structures)

Minimum center-to-center distance of bolts shall be 2.5 times nominal diameter.

Minimum distance from the center of the bolt to the edge of the plate is given below:

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<th>Sheared or Manual flame cut edges</th>
<th>Rolled Automatic flame cut sawn or milled edges</th>
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<td>10</td>
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7.4.4.5 Connections

In general, welding will be used for fabrications and joint connections. However in few cases like shear connection, bolted connections may be adopted. For removable type beams, bolted connections will be used. Welding shall be done as per IS 816, 823 & 861 (latest). Bolting shall be done as per IS: 1363, 1364 & 1367 (latest).

7.4.4.7 DESIGN CONCEPT

7.4.4.7.1 Machine Foundation

The machine/equipment foundation shall be designed and detailed as per job specification and IS: 2974. However, appendages to such foundations shall be reinforced suitably to ensure integral action.
All machine / equipment foundations shall be separated from adjoining parts of building, other foundations and floor / pavements slabs. Joints at floor / pavement slab shall be suitably sealed.

The soil pressure below the foundations, under the dead load case, shall not be allowed to exceed 80% of the net SBC of the soil or the pile capacity.

The raft foundations shall be provided with 15% extra reinforcement over and above that required as per design.

Foundations and structures for machines subject to vibrations, shall be so proportioned, that the amplitude and frequency of the foundations / structures are within the permissible limits as per relevant IS codes.

Machine foundations shall be so designed that the natural frequency of the foundation system shall not resonate with the following:

a) Operating speed of motor.
b) Operating speed of machine.
c) 2 x operating speed of the machine.
d) Critical speed of the machine (for centrifugal machines)

The natural frequency of the foundation shall be ± 20% away from the above-mentioned frequencies. However, the amplitudes of vibration of the foundation block shall always be checked to be within permissible limits.

When several foundations for similar machines need to be seated on a common raft, the computation of the vibration shall proceed assuming that each machine foundation is independent of others by breaking the raft into sections corresponding to separate foundations. The design value of the amplitude shall be increased by 30%.

Dynamic analysis of compressor foundation and amplitude calculation will be done by STAAD-Pro / STARDYNE software / Excel calculation.

7.4.4.7.2 Substation

3D STAAD-Pro modelling shall be done for analysis and design. To give the stability to panel floor slab, longitudinal beams will be provided all along the panel cutout. STAAD-Pro modelling will include transformer cross- brick wall supporting framework, which will be supported on single pile/cap connected by foundation tie beams in both directions. In seismic analysis, mass modelling will be done in such a way, that C.G. of the mass remains unchanged.

In STAAD-Pro modelling, mass of the slab will be considered but slab itself will not be modeled and stiffness of slab is ignored. However peripheral floor / roof beams will not be considered to carry any horizontal bending moment, as the slab, because of in plane rigidity, will provide diaphragm action. If required, floor / roof beams may be designed as T-beam for span moment using Excel sht.
Lintel beams on the transformer side will be provided in such a way that it clears the transformer bus duct. For stability of panel brick wall, it will be considered supported on all four sides. Necessary holdfasts will be provided for transferring shear from panel brick wall top edge to the beam. Deflection of slab and beam will not be checked if stiffness criterion as per IS: 456-2000 is satisfied.

### 7.4.4.7.3 Compressor House (Optional Item)

3D STAAD-Pro modeling shall be done for analysis and design. Crane leg, consisting of two joists and adequately laced / braced, roof leg, roof portal, roof monitor, gantry walkway level bracings, rafter bracings, vertical bracings, gable end column will be modeled. Impact factor, surge, L.L., wind load will be considered as per IS: 875 / bid document. In the long direction, compressor shed will be considered as braced frame. Both the crane legs will be braced in the vertical plane in the long direction in end bays, subject to clearance for piping. Surge (transverse) loading from the crane will be transferred to main framing system through horizontal bracings at the gantry walkway level. Surge (longitudinal) from the crane will be transferred to the vertical bracing system in the long direction. Gantry girder will be designed as simply supported.

### 7.4.4.8 FIRE PROOFING OF STEEL STRUCTURE (As & if applicable)

<table>
<thead>
<tr>
<th>General</th>
<th>Steel structures requiring fire proofing shall be adequately fire proofed as per OISD-STD-164 (Fire Proofing in Oil &amp; Gas Industries)</th>
</tr>
</thead>
</table>

Saipem Triune Engineering Pvt. Ltd., New Delhi

DESIGN BASIS FOR MADHUBAN, BAGHJAN & CHABUA

Document Number Rev

9473-05-BD-001 0

Sheet 218 of
Latest revision of Codes / Standards shall be followed, as applicable, unless specified otherwise

1. **Concrete & Steel Design**

- IS: 456  - Code of Practice for Plain & Reinforced Concrete
- IS: 3370 - Code of Practice for concrete structures for storage of liquids
- IS: 4326 - Code of Practice for Earthquake Resistant Design and construction of buildings
- IS: 4991 - Criteria for blast resistant design and construction of buildings
- IS: 5525 - Detailing of reinforcement in RCC works
- IS: 8112 - 43 Grade OPC
- IS: 13290 - Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces
- IS: 800  - Code of Practice for general construction in steel
- IS: 816  - Code of Practice for use of metal Arc Welding for general construction

2. **Foundation Design**

- IS: 1080 - Code of practice for design and construction of Shallow foundations on soil
- IS: 1904 - Code of practice for design and construction of foundations in soils, General requirements
- IS: 2950 - Code of practice for Design of Raft Foundations
- IS: 5249 - Determination of dynamic properties of soil
- IS: 6403 - Code of practice for determination of bearing capacity of shallow foundations
3. **Loading Standards**

- IS: 875 - Code of practice for design loads for buildings and structures.
- IS: 1893 - 2002 Criteria for earthquake resistant design of structures.

4. **Cement**

- IS: 8112 - Specification for 43 Grade Ordinary Portland Cement (OPC)
- IS: 1489 - Specification for Portland Pozzolona Cement (PPC)

5. **Reinforcement**

- IS: 432 - Mild Steel Bars
- IS: 1786 - Cold Twisted Steel Bars
- IS: 2502 - Bending and fixing of bars for concrete reinforcement
- IS: 5525 - Detailing of reinforcement in RCC works

6. **Structural Steel**

- IS: 2062 - Steel for General Structure Purposes
- IS: 1161 - Steel tubes for structural purpose
- IS: 1363 - Hexagon Head Bolts, Screws & Nuts

7. **Design Aids**

- SP: 6 - Structural Steel Handbook
- SP: 7 - National Building Code of India
- SP: 16 - Design Aids for Reinforcement Concrete
- SP: 22 - Explanatory Handbook on Codes of Earthquake
7.5 SCOPE OF WORK FOR ELECTRICAL
CLIENT : OIL INDIA LTD., DULIAJAN.
PROJECT : IMPLEMENTATION OF 1NO. FGS, 1 NO. CGGS & O.T.POINTS

DISCIPLINEWISE SCOPE OF WORK AND DESIGN BASIS

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EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA

ELECTRICAL

SCOPE OF WORK
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)
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<td>3.0 CONTRACTOR’S SCOPE OF WORK</td>
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</table>
7.5.1.1 INTRODUCTION

M/s OIL India Limited (OIL), a government of India Enterprise presently engaged in exploration, drilling, production and transportation of crude oil and natural gas desires to hire the services of reputed contractors for detail design & turnkey execution of 2Nos. of Non-associated gas production facilities one each at Baghjan & Chabua and one No. gas off-take point at Madhuban, Duliajan in upper Assam India.

7.5.1.2 ELECTRICAL SCOPE OF WORK

7.5.1.2.1 General requirements

This specification describes the brief scope of work and design criteria to be followed by the contractor for the electrical work for the facilities covered in the bid package. The electrical shall consist of design, detailed engineering, supply, erection, testing and commissioning, operation & Maintenance of the complete electrical facilities including supply of all consumables, tools & tackles, equipment/gadgets required for proper Installation, commissioning, operation & maintenance of Electrical system. Preparation of equipment specifications, data sheets, drawings and standards are also included in bid package.

The electrical system shall be designed to provide:
- Safety to personnel and equipment.
- Reliability of service.
- Minimum fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Electric supply to electrical equipment and machinery within the design operation limits.
- Adequate provision for future extension and modification.
- Maximum inter-changeability of equipment.
- Fail-safe feature.

7.5.1.3 CONTRACTOR’S SCOPE OF WORK

The complete electrical facilities for the scope covered in the bid package are included in contractor’s scope of work. All the new Electrical Equipments, associated cabling as required, earthing etc. shall be provided for the proposed new packages. Accordingly the contractor’s electrical scope of work shall included but not limited to the following:

7.5.1.3.1 Design and engineering

Engineering activities to be performed by contractor shall include but not limited to the following:

(i) Pre – engineering survey and collection of relevant data / drawings from site.
(ii) Basic Engineering calculations viz. load analysis, fault level calculations, generator sizing calculation, voltage drop, cable sizing, lighting, earthing, lightning protection, protection coordination.
(iii) Preparation of electrical load list of all electrical equipments and motor list indicating tag nos., designation, kW & Voltage rating, type, manufacturer's name, frame size, enclosure type, speed mounting details, etc. The approval number from DGMS for hazardous area equipment shall also be reflected in load and motor list.

(iv) Preparation of Data sheets for generators, motors, switchgears, panels, UPS, cables etc.

(v) Preparation of single line diagram of MV switchgear & Control panels.

(vi) Preparation of GA drawings of MV Switchgear & Control Panels.

(vii) Preparation of electrical Power Distribution Plan, Internal communication system design (comprising of portable VHF Trans-receivers, Telephone, Fire alarm, CCTV System, etc.), connection diagram for the electrical equipment such as motors, push button stations, electrical heaters etc. associated with the package.

(viii) Preparation of Control & Protection Schematics, annunciation schemes, etc.

(ix) Preparation of area classification drawings and specify the type and requirement of certifications for the equipments to be used in hazardous areas.

(x) Preparation of complete electicals for package equipments.

(xi) Preparation of complete cable schedule.

(xii) Sizing calculations for cable trays, cable trenches, MCTs etc.

(xiii) Preparation of Bill of Materials for cabling, earthing, lighting, lightning protection & other miscellaneous items.

(xiv) Preparation of various Electrical Layout drawings such as substation and substation equipment, equipment layout for the area, cabling layout (With routes marked for buried cables), earthing layouts (With details of Electrodes & straps) & complete lighting layout showing the final positions of High masts, Lighting poles/structures and type & rating of luminaries, lighting transformers & related switchgears, lightning protection (With dissipation array technology for storage tanks), etc.

(xv) Preparation of equipment installation and cable termination drawing.

(xvi) Preparation of interconnection drawings, terminal diagrams including all hook – up drawings.

(xvii) Preparation of inspection and testing procedures for all electrical equipments.

(xviii) Preparation of as built drawings and operation & maintenance manual.

(xix) Any other works / activities which are not listed above, however, necessary for completeness of electrical system.

All detail engineering drawings, enquiry / purchase specifications, equipment sizing and selection, type and make of equipment shall be subject to approval of company or his authorized representatives. No equipment shall be purchased unless the make and type are approved by the company or its authorized representative in writing. All equipment shall be new and in first – class condition. All signs, labels, drawings, manuals and operations instructions shall be in English.

7.5.1.3.2 Supply, installation, testing, commissioning of following equipment including all procurement activities like preparation of material requisitions, technical
queries, tech. bid analysis, purchase requisition, vendor drawing checking, inspection, etc.

i. 2 Nos 350kVA, 415V, 50Hz, 0.8pf Gas Generator set with Auto Mains Failure (AMF) panel with paralleling facility and all other necessary accessories each at Chabua and Baghjan.

ii. 1 No 125 KVA, 415V, 50Hz, Diesel Generator set (For black start) with all other necessary accessories each at Chabua and Baghjan.

iii. 2 Nos 500kVA, 415V, 50Hz, 0.8pf Gas Generator with Auto Mains Failure (AMF) panel with paralleling facility and all other necessary accessories at Madhuban.

iv. 1 No 63 KVA, 415V, 50Hz, Diesel Generator set (For emergency load) with all other necessary accessories at Madhuban.

v. All DG sets shall have day oil tank of 12hrs capacity which shall be made integral to the base frame as against separate tank.

vi. Suitable rated 415 V AC PMCC at each location.

vii. 2 Nos Lighting Distribution Board one each for non hazardous and hazardous area lighting for each location of rating as required.

viii. 1 No 415/240 V 3 phase Lighting transformer of suitable rating as required for hazardous area lighting for each location.

ix. 1 No 415/440 V 3 phase Lighting transformer (with neutral solidly earthed) of suitable rating as required for non hazardous area lighting for each location.

x. 1 No 40 KVA and 2 Nos. 30KVA UPS and UPS Distribution Board for Madhuban, Baghjan and Chabua, respectively.

xi. Indoor and Outdoor Lighting boards.

xii. Indoor and Outdoor Lighting fixtures and lighting poles with all accessories.

xiii. 30 meters High Mast GI Lighting Poles with control gear box/junction box and all other accessories.

xiv. LV Power and Control Cables. RCC cable trenches, however, in case cables are buried, depending upon site requirement, then buried cable route shall also be marked.

xv. Earth electrodes and earth strips.

xvi. Internal communication system (The system shall comprise of microprocessor based electronic exchange( EPABX), Telephone system, Main Distribution Frame(MDF), back up power supply system, intercom, Fire alarm & CCTV System, Local communication facility using portable VHF Trans-receivers between the control room and the Operator room , An Air Conditioned switch room in the Control room, Power backup for the telephones / IT equipment, Wiring for all telephone connections inside the building as well as building to building/location., Separate concealed conduit for Computer network cabling, Supply & Erection of a self supporting tower / guyed mast for radio communication system, etc.)

xvii. Any other equipment not listed above but necessary for completeness of the electrical system.
7.5.1.4 CODES AND STANDARDS

The design, installation, testing & commissioning shall be as per established codes, standards, sound engineering practices. STEP standards and shall conform to the statutory regulations applicable in the country. The main codes, standards and statutory regulations are as follows. The latest edition of these shall be followed.

7.5.1.4.1 STATUTORY REQUIREMENTS

- Indian Electricity Rules
- Indian Electricity Act.
- The Factory Act.
- The Mines Act. (DGMS)
- The Petroleum Rules (Ministry of industry, Govt. of India)
- Sate Electricity Rules
- National Electric Code, USA
- OISD Guidelines

7.5.1.4.2 INDIAN STANDARD

| IS  | 5216 | Guide for safety procedures and practices in electrical works. |
| IS  | 5728 | Guide for short circuit calculations |
| IS  | 5572 | Classification of hazardous area |
| IS  | 5571 | Guide for selection of electrical equipments for hazardous area. |
| IS  | 8239 | Classification of maximum surface temperatures of electrical equipment for use in explosive atmosphere. |
| IS  | 3202 | Code of practice for climate proofing an electrical equipment |
| IS  | 585  | Voltage and frequency for AC transmission and distribution system. |
| IS  | 3716 | Insulation coordination application guide. |
| IS  | 732  | Code of practice for electrical wiring installations – system voltages not exceeding 650 V. |
| IS  | 2274 | Code of practice for electrical wiring installation – system voltages exceeding 650 V. |
| IS  | 6665 | Code of practice for industrial lighting |
| IS  | 3646 | Interior illumination: Part i and Part-ii |
| IS  | 1944 | Code of practice for lighting of public thoroughfares. |
| IS  | 7689 | Guide for control of undesirable static electricity. |
| IS  | 2309 | Protection of buildings and allied structures against lighting |
### DOCUMENTS

In addition to the above mentioned Codes and standards, the following documents shall be used as guidelines by the contractor for carrying out all activities:

<table>
<thead>
<tr>
<th>Document Description</th>
<th>Document Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Design Basis</td>
<td>9473-00-06-DB-001</td>
</tr>
<tr>
<td>Electrical Installation Standards</td>
<td>9473-00-06-DB-002</td>
</tr>
<tr>
<td>Single Line Diagram (Madhuban).</td>
<td>9473-10-06-A1-6002</td>
</tr>
<tr>
<td>Single Line Diagram (Baghjan).</td>
<td>9473-20-06-A1-6000</td>
</tr>
<tr>
<td>Key Area Classification drawing-Madhuban</td>
<td>9473-10-06-A0-6005</td>
</tr>
<tr>
<td>Key Area Classification drawing-Chabua</td>
<td>9473-30-06-A1-6004</td>
</tr>
<tr>
<td>Key Area Classification drawing-Baghjan</td>
<td>9473-20-06-A1-6003</td>
</tr>
<tr>
<td>Sub Station Equipment layout-Madhuban</td>
<td>9473-10-06-A1-6014</td>
</tr>
<tr>
<td>Sub Station Equipment layout-Chabua</td>
<td>9473-30-06-A1-6013</td>
</tr>
<tr>
<td>Sub Station Equipment layout-Baghjan</td>
<td>9473-20-06-A1-6012</td>
</tr>
<tr>
<td>Overall lighting layout-Madhuban</td>
<td>9473-10-06-A1-6011</td>
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<tr>
<td>Overall lighting layout-Chabua</td>
<td>9473-30-06-A1-6010</td>
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<tr>
<td>Overall lighting layout-Baghjan</td>
<td>9473-20-06-A1-6009</td>
</tr>
<tr>
<td>Load list Madhuban</td>
<td>9473-10-06-LT-003</td>
</tr>
<tr>
<td>Load list Chabua</td>
<td>9473-30-06-LT-005</td>
</tr>
<tr>
<td>Load list Baghjan</td>
<td>9473-20-06-LT-004</td>
</tr>
<tr>
<td>Technical Specification for Medium Voltage Switchgear</td>
<td>9473-00-06-TS-002</td>
</tr>
<tr>
<td>Technical Specification for Power and Control Cables</td>
<td>9473-00-06-TS-004</td>
</tr>
<tr>
<td>Technical Specification for UPS System</td>
<td>9473-00-06-TS-006</td>
</tr>
<tr>
<td>Technical Specification for Lighting &amp; Power</td>
<td>9473-00-06-TS-008</td>
</tr>
<tr>
<td>Distribution Board</td>
<td></td>
</tr>
<tr>
<td>Data sheet for Medium Voltage Switchgear Madhuban</td>
<td>9473-10-06-DS-PMCC-0001</td>
</tr>
<tr>
<td>Data sheet for Medium Voltage Switchgear Chabua &amp; Baghjan</td>
<td>9473-00-06-DS-PMCC-0001</td>
</tr>
<tr>
<td>Data sheet for Power &amp; Control Cables (Madhuban, Chabua &amp; Baghjan)</td>
<td>9473-00-06-DS-CAB-0001</td>
</tr>
<tr>
<td>Data sheet for UPS - Madhuban</td>
<td>9473-10-06-DS-UPS-0001</td>
</tr>
</tbody>
</table>
Data sheet for UPS - Chabua & Baghjan 9473-00-06-DS-UPS-0001
Data sheet for Lighting & Power - Madhuban Distribution Board 9473-10-06-DS-PDB-0001
Data sheet for Lighting & Power - Chabua & Baghjan Distribution Board 9473-00-06-DS-PDB-0001
EPMC SERVICES
FOR
CGGS & OFF TAKE AT MADHUBAN
AND
FGGS AT BAGHJAN & CHABUA
ELECTRICAL DESIGN BASIS
FOR
OIL INDIA LTD., DULIAJAN (ASSAM)

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
<th>Standard Number</th>
<th>Rev</th>
</tr>
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<td>07.02.08</td>
<td>ISSUED FOR BID</td>
<td>9473-06-DB-001</td>
<td>0</td>
</tr>
</tbody>
</table>

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7.5.4.1 **SCOPE**

This specification covers the basic requirement of design and engineering of electrical system together with project design criteria and data sheets.

The electrical system shall cover the following:

- Design calculations (Load List, Cable Sizing etc)
- Power Generation
- Power distribution system
- Sub-stations
- Area classification
- Power layouts including cable tray/ trench arrangement
- Lighting layouts
- Earthing and lightning protections layout
- Communication and fire alarm system

The designed electrical system shall provide:

- Safety to personnel and equipments
- Reliability of service
- Minimum fire risk
- Ease of maintenance and convenience of operation
- Adequate provision of future expansion and modification.
- Maximum interchangeability of equipments
- Automatic protection of all electrical equipments through selective relaying systems.

7.5.4.2 **CODES AND STANDARDS**

The design, installation, testing & commissioning shall be as per established codes, standards, and sound engineering practices. STEP standards and shall conform to the statutory regulations applicable in the country. The main codes, standards and statutory regulations are as follows. The latest edition of these shall be followed.

- Indian Electricity Rules
- Indian Electricity Act.
- The Factory Act.
- The Mines Act. (OMR-84)
- The Petroleum Rules (Ministry of industry, Govt. of India)
- Sate Electricity Rules
- DGMS Guidelines
- OISD Guidelines

7.5.4.2.1 **Indian Standard**

| IS   | 5216 | Guide for safety procedures and practices in electrical works. |
| IS   | 5728 | Guide for short circuit calculations |
DESIGN BASIS
FOR
MADHUBAN, BAGHJAN & CHABUA

16-QMP-05-3A

Document Number Rev
9473-06-BD-001 0

Sheet 235 of

IS - 5572 Classification of hazardous area
IS - 5571 Guide for selection of electrical equipments for hazardous area.
IS - 8239 Classification of maximum surface temperatures of electrical equipment for use in explosive atmosphere.
IS - 3202 Code of practice for climate proofing an electrical equipment
IS - 585 Voltage and frequency for AC transmission and distribution system.
IS - 3716 Insulation coordination application guide.
IS - 694 PVC Insulated cables for working voltages up to and including 1100 V.
IS - 732 Code of practice for electrical wiring installations – system voltages not exceeding 650 V.
IS - 2274 Code of practice for electrical wiring installation – system voltages exceeding 650 V.
IS - 6665 Code of practice for industrial lighting
IS - 3646 Interior illumination: Part i and Part-ii
IS - 7689 Guide for control of undesirable static electricity.
IS - 2309 Protection of buildings and allied structures against lighting
IS - 3043 Earthing
IS - 2148 FLP Enclosure

7.5.4.2.2 OISD STANDARDS

OISD - STD-113 Classification of Area for Electrical Installations at Hydrocarbon Processing and Handling Facilities.
OISD - STD-118 Layouts for Oil and Gas Installations.
OISD - STD-110 Recommended Practices on Static Electricity.
OISD - STD-147 Inspection and Safe Practices during electrical installations.
OISD - STD-149 Design aspects for safety in electrical systems.

7.5.4.3 ENVIRONMENT CONDITIONS

7.5.4.3.1 Site Conditions

The following site conditions shall be applicable as their specific value specified in project design criteria/ data sheets.
- Maximum/ Minimum ambient temperature 40°C/7°C
- Maximum Relative Humidity 93% 
- Site elevation with respect to sea level less than 1000m 
- Atmospheric condition including any corrosive fluid/gas available. Yes 
- Soil resistivity: Later after soil investigation 
- Maximum wind velocity with direction. 50m/sec. 
- Seismic Zone V

7.5.4.3.2 Design Temperature
All electrical equipment and systems shall be designed for a rated output in an ambient temperature of 40°C.

7.5.4.3.3 Degree OF INGRESS PROTECTION
The following minimum degrees of enclosure protection shall apply.

<table>
<thead>
<tr>
<th>SI no</th>
<th>Equipment</th>
<th>IP Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Switchboards, distribution boards and electrical control panels</td>
<td>IP 42</td>
</tr>
<tr>
<td>2</td>
<td>Alternator</td>
<td>IP 23</td>
</tr>
<tr>
<td>3</td>
<td>UPS</td>
<td>IP 31</td>
</tr>
<tr>
<td>4</td>
<td>MV Motors</td>
<td>IP 55</td>
</tr>
<tr>
<td>5</td>
<td>Lighting fixtures in process and utility areas</td>
<td>IP 55</td>
</tr>
<tr>
<td>6</td>
<td>Junction boxes</td>
<td>IP 55</td>
</tr>
<tr>
<td>7</td>
<td>Welding/convenience receptacles in process areas</td>
<td>IP 55</td>
</tr>
<tr>
<td>8</td>
<td>Local control stations (local pushbutton stations)</td>
<td>IP 55</td>
</tr>
</tbody>
</table>

7.5.4.4 HAZARDOUS AREA CLASSIFICATION:

7.5.4.4.1 Basis of Area Classification
Classification of hazardous area shall be as per following national/international standards as applicable.

- IS - 5572/5571
- BS - 5345
- IEC - 79
- API-RP - 505
- OISD - 113

7.5.4.4.2 Equipment Selection Criteria
The following factors shall be considered for proper selection of equipments for use in hazardous area.
- Area classification i.e. Zone-0, 1 or 2.
- Gas group classification. The characteristics of the gas or vapour involved in relation to the ignition current or minimum ignition energy and safe gap data.
- Temperature classification - The ignition temperature of gas or vapour involved or the lowest value of ignition temperature if more than one combustible material are present.
- Environmental conditions in which equipments is to be installed – The selected electrical equipment shall be suitably protected against corrosive and solvent agents, water ingress, thermal and mechanical stresses as determined by the environmental conditions.

The types of protection for electrical equipment in hazardous area, generally used are as follows:

Zone 0 - Intrinsically Safe only- Type of Protection

Zone 1 - Intrinsically Safe - Type of Protection

- Flameproof equipment, Type of protection “d”
- Pressurized enclosure, Type of protection “p”
- Sand filled equipment, Type of protection “q”
- Oil immersed equipment, Type of protection “o”

Zone 2 - Protection as suitable for Zone 0 and 1

- Increased safety equipment, Type of protection “e”
- Non sparking equipments, Type of protection “n”

**Note**

1. Electrical equipment installation in Zone-0 area should be avoided.
2. Switchgear and control room should be located in safe area.
3. For OIL CGGS/FGGS installations all electrical equipments shall be Flameproof type (Ex-d) only. Type “e” or “n” is not acceptable.

**7.5.4.4.3 Approval/Certification**

Electrical equipments intended to use in hazardous area shall be approved by one of following recognized testing and certifying authorities:

UL - Underwriters Laboratories inc (USA)
FM - Factory Mutual Research Corporation (USA)
BASEEFA - British Approvals Service for Electrical Equipment in Flameproof Atmospheres.
PTB - Physikalisch Technische Boundesantait (Germany)
CMRS & CCE- Central Mining Research Station & Chief Controller of Explosives (Indian).
DGMS - Director General of Mine Safety
RS - Research Institute of Industrial safety (JAPAN) 5.0
In addition to above all electrical equipments intended for use in hazardous area must be certified by CMRS and approved by DGMS - Dhanbad as flameproof for use in Zone-1 and Zone-2, gas group-IIA & IIB of oil mines. Imported flameproof electrical equipment must also be approved by DGMS-Dhanbad. All approvals must be valid and approval number must be mentioned on equipment name plate.

### 7.5.4.4 Electrical Equipments For Hazardous Areas

The electrical equipments for hazardous areas shall be selected as per IS-5571 and Petroleum rules. The minimum requirements are summarized below.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Zone-1</th>
<th>Zone-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV Motors</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Push buttons station</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Motor starters</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Plug and socket</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Welding receptacle</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Lighting Fixtures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Lighting Fitting</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>ii. Control gear box</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Junction boxes</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Hand lamps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Light fitting</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>ii. Plug and socket</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Break glass unit (Fire alarm system)</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
<tr>
<td>Lighting panel/ power panel</td>
<td>Ex-d</td>
<td>Ex-d</td>
</tr>
</tbody>
</table>

**Notes**

1. The electrical equipment for hazardous areas shall generally be suitable for gas group IIA & IIB and temperature classification T3 as applicable to the selected type of explosion protection.
2. Irrespective of the area classification (whether Zone-1 or Zone-2) all lighting fixtures within the storage areas shall be flameproof type.

### 7.5.4.5 DESCRIPTION OF ELECTRICAL SYSTEM:

Power supply and electrical systems for process operation, illumination, etc. at CGGS Madhuban and FGSs at Chabua and Baghjan shall be from two Gas Driven Generator Sets.
7.5.4.5.1 Power Supply

In plant Power Supply

It is arranged through in plant generator set using Diesel/Gas as fuel; this power shall be used for all the loads.

CRITICAL POWER (UPS for Madhuban, Chabua & Baghjan)

It is arranged through uninterrupted power supply system. Critical power shall feed the following type of loads, at least for 12 hrs whenever GG power is not available. The critical loads shall be of following types:

- Critical instrumentation loads/ controls
- Critical security system loads
- Critical communication loads
- Plant shut down loads
- Critical Lighting loads

Critical loads are those, which require continuous power without momentary interruption.

EMERGENCY POWER (DG Set for Madhuban)

It is arranged through DG Set. Emergency power shall feed the following type of loads whenever power from gas driven generators is not available. The emergency loads shall be of following types:

- UPS load
- Lighting transformer for hazardous area
- Fire Water System
- Any other load considered essential

Emergency loads are those, which require power when gas generators are not available for safety reasons.

BLACK START / EMERGENCY POWER (DG Set for Chabua & Baghjan)

It is arranged through DG Set. Black Start power shall feed the following loads to prepare gas(fuel) required for GG set. The Black Start loads shall be of following types:

- Instrument air system
- Water treatment system (for fire fighting system)
- Heater load (for gas heater)
- Lighting
- UPS
- Any other load considered essential
7.5.4.5.2 Capacity Of Electrical Plant

Power Source Details

General
A. Independent system or existing system : Independent system

Chabua
Power supply at Chabua FGS shall be arranged by suitably rated 2 nos. Gas Engine driven Generator sets with 100% backup i.e. (1W+1S). A suitably rated DG set shall also be required for Black Start as gas will not be available for GG sets. All the generators shall have spare capacity of 20% for future loads over & above the present load requirement. The following loads shall be considered on DG set for Black start:

i) Instrument air system
ii) Water treatment system
iii) Heater load (for gas heater)
iv) Lighting
v) UPS

After the gas is available start GG set and change over the supply manually to GG. Provision of auto start, within 30 secs, for all the running loads shall also be made.

LV Generator (with Gas fuel)
A. Number of generator : 2 Nos. (1W+1S)
B. Generator rating/Voltage/Power factor: 350kVA/ 415V/ 0.8
C. Starting : Electrical (AMF Type)
D. Paralleling Facility : Required

LV Generator (with Diesel fuel)
A. Number of generator : 1 No. only for black start
B. Generator rating/Voltage/Power factor : 125kVA/ 415V/ 0.8
C. Starting : Manual
D. Paralleling Facility : Not Required

Baghjan
Power supply at Baghjan FGS shall be arranged by suitably rated 2nos.Gas Engine driven Generator sets with 100% backup i.e. (1W+1S). A suitably rated DG set shall also be required for Black Start as gas will not be available for GG sets. All the generators shall have spare capacity of 20% for future loads over & above the present load requirement. The following loads shall be considered on DG set for Black start:

i) Instrument air system
ii) Water treatment system
iii) Heater load
iv) Heater load (for gas heater)
v) Lighting
vi) UPS

After the gas is available start GG set and change over the supply manually to GG. Provision of auto start, within 30 secs, for all the running loads shall also be made.
**LV Generator (with Gas fuel)**

- **A. Number of generator**: 2 Nos. (1W+1S)
- **B. Generator rating/Voltage/Power factor**: 350kVA/415V/0.8
- **C. Starting**: Electrical (AMF Type)
- **D. Paralleling Facility**: Required

**LV Generator (with Diesel fuel)**

- **A. Number of generator**: 1 No. only for black start
- **B. Generator rating/Voltage/Power factor**: 125kVA/415V/0.8
- **C. Starting**: Manual
- **D. Paralleling Facility**: Not Required

**Madhuban**

Power supply at Duliajan shall be arranged by suitably designed Gas engine driven Generator set with 100% backup i.e. 1W+1S. However provision shall be made for supplying Emergency Loads through suitably designed DG set. All the generators shall have 20% spare capacity for future loads over & above the present load requirement. Gas shall be available for GG sets.

**LV Generator (with Gas fuel)**

- **A. Number of generator (1W+1S)**: 2 Nos.
- **B. Generator rating/Voltage/Power factor**: 500kVA/415V/0.8
- **C. Starting**: Electrical (AMF Type)
- **D. Paralleling Facility**: Required

**LV Generator (with Diesel fuel for critical load)**

- **A. Number of generator**: 1 No.
- **B. Generator rating/Voltage/Power factor**: 63kVA/415V/0.8
- **C. Starting**: Manual
- **D. Paralleling Facility**: Not Required

All electrical system components shall be sized to suit the maximum load & shall ensure that voltage of 415V available at load terminals under the worst operating conditions. Accordingly, the maximum simultaneous consumption of power, required by continuously operating loads shall be considered and an additional margin shall be taken into account for intermittent service loads, if any.

The amount of electrical power consumed by each process unit shall be calculated for its operation at the design capacity. Paralleling arrangement to be considered for the GG sets. Accordingly the neutral of the GG sets shall be grounded through.

**7.5.4.5.3 Utilization Voltage And Operating Philosophy**

<table>
<thead>
<tr>
<th></th>
<th>MV Distribution through</th>
<th>Resistance Earthed</th>
</tr>
</thead>
</table>

Saipem Triune Engineering Pvt. Ltd., New Delhi

DESIGN BASIS
FOR
MADHUBAN, BAGHJAN & CHABUA

Document Number Rev
9473-06-BD-001 0

Sheet 241 of
Transformer (if required) | Solidly Grounded with Neutral contactor
---|---
B. MV distribution system neutral | 415VAC
C. MV motor voltage | Yes
D. Mechanical transfer at MV (At PCC Level) two incomers | 240V AC, 1 ph / 415V 3ph 4W
E. Motor rated below 0.18 KW | 415 V AC 3 ph
F. UPS system in coming power supply | Yes
G. Power Panels and Auxiliary Service Boards incoming power supply | 415 V AC 3 ph
H. Welding receptacles | 415 V AC 3 ph
I. Bulk load like process heaters etc. | 415 V AC 3 ph
J. Lighting for non-hazardous area | 440 V AC 3 ph (through 415/440, 3-ph lighting transformer with neutral solidly earthed.)
K. Convenience outlets for non-hazardous area | 440 V AC 3 ph (through 415/440, 3-ph lighting transformer with neutral solidly earthed.)
L. Lighting for hazardous area | 240 V AC 3 ph (through 415/240, 3-ph lighting transformer)
M. Convenience outlets for hazardous area | 240 V AC 3 ph (through 415/240, 3-ph lighting transformer)
N. Motor operated valves | 415 V AC 3 ph (if any)
O. UPS output voltage | 230V AC
P. Normal instrumentation power supply | 230V ±5%, 50Hz ±2%AC

7.5.4.5.4 Voltage And Frequency Variation

**AC SYSTEM**

The following maximum variations from its nominal value shall be considered for equipment:

Voltage  -  415V ±5 %
Frequency - 50Hz ±5 %

The following maximum variations shall be considered:-

- For electrical control circuit  ±5%
- For Instrumentation  Refer Instrument Design basis.

7.5.4.5.5 Voltage Drop

Voltage drop at the worst affected bus during largest motor starting or re-acceleration of a group of motors shall not exceed 15 percent.
The available voltage at motor terminal during start up shall be sufficient to ensure positive starting or re-acceleration of the motor (even with the motor fully loaded) without causing any damage to the motor.

### 7.5.4.5.6 System Neutral Earthing

Neutral of the GG sets shall be solidly grounded with neutral contactor in the respective circuits.

### 7.5.4.5.7 Control Of Electrical System

All circuit breaker shall be controlled locally i.e. from respective switchboard/panel. No remote control is envisaged for circuit breakers. No auto-changeover/bus transfer Scheme is envisaged for incomer breakers.

Motors shall be controlled from field as well as from a remote distribution control system (DCS), located in Control Room. Local push button stations shall be provided in field near each motor. Control from DCS shall be as follows:

- Start command from DCS
- Stop command from DCS
- Feedback – Available to DCS
- Feedback – Run to DCS
- Feedback – Trip on Fault to DCS
- Permissive interlocks as required from DCS
- Selection of Local/Remote control from DCS

For wiring of motor starter interface with DCS, a marshalling section will be provided with PCC/MCC, where wiring from all starters shall be terminated. The marshalling cabinet shall consist of aux. relays with coil rated for 24 V DC output to be generated by DCS for motor Start/Stop and Local/Remote selection. All the signals will be hard wired from DCS to marshalling cabinet from where the signals will be internally hardwired to respective MCC modules. For status feedback of motors to DCS the signals of motor starter status to be hard wired upto marshalling cabinet and converted to signals suitable for transmitting to DCS/PLC through serial link.

For package equipment, the control/feedback shall be hardwired directly to vendor’s panel from/to motor starters. PCC/MCC shall have only E. Stop push buttons for motors. No starting is required from PCC/MCC.

### 7.5.4.6 POWER SYSTEM DESIGN

The power distribution system shall be designed considering following possible factors, which affect the choice of system to be finalized

- Total load
- Concentration of loads
- Size of individual load
- Reliability of power sources
- Continuity of supply
- Flexibility of operation
- Initial cost
- Operating and maintenance cost.

### 7.5.4.6.1 Load Analysis

In order to determine the distribution of load throughout the installation and to establish the single line diagrams a load analysis shall be carried out. Preliminary data from suppliers shall be the basis of the preliminary analysis and shall be updated on a regular basis until all purchased supplier data is received.

Each electrical load shall be categorized as continuous, intermittent or standby as appropriate. An additional load of 60kW shall be considered for M/s AGC for their setup near CGGS Madhuban, while sizing the Gen-set capacity at Madhuban.

### 7.5.4.6.2 Cable Sizing And Voltage Drop Criteria

Cable sizing shall be carried out taking into account the following considerations:

- Continuous current rating
- Voltage drop criteria(for starting and running)
- Fault ratings
- Grouping factors
- Ambient temperature
- Under ground or over ground

The cables shall be sized subject to the following minimum sizes.

- Electrical power cables : 2.5mm² (Cu)
- Electrical control cables : 1.5mm² (Cu)

Distribution system cable sizing shall be such that the following voltage drops at the circuit full load current are not exceeded:

<table>
<thead>
<tr>
<th>SI No</th>
<th>Description</th>
<th>Voltage Drop(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overall voltage drop from voltage source to any point in the system (end point)</td>
<td>6.0</td>
</tr>
<tr>
<td>2</td>
<td>Power feeder to PMCC</td>
<td>2.0</td>
</tr>
<tr>
<td>3</td>
<td>Feeder to motor (normal operation), heater and sub circuits other than lighting and small power</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>Maximum voltage dip at a supply switchboard during motor starting</td>
<td>12.0</td>
</tr>
<tr>
<td>5</td>
<td>Maximum voltage dip at motor terminals during starting</td>
<td>20.0</td>
</tr>
<tr>
<td>6</td>
<td>Lighting and small power</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• To lighting/small power panels in field</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>• Total for sub-circuit</td>
<td>6.0</td>
</tr>
</tbody>
</table>
7.5.4.6.3 Lighting Calculation

Lighting calculation shall be done either manually or by using vendor software (point to point calculations). Lighting levels shall be considered as per NEC/IS/DGMS as applicable. Otherwise, following levels will be maintained for various areas:

<table>
<thead>
<tr>
<th>SI No</th>
<th>Description</th>
<th>Lighting Level (Lux)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enclosed Process areas</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>Open Process areas</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Electrical Room</td>
<td>300</td>
</tr>
<tr>
<td>4</td>
<td>Control Room</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>Pump shed</td>
<td>150</td>
</tr>
<tr>
<td>6</td>
<td>Tank areas</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>General Areas</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>Engineer's Room</td>
<td>300</td>
</tr>
<tr>
<td>9</td>
<td>Roads</td>
<td>30</td>
</tr>
</tbody>
</table>

7.5.4.6.4 Earthing Calculation

Protective earth conductors shall be sized according to the short circuit withstand capacity and clearance time, material, permitted temperature rise and earth loop impedance values.

The resistance value of earthing system shall be decided on the basis of IS-3043.

7.5.4.6.5 Short Circuit Capacities

Each short-circuit interrupting device shall be designed to have rupturing capacity equal to or higher than the maximum value of short circuit current calculated at its location. The related switchgear and cables shall withstand the above maximum available fault current for one second.

7.5.4.6.6 Protection And Metering Schemes

The protective system shall be selected and coordinated to ensure the following:

a) Protection of equipment against damage, which can occur due to following:

- Internal or external short circuit
- Over load
- Over voltage
- Under Voltage
- Single Phasing
- Lower/ Higher frequency
b) As far as possible, the continuity of operation of those parts of the system which are unaffected by the fault.

c) Personnel and plants safety.

Accordingly, relays and protective devices shall be suitably selected and coordinated.

All electrical feeders shall be provided with CBCT and ELR of 500mA sensitivity.

7.5.4.6.7 Metering

The metering device HV and MV switchboards shall be as below

<table>
<thead>
<tr>
<th>Feeder Type</th>
<th>A</th>
<th>V</th>
<th>H</th>
<th>P</th>
<th>F</th>
<th>Kwh</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCC/PMCC Incomer</td>
<td></td>
<td></td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCC bus P.T</td>
<td>-</td>
<td></td>
<td></td>
<td>×</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDB incomer</td>
<td>×</td>
<td></td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DG Set</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
<td></td>
<td></td>
<td>×</td>
</tr>
</tbody>
</table>

**NOTE**

1. Field Ammeters are to be provided for all motors rated above 15 KW.
2. Indicating lamps in switchboards shall be cluster type LED lamp.

7.5.4.7 SUB STATION

Top of floor of main substation shall be 1 to 1.5m above finished ground level. The substation building shall be sized keeping in mind the need for future expansion and taking into care adequate clearance between equipments as per statutory regulations for small substation, cables shall be laid in trenches the bottom of the trenches shall be elevated above surrounding grade level.

Where the sub-station is of unattended type, necessary monitoring, operation and alarm facilities shall be provided in the control room. In case the sub-station is attended type, a small attendant’s room shall be provided which may be air-conditioned.

7.5.4.8 ELECTRICAL EQUIPMENT

The equipment in general shall conform to relevant Indian Standards and shall be suitable for installation and satisfactory operation in the service conditions mentioned in project design data.
If not specifically mentioned therein, a maximum ambient temperature of 40°C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration.

7.5.4.8.1 Medium Voltage Switchgear (PMCC/MCC)

MV switchgears shall be metal clad, free standing, dust, damp and vermin proof with minimum IP-42 degree of protection and with cubicles designed on modular basis. The bus bars and connections shall be adequately sized, braced and supported (non-hygroscopic material) to withstand mechanical forces and thermal effects under short circuit conditions. The main horizontal bus bars shall have continuous rating with same cross-sectional area, throughout the length of the switchboard. An earth bus shall be provided along the full length of the switchboard. Space heaters shall be provided to avoid moisture condensation. Switchboards shall be complete with necessary metering instruments, selector switches, control switches, push buttons, indicating lights etc.

The power and motor control centers shall have fully draw out design with cubicles designed on modular basis, to permit inter-changeability. It shall generally include incomers, bus coupler, outgoing MCCB feeders and motor feeders. Motor starter unit modules in these shall be complete with MCCB, Contactors, protective devices, RESET push buttons and “ON” “TRIP” indication lamps. Since MCCBs are used for motor feeders, the withstand capacity of the associated contactors and thermal overload relays shall be verified. The protective devices in motor feeders shall normally include overload, single phasing, earth fault and locked rotor protection as per individual cases. The thermal overload relays shall be of auto reset type with provision of hand-reset type. If required from process point of view, motor below and up to 15 KW shall have remote ammeter and the necessary CT shall be provided in the cubicle. Remote ammeters shall be provided for all motors rated above 15 KW. A separate control transformer shall provide control supply for modules. Auxiliary wiring shall not be routed near power buses.

In case of MCC the motor control centre shall generally include motor feeders of rating upto and including 55 KW. The maximum rating of the bus bar shall preferably be limited to 600 A.

In case of PMCC/PCC the rating of the busbar shall be as per the Transformer/ Generator rating.

In case of PMCC/PCC/MCC having two incomers, necessary tie switch shall be provided for bus sectionalizing. Heavy-duty type load break switches /ACB shall be used for incomers and tie and these shall have suitable mechanical interlocks.

The auxiliary service switchboard containing mainly MCB units may be in fixed execution and it shall have horizontal and vertical bus bars like those in PMCC/PCC and MCC. The minimum rating of the MCB unit shall be as per
load requirement. Where required, contactor controlled feeders, shall be provided to feed lighting panels.

**MV SWITCHBOARD TYPE**

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCC/PMCC Breakers panels, Contactor feeders</td>
<td>Draw out, single front</td>
</tr>
<tr>
<td>LDB</td>
<td>Fixed, single front</td>
</tr>
<tr>
<td>Motors PMCC</td>
<td>Above 55kW up to &amp; including 160kW</td>
</tr>
<tr>
<td>Type of switchboard for package</td>
<td>Compartmentalized / fixed type</td>
</tr>
<tr>
<td>Current transformer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CT Secondary</td>
</tr>
<tr>
<td></td>
<td>Protection:</td>
</tr>
<tr>
<td></td>
<td>Metering:</td>
</tr>
<tr>
<td></td>
<td>1/5A</td>
</tr>
<tr>
<td></td>
<td>1A</td>
</tr>
</tbody>
</table>

**7.5.4.8.2 Motor**

Motors shall be totally enclosed, fan cooled type and suitable for continuous outdoor use with IP-55 protection as a minimum. When employed in hazardous areas, they shall be of FLP type ex’d only.

Motors up to and including 150 KW shall be rated for medium voltage and motors of rating above 150 KW shall be rated for high voltage. However, the rating of medium voltage motors can be extended if required. Sleeve or antifriction type bearings shall be used. Vertical motors shall have thrust bearings suitable for the load imposed by the driven machinery.

Unless specified all motors shall have class ‘F’ insulation. The maximum permissible temperature rise shall be limited to the values applicable for class ‘B’ insulation.

Motors above 30 KW rating shall have anti condensation heaters and separate terminal box shall be provided for all motors.

**Limiting condition for motor start up**

i. **MV Motors:**
   - 660% up to 75 KW,
   - 550% above 75 KW

ii. **Method of starting (MV Motors):**
   - Below 5 hp DOL
   - and
   - 5hp & above Star Delta

**Motor starter type:**

i. **MCCB and Contactor with O/L relay**: For all motor feeders & CBCT with ELR for earth fault protection

ii. **CT for remote metering**: Motor rated above 15kW
iii. Ammeter on MCC/PMCC : For all motor feeders

7.5.4.8.3 Inplant Generator

Power generator shall form a complete package consisting of engine, alternator panel, control panel etc. Generator shall be designed to have allowable voltage dip when largest motor of the system is started with all other loads are ON. Unless otherwise specified the excitation system shall be brushless type. The generator shall have automatic voltage regulator. Proper instrumentation shall be provided for monitoring all parameters. Necessary alarm/annunciation shall be provided for abnormal condition.

The generator shall have protection against short circuit, earth faults, overloads, field failure, prime mover failure & earth leakage etc. Stator ends shall be brought out to terminal box mounted externally. The terminal box shall have sufficient space to receive the specified size of cables. Rotating rectifier diodes shall be located in easily accessible location to have ease of maintenance.

Breaker in generator control panel shall be closed on to load only after the requisite voltage builds up.

Where two generators (1W+1S) are provided, they shall be suitable for auto mains failure. Provision of paralleling shall also be provided.

7.5.4.8.4 Ups System

A. Redundancy : 100%
B. Type of redundancy : Parallel redundant
C. Back-up time : 1hr (100 % Load)
D. Inverter bypass transformer : Static
E. Bypass transfer control : Auto/Manual
F. Separate fault diagnostic unit: Yes
G. Battery type : SMF/Ni –Cd
H. Type of UPS : IGBT

7.5.4.8.5 Cables And Wires

Medium voltage power cable shall be PVC insulated, PVC sheathed, armoured copper conductors. Control cables shall be PVC insulated, PVC sheathed armoured copper conductor. All cables shall be low smoke, Halogen free, FRLS type.

Telephone cables shall be PVC insulated screened armoured and overall PVC insulated screened armoured and overall PVC sheathed copper conductor size of 0.9 mm². For fire alarm system plant communication, conductor size shall be 1.5 mm².

Cables shall be sized based on maximum continuous full load current, voltage drop during starting (for motors) and drop over the length laid, system voltage, system earthing and short circuit withstand criteria as
applicable. The derating due to ambient air temp., ground, grouping and proximity of cables, etc., shall be taken into account.

The minimum size for power & control cables shall be as follows:

Medium voltage - Power cable (Copper) 2.5 mm²
Control cable (Copper) 2.5 mm²

In case of difficulty in connection to relays instruments 1.5 mm² conductor may be used

- Lighting – 2.5 mm² copper.
- For lighting inside building, 1.5 mm² copper conductor. PVC insulated, FRLS type wires shall be used in conduit system.
- All field cables shall have one additional core for internal earthing of the equipment, i.e., all Power cables to motor, etc. shall be 4 core or 3.5 core. Control cables also must have one additional core for internal earthing.

7.5.4.8.6 Control Station

Each motor shall be provided with a control station in the field. The control station enclosure shall have suitable protection for site conditions such as flameproof, weatherproof, dustproof, corrosion resistant, etc.

The control station shall include the following equipment as per individual requirements:

- Start/stop push button
- Ammeter (more than 15kW)
- Auto/Manual selector switch, and
- Cable glands

Stop push button shall generally have stay put feature except in the case of critical drives such as lube oil pump etc.

7.5.4.8.7 Power/Lighting Panels

Power Panels and Normal Lighting Panels/Hazardous area lighting panels shall be located at various places throughout the plant for feeding lighting fixtures/welding receptacles/convenience receptacles.

7.5.4.8.8 Convenience Receptacles

These shall have the necessary mechanical interlocks and earthing facilities. The enclosure shall have suitable protection for site conditions specified (explosion proof, weatherproof, dustproof, corrosion resistant, etc.)
Adequate number of welding receptacles shall be provided at suitable locations to ensure accessibility with a 50 meters length of trailing cable, to any point in the process area. These shall be rated for 63A suitable for 415 V, 3-phase system with a scraping earth.

Adequate number of sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 15 meters length of cable to any point in the process area. These shall be rated for 15A single phase, supplied at 240V.

7.5.4.8.9 For Motor Actuators Operated Valves

Generally MOVs requiring only local control shall be provided with integral starters, MOVs requiring local/remote control shall have remote mounted starters. The necessary local/remote selector switch, start/stop control switches or push buttons, torque limit switches, etc. shall be provided on actuator for local/remote control depending on mode of selection. In case of failure of torque limit switches, the mechanical design shall be adequate to stall and trip the motor without damage.

The control circuits shall be AC operated. The actuator shall be provided with an anticondensation heater.

7.5.4.9 LIGHTING SYSTEM

7.5.4.9.1 For hazardous area lighting suitably rated lighting transformer of 415/240 V, 3 phase shall be provided. All outgoing circuits of lighting DB or sub DB shall have 3 pole or 2 pole MCCB/MB with ELCB for lighting and receptacle circuits.

7.5.4.9.2 For non hazardous area lighting suitably rated lighting transformer of 415/440 V, 3 phase with neutral solidly grounded shall be provided. All outgoing circuits of lighting DB or sub DB shall have 3 pole or 2 pole MCCB/MB with ELCB for lighting and receptacle circuits.

Hazardous Area Lighting system shall be designed for 240V AC ph-ph with illumination levels as per IS standard and good engineering practice. This system consists of lighting and power panels, fixture, junction boxes, 3 pin 5A/15A convenience socket outlets, cable gland connecting cables, wires, switches, etc. Lighting transformer shall be used before lighting panels. All equipment/accessories as required above shall be conforming to the required area classification and environmental conditions.

Buildings such as substation, control room, office building, canteen, etc. shall be lighted with fluorescent light fitting. Process areas shall be illuminated by high mast having HPSV lamp fixtures. HPSV shall be used for yard lighting and road lighting. The road lighting and other outdoor area lighting shall be automatically controlled by using timer. Taller structures shall have aviation obstruction lighting as per statutory regulations. All lighting poles shall be grouted suitably with RCC foundation. The high mast shall be installed 30 meter (minimum) away from the nearest crude handling facilities.
Lighting and power panels shall be fed from main lighting distribution board or auxiliary service switchboard. These panels shall be provided with miniature circuit breakers or miniature circuit breakers and residual current device or switches and fuses combination or residual current breaker with over load protection for the control and protection of circuits. Earth leakage protection shall also be provided. Panels shall normally be located in safe areas where unavoidable, flameproof lighting panels shall be used in hazardous areas. Where necessary, distribution box may also be used in place of lighting panel for lighting circuits tapping.

Wiring for lighting and convenience outlets shall be carried out with PVC armoured cables run along the column/ platform and structures. The armoured cable shall enter lighting fixtures/JB through double compression FLP type gland in Zone 1&2 area. Wherever required suitable mechanical protection shall be provided for lighting fixtures (e.g. wire guard). Two pole isolation devices shall be used for controlling fixtures in hazardous areas to isolate phase as well as neutral. Wiring for substation, workshop, laboratory, canteen building etc. shall normally be of surface conduit/ armoured cable type. Concealed conduit wiring shall be provided in building and control room. For buildings with false ceiling, concealed conduit wiring shall be used below the false ceiling and surface conduit wiring above the false ceiling.

Adequate number of junction boxes shall be used to aid wire pulling and inspection. No joints shall be allowed inside these JBs.

The street lighting fixtures shall be looped from respective JBs and it shall be looped alternatively to increase flexibility and reliability.

In addition to the normal lighting system emergency lighting shall be provided to allow personnel safety during plant operation and for safe shut down during normal lighting system failure. The emergency lighting system shall be energised automatically.

7.5.4.9.3 CONTROL PHILOSOPHY -LIGHTING

A. Street lighting : Auto with provision for manual operation
B. Outdoor process area : Auto with provision for manual operation
C. Process building : Auto with provision for manual operation
D. Lamp type for outdoor lighting : HPSV-Process area /Street light
E. ELCB for all O/G feeders of LDB: Yes

7.5.4.9.4 AC EMERGENCY LIGHTING (From DG set)

A. Name of process plants : All process areas (50%)
B. Name of buildings : All buildings- Plant and non plant (Minimum20%)
C. Yard Lighting : 50%
7.5.4.10 CABLING AND WIRING SYSTEM

Cables shall be laid above or below grade as indicated in the job specification.

Below grade : Cable trenches shall be RCC with cable hanger.

Above grade : Trays, racks or clamping on wall structure (in the case of less number of cables).

The trenches shall be sized depending upon the number of cables. The trenches in process/ hazardous areas and within sub-station shall be RCC type with chequre plate cover, cable trenches shall be completely filled up with sand. Cables in outdoor non-hazardous/ unpaved areas cables shall be directly buried in ground. Where underground cables cross road-ways, pipe sleepers at grade etc., they shall be protected by being drawn through sleeves ducts to provide a permanent crossing. Concrete lined trenches shall have suitable drainage arrangement to avoid water collection. Concrete lined cable trenches shall be sealed against ingress of liquid and gases wherever the trenches leave a hazardous area or enter control room or substation. Pipes laid for mechanical protection shall be sealed at both ends.

Above ground cables shall be well supported and suitably protected against mechanical damage. Routing shall be decided to avoid interference with hot sources or places subject to undue fire risk.

Cable trays, rack and trenches shall be sized to allow for 20% future cables reserves.
Instrument and communication cables shall not be laid in the same trench along with electrical cables. The overall cable layouts shall be designed for minimum interference between signal and power cables.

7.5.4.11 EARTHING SYSTEM

Earthing system in general, shall cover the following:

- Equipment earthing, static charge earthing of vessel and earthing for personnel safety
- System neutral earthing and
- Lightning protection using dissipation array technology for high buildings and storage tanks.

The earthing system envisaged an earthing network with designed number of earth electrodes attached to it. The following shall be earthed:

- System neutral
- Current and potential transformer secondaries
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchgears, motors, lighting/ power panels, cable trays, terminal boxes, etc.
- Steel structures
- Storage tanks
- Cable shields

**System Earthing**

Each generator shall be provided with two dedicated earth electrodes for earthing of neutrals. Lighting transformer neutrals shall be connected to earth grid.

**Equipment Earthing**

Earthing shall be carried out with GI electrodes and GI earthing strips as main earthing equipment. For equipment earthing, the following earthing schedule shall be followed.

<table>
<thead>
<tr>
<th>SI No</th>
<th>Type of equipment</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motors below 5.5 KW</td>
<td>25x6 mm GI Flat</td>
</tr>
<tr>
<td>2</td>
<td>Motors 5.5KW to 30 KW and Welding receptacle</td>
<td>25x6 mm GI Flat</td>
</tr>
<tr>
<td>3</td>
<td>Motors 37KW and above</td>
<td>40x5 mm GI Strip</td>
</tr>
<tr>
<td>4</td>
<td>Storage Tanks (Vertical and horizontal)</td>
<td>40x5 mm GI Strip</td>
</tr>
<tr>
<td>5</td>
<td>Vessels and Heat Exchanger</td>
<td>40x5 mm GI Strip</td>
</tr>
<tr>
<td>6</td>
<td>Lighting Power and Instrument Panels</td>
<td>25x6 mm GI Strip</td>
</tr>
<tr>
<td>7</td>
<td>Main Earth Bus/PMCC/PCC/MCC/Dist Transformer</td>
<td>50x6 mm GI Strip</td>
</tr>
<tr>
<td>8</td>
<td>UPS/LDB</td>
<td>40x5 mm GI Strip</td>
</tr>
<tr>
<td>9</td>
<td>Push Button Station</td>
<td>8 SWG Solid GI Wire</td>
</tr>
<tr>
<td>10</td>
<td>Street Light Poles</td>
<td>25x6 mm GI Strip</td>
</tr>
<tr>
<td>11</td>
<td>Lighting Transformer</td>
<td>40x5 mm GI Earth Flat</td>
</tr>
<tr>
<td>12</td>
<td>Building/Structure column</td>
<td>40x5 mm GI Strip</td>
</tr>
</tbody>
</table>

All utility, process pipelines, vessels, tanks, manifolds and flanges shall be earthed on entering or leaving the hazardous areas, except where conflicting with the requirements of cathodic protection. In addition steel pipe racks in the process units and offsite areas shall be earthed at every 25 meters. Equipment located remote from main earth network, may be earthed by means of individual earth conductors and earth electrodes.

For sensitive electronic process equipments & PLC system, separate earth pit with copper plate electrodes & copper strips of suitable size shall be provided. Power system earth pits shall be isolated from electronic system earthing.

Lightning protection generally shall be provided for the equipment, structures and buildings, which are higher than 20 meters. Self conducting structures
shall not be provided with aerial rod and down conductors they shall be connected to the earthing system at two points of the base. An independent earthing network shall be provided for lighting protection and this shall be bonded with the main earthing network only at the buried electrode.

The resistance value of an earthing system to the general case of earth shall be as follows:

- For the electrical system and equipment a value that ensures the operation of the protective device in the electrical circuit but not in excess of 1 ohm. However, for generating stations and large substations this value shall not be more than 1 ohm
- For lighting protection, the value of 5 ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.

The main earthing network shall be used for earthing of equipment to protect against static electricity.

Earth rods and conductors shall be designed to cope up with the conditions imposed. The earth conductor shall be adequately sized to carry the applicable maximum earth fault current without undue temperature rise. All joints shall be protected to prevent corrosion.

All the electrical equipment operating above 250 volts shall have two separate and distinct connections to earth grid.

Normally earthing system shall comprise of GI strip as main earth grid along with suitably located GI disconnecting plates to provide multiple earth connections between earth grid and equipment and for connections between main earth grid and electrodes.

Connections between GI earth electrode and the disconnecting plates shall be done by GI strip.

Connections between the disconnecting plate and various equipments shall be done by GI wire or GI wire rope.

In corrosive areas aluminum disconnecting plates along with suitably sized PVC insulated aluminum conductors cables, may be used for earthing grid/connections.

7.5.4.11.1 EARTHING MATERIALS

A. Earth electrode : 65mm dia, 3m long GI pipe
B. Main earth loop material : GI strip
C. Substation earth loop : GI strip
D. Lightning system : As per IS 2309
7.5.4.12 INTERNAL COMMUNICATION SYSTEM

1. The local communication facility using portable VHF Trans-receivers between the control room and the Operator room shall be provided.

2. Suitable Telephone Exchange shall be considered for in plant communication. The total no. of points required for intra communication within the CGGS & OTP and the FGSs shall be minimum as below:

**CGGS&OTP AT MADHUBAN NEAR NHK W/50**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Control Room Building</td>
<td>11 nos.</td>
</tr>
<tr>
<td>ii)</td>
<td>Securities barrack</td>
<td>1 no.</td>
</tr>
<tr>
<td>iii)</td>
<td>Security gate cabin</td>
<td>1 no.</td>
</tr>
<tr>
<td>iv)</td>
<td>Watch towers</td>
<td>4 nos.</td>
</tr>
<tr>
<td>v)</td>
<td>Operator Shed</td>
<td>1 no.</td>
</tr>
<tr>
<td>vi)</td>
<td>Gen-set Shed</td>
<td>1 no.</td>
</tr>
<tr>
<td>vii)</td>
<td>Air Compressor Shed</td>
<td>1 no.</td>
</tr>
<tr>
<td>viii)</td>
<td>ETP</td>
<td>1 no.</td>
</tr>
<tr>
<td>ix)</td>
<td>Fire service pump shed</td>
<td>1 no.</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>22 NOS.</strong></td>
</tr>
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**FGSs AT CHABUA AND BAGHJAN (FUTURE; FOR DESIGN PURPOSE ONLY)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Control Room</td>
<td>2 nos.</td>
</tr>
<tr>
<td>ii)</td>
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<tr>
<td>iii)</td>
<td>Security gate cabin</td>
<td>1 no.</td>
</tr>
<tr>
<td>iv)</td>
<td>Watch towers</td>
<td>4 nos.</td>
</tr>
<tr>
<td>v)</td>
<td>Operator shed</td>
<td>1 no.</td>
</tr>
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<td>vi)</td>
<td>Gen-set Shed</td>
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<tr>
<td>vii)</td>
<td>Air Compressor Shed</td>
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</tr>
<tr>
<td>viii)</td>
<td>Fire Service Pump Shed</td>
<td>1 no.</td>
</tr>
<tr>
<td>ix)</td>
<td>WTP</td>
<td>1 no.</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>13 NOS</strong></td>
</tr>
</tbody>
</table>

3. An Air Conditioned switch room is to be arranged in the Control room building for IT and Telephone equipment and MDF (Main Distribution Frame) at a suitable place.
4. Power backup for the Telephone / IT equipment shall be utilized from the UPS installed at the Control room as proposed. UPS system shall have sufficient capacity.

5. Wiring for telephone connection shall be with two pairs of cable (1 spare) to each telephone point from MDF. Cables within the building should be PVC unarmored 0.5 mm telephone cable. For each telephone point there should be one Flush Moulded Box with Front Plates and 2 Nos. of RJ connectors (all of make MK or Anchor) for termination of both pairs of cables.

6. Within the building the telephone wirings shall be concealed.

7. Wiring for the Hazardous Zone telephone points should be using suitable armoured telephone cable and flame proof junction boxes.

8. Telephone wiring for building to building / locations shall be underground using Jelly Filled Armoured telephone cables with minimum 0.5mm dia. copper conductors. UG cables in a building should be terminated in Krone Disconnection modules mounted in GI or other appropriate boxes for onward distribution within the building.

9. Identify the ‘Hazardous Zones’ and ‘Gas Groups’ in which the telephones will be installed inside the installation. Accordingly specify the requirements of DGMS certification and the type of certifications for telephone instruments. Depending on the classification of Zones, Gas Groups and required Certification, OIL shall procure the telephone instruments.

10. Telephone Switch (Exchange), compatible to the existing Central Exchange at OIL. Telephone Exchange, Duliajan and MDF shall be procured by OIL.

11. PSTN communication facility shall be provided by OIL as alternative communication and for communicating with external agencies.

12. Connectivity between OIL Telephone Exchange Duliajan and CGGS & FGSs shall be through radio network and VSAT procured by IT Department for ERP application.

13. During construction period for use of OIL Engineers, facility for one number telephone communication will be provided by OIL using existing Cable Network (for CGGS) / MART (for FGSs) communication systems.

14. Separate concealed conduit for Computer network cabling shall be provided by contractor, however, the Computer network cabling shall be carried out by OIL within the main building in the conduits installed by the contractor.
15. A self supporting tower shall be procured and erected by the contractor, either on the rooftop of the Control room building or at a place adjacent to the control room, for radio communication system at CGGS&OTP Madhuban and FGS Chabua. The height of the tower shall be approx. 30 meters from the ground level. Identify one suitable place for erection of the tower at a safe distance within the boundary of the installation as per OMR/OISD and the location is to be shown in the plot plan.

16. Network equipment shall be provided by OIL.

Based on the above mentioned points the following scope of work to be considered

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>LSTK Contractor scope of Supply</th>
<th>OIL Scope of Supply</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>Local communication facility using portable VHF Trans-receivers between the control room and the Operator room shall be provided.</td>
<td>Telephone Switch (Exchange), compatible to the existing Central Exchange at OIL Telephone Exchange, Duliajan and MDF shall be procured by OIL.</td>
</tr>
<tr>
<td>2.</td>
<td>An Air Conditioned switch room is to be provided in the Control room</td>
<td>PSTN communication facility shall be provided by OIL.</td>
</tr>
<tr>
<td>3.</td>
<td>Power backup for the telephones / IT equipment</td>
<td>Radio Connectivity between OIL Telephone Exchange, Duliajan and CGGS and FGSs shall be provided by OIL</td>
</tr>
<tr>
<td>4.</td>
<td>Wiring for all telephone connections inside the building as well as building to building/location.</td>
<td>During construction period for use of OIL Engineers minimum telephone facilities will be provided by OIL</td>
</tr>
</tbody>
</table>
9. Separate concealed conduit for Computer network cabling shall be provided. Computer network cabling shall be carried out by OIL within the main building.

10. Supply & Erection of a self supporting tower / guyed mast for radio communication system. Network equipment shall be provided by OIL.

11. V-Sat communication if required.

Internal communication facility comprising of telephone system shall be provided for the following areas:
- Control Room
- Operator Room
- Security Room
- Plant in charge Room
- Chemistry Lab
- PMCC Room
- Instrumentation Room
- VIP Room

The system shall comprise of microprocessor based electronic exchange (EPABX), Telephone system, Main Distribution Frame(MDF), back up power supply system.

7.5.4.13 FIRE ALARM SYSTEM

Fire alarm system covers all the plant buildings, process area, utility area, storage areas, etc. The configuration for the above system shall be decided considering specific project requirements.

7.5.4.14 CCTV SYSTEM

CCTV System complete with Camera(s) & monitor(s) shall be provided in CGGS & OTP, Duliajan to monitor process area, utility area, storage areas etc. The configuration for the above system i.e no. of camera(s) & monitor(s) shall be decided considering specific project requirements.

7.5.4.15 DRAWINGS

STEP installation standards shall be used for equipment erection. In case of schematic diagrams, vendor drawings shall be final documents. As built
drawings shall be prepared only in cases where construction, supervision, and commissioning is carried out by STEP.
7.6 SCOPE OF WORK FOR INSTRUMENTATION
## DISCIPLINEWISE SCOPE OF WORK AND DESIGN BASIS

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# EPMC SERVICES

FOR

CGGS & OFF TAKE AT MADHUBAN AND

FGGS AT BAGHJAN & CHABUA

INSTRUMENTATION

SCOPE OF WORK

FOR

OIL INDIA LTD., DULIAJAN (ASSAM)

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Saipem Triune Engineering Pvt. Ltd.,
New Delhi

SCOPE OF WORK FOR
MADHUBAN, BAGHJAN & CHABUA

Document Number  Rev
9473-09-SOW-001   1
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7.6.1.1 GENERAL

M/s OIL India Ltd (OIL), is a pioneer oil company to explore and exploit crude oil and natural gas with its headquarter at Duliajan, Assam. The development of non-associated gas fields in OIL’s Upper Assam operational area is underway. As part of this development scheme, OIL desires to construct state-of-the-art stations namely, two non-associated gas production setups (Field Gathering Stations : FGS) one each at Baghjan and Chabua and one high volume self contained Gas Gathering, Custody Transfer and Metering Delivery Terminal (Central Gas Gathering Stations and Offtake Point; CGGS & OTP) at Madhuban in Upper Assam, India.

The purpose of this document is to define general requirements and philosophy of Instrumentation and controls, necessary for Design, Engineering, Manufacture, Inspection & Testing, Installation, Commissioning and Handover of the facilities mentioned in the above paragraph. It is to be noted that for FGG at Baghjan, no Engineering is to be done and the facility shall not be implemented now. Best Available Technology (BAT) that has been well proven shall be used for the implementation of the envisaged facilities.

This specification together with instrumentation shown in various P&IDs, Design Basis, Technical Specifications and other related drawings/ documents and relevant parts of the bid document shall describe the complete details of scope of work of LSTK Contractor for Instrumentation part of the bid document.

LSTK bidders are advised to visit site and carry out survey to assess the exact quantum of work, and to familiarize with working condition, climate, space, etc. It would be pre-assumed that the LSTK Contractor has carried out the necessary site assessment, investigation/ familiarization and has collected the required information and evaluated the same before submitting the bid.

7.6.1.2 SCOPE OF WORK

LSTK contractor shall be responsible for complete instrumentation work including, but not limited to the following:

Complete design, detailed engineering, preparation of drawings/ documents as per the “List of Deliverables” enclosed elsewhere in the bid as a minimum, sizing, selection, procurement, supply, installation, inspection at manufacturer/supplier’s premises, hook-up, tubing, supporting, cabling, testing, calibration, loop checking and commissioning of all instruments and controls. The scope shall also include supply of spares, accessories, installation material etc., arranging all types of equipment for testing, calibration, loop checking and any other activity that is required for safe and efficient start up, operation and shut down of the plant. It is to be noted that for FGG at Baghjan, no engineering is to be done and the facility shall not be implemented now. For FGG at Chabua and CGGS & OTP at Madhuban, activities as mentioned above shall be carried out.

It shall be the responsibility of the LSTK contractor to ensure that Best Available Technology is employed for implementing the job. LSTK Contractor to
propose the Best Available Technology to Owner/ PMC for their approval before implementation of the same.

7.6.1.2.1 Scope Of Supply (For FGS At Chabua And CGGS & OTP At Duliajan)

LSTK Contractor’s scope of supply (using proven Best Available Technology) shall include but not limited to the following:

7.6.1.2.1.1 Supply of all field instruments for as shown in the P&IDs, as specified in Design Basis and Technical Specifications attached elsewhere in the bid document. Instruments confirming to proven Best Available Technology shall be supplied (eg. Instruments compatible with Foundation Fieldbus technology, fail safe instruments etc.) All supplied instruments shall have relevant certification as mentioned in Design Basis for Instrumentation attached elsewhere in the bid document.

7.6.1.2.1.2 Supply of suitable DCS monitoring and controlling system, ESD PLC, Fire Alarm Panel, Access Control System, operator/ engineering workstations, ESD pushbutton panel, metering panel, printers, scanners and any other control room equipment required for the safe, proper and efficient operation of the plant, as per the philosophy shown in Control System Architecture and Control Room Layout enclosed elsewhere in the bid document, as a minimum. While installing the instrumentation for the process monitoring and control system, adequate provisions for connectivity to SCADA system shall be kept. Hardware/software confirming to proven Best Available Technology shall be supplied (eg. Foundation Fieldbus compatible host system, fail safe I/O cards, SIL certified control system etc)

7.6.1.2.1.3 All design and installation shall be carried out so as to ensure future expansion as indicated in P&IDs with dotted lines, if any.

7.6.1.2.1.4 Supply of all necessary furniture required for mounting consoles, printers, scanners PC’s, operator and engineer chairs etc.

7.6.1.2.1.5 Supply of Intrinsic Safety barriers for all IS instruments.

7.6.1.2.1.6 Supply of Smoke/Heat Detectors, Gas Detectors, Flame Detectors, hooter etc. as required for the safe and efficient operation of the plant.

7.6.1.2.1.7 Interconnection of the various control systems as per the Control System Architecture attached elsewhere in the bid document

7.6.1.2.1.8 Interconnection of various packages with the main control system

7.6.1.2.1.9 Supply of Fieldbus Tester with all necessary accessories for monitoring and troubleshooting of fieldbus networks, including signal levels, noise levels, power levels, wiring integrity, bus traffic etc.

7.6.1.2.1.10 Supply of various installation material as per Construction Standards including but not limited to the following:

i) Impulse piping / tubing
ii) Pneumatic tubing
iii) Instrument valves & Manifolds
iv) Pipe/ Tube fittings
v) Mounting accessories like Stanchions, Canopies, brackets including all necessary supports, grouting etc.

7.6.1.2.1.11 Supply of instrument accessories such as HART communicator, Foundation Fieldbus Tester, Air Filter Regulator, Limit Switches, Valve Positioners, Solenoid valves etc. even if the same is not indicated in the P&IDs for any instruments, but required for functional completion of instrumentation and controls.

7.6.1.2.1.12 Supply of instruments like portable dew point meter, fire & gas detectors, etc. even if not indicated in P&IDs, but required as per Design Basis and in accordance with Technical Specification attached elsewhere in the bid package.

7.6.1.2.1.13 Supply of instruments like portable dew point meter, fire & gas detectors, etc. even if not indicated in P&IDs, but required as per Design Basis and in accordance with Technical Specification attached elsewhere in the bid package.

7.6.1.2.1.14 Supply of Junction Boxes for different types of instruments like intrinsic safe/ ex-proof, fieldbus & conventional signals, alarm, shutdown etc. for interfacing to Control Room, for all instruments.

7.6.1.2.1.15 Supply of single cables and cable glands for interconnection between all LSTK Contractor supplied instruments and junction boxes, supply of multi cables between the junction boxes and control room along with Multi Cable Transits (MCT) and cable glands. All spare cable entries at the instrument side and junction box side shall be plugged.

7.6.1.2.1.16 Supply of cable trays, tray supports, cable trenches, instrument hookup hardware and other erection hardware as required for implementation of the job.

7.6.1.2.1.17 Supply of Power Distribution Boards for distributing power supplies required at field, Control room and wherever required for successful completion of the project.

7.6.1.2.1.18 Supply of consumables, wherever required, shall be entirely the LSTK Contractor’s responsibility. As a minimum these shall include

i) Teflon tape, insulation tape, welding rods, glass cutting sets, welding set.
ii) Nuts & bolts for support, clamps for tubes & pipes, expansion bolts of various sizes for fixing to concrete structures.
iii) All industrial gases like Oxygen, Acetylene or inert and all types of electrodes, brazing rods, flux etc. for welding purposes, with necessary facilities for testing the welded joints.
iv) All materials for minor civil work like grouting etc. wherever required.
v) Ferrules, sleeves, tag no plates, clamps for securing the cables, fasteners, marker plates and tiles required for installation of instruments, cables, trays, trenches, junction boxes
vi) Lubricating oil, silicon oil, grease, soap solution wherever required.
vii) Calibration gases for testing and calibration of Gas / HC detector.
viii) Nitrogen for purging and testing.
7.6.1.2.1.19 No instrument requiring special maintenance or operating facilities shall be offered or supplied as far as possible.

7.6.1.2.1.20 LSTK Contractor shall also provide testing and calibration instruments minimum required for operation and maintenance of the plant. Field calibrator/configurator, which is compatible with both normal and fieldbus transmitters, shall be supplied by the LSTK contractor. This shall also include supply of one integrated test/calibration bench.

7.6.1.2.1.21 LSTK contractor shall provide training system (simulator) for the offered DCS and PLC systems.

7.6.1.2.1.22 The scope includes ordering, fabrication, procurement, any import formalities, port clearances, packing and transportation to site, stores management which includes preservation and storage of equipments and materials in covered storage/air conditioned storage (as required) and open storage.

7.6.1.2.1.23 Vendor manuals relating to installation, operation and maintenance, test certificates should necessarily be sent along with the equipment, besides being furnished after placement of orders.

7.6.1.2.1.24 Before ordering, approval shall be taken from Owner/PMC for all the instruments and materials. Any item ordered which do not conform to the Contractual requirement, identified at any stage of the project, shall be liable to rejection. Replacement/modification, cost and project delay arising out of this shall be to the LSTK Contractor’s account.

7.6.1.2.1.25 Whenever clearances are to be taken before placement of order, it would be necessary to submit only one technically acceptable offer for OIL’S approval. The details of the instruments and materials involved shall be brought out in the contract document and to be firmed up during the residual engineering stage.

7.6.1.2.1.26 Supply of any other item not specifically mentioned here, but required for realization of the bid package requirements, P&IDs and any other item required for the safe, effective and proper operation of the plants shall be solely the responsibility of the LSTK contractor.

7.6.1.2.1.27 Supply & installation of three sets of Asset Management software (one for each location) for managing all the Foundation Field Bus compatible equipment from the respective control rooms.

7.6.1.3 INSTALLATION & COMMISSIONING
LSTK Contractor shall be responsible for installation, interconnection, calibration and commissioning of the instruments and Controls which includes:

7.6.1.3.1.1 Installation and commissioning of all the items as mentioned

7.6.1.3.1.2 Installation of all instruments within LSTK Contractor’s battery limit, as per the Hookup/Installation Standards attached elsewhere in the bid package.
7.6.1.3.1.3 Installation of Junction Boxes.

7.6.1.3.1.4 Laying and termination of cables between field instruments and Junction Boxes and between JBs and Control Room as per good engineering practices, by providing cable glands, putting identification tags, identifying the cable/cores and putting the ferrules.

7.6.1.3.1.5 Calibration and shop testing of all LSTK Contractor supplied instrumentation items.

7.6.1.3.1.6 Installation of Cable Trays/ Trenches up to the control room.

7.6.1.3.1.7 Installation, hook-up and commissioning of DCS, PLC and other control room equipment.

7.6.1.3.1.8 Necessary software for control systems.

7.6.1.3.1.9 LSTK Contractor shall suitably design the auxiliary panels for flow computers, ESD push buttons, etc.

7.6.1.3.1.10 LSTK Contractor shall suitably design the MCT for cable entry to Control Rooms.

7.6.1.3.1.11 Proper interfacing of the various components of the control systems to the Ethernet (as per Control System Architecture drawing) shall be LSTK Contractor’s responsibility. All necessary hardware/software required for interfacing shall be in LSTK Contractor’s scope of supply.

7.6.1.3.1.12 Loop checking of instruments and checking the functional performance of all elements comprising the loop and ensuring proper configuration, functioning and interconnection shall be LSTK contractor’s responsibility.

7.6.1.3.1.13 LSTK contractor shall be responsible for commissioning of all the instrumentation and controls.

7.6.1.3.1.14 Commissioning activity shall be carried out in a systematic manner so to avoid any accident to plant and operating personnel.

7.6.1.3.1.15 During the plant start up all the instruments calibration, controller alignment, trip point settings shall be trimmed so as to meet the operation requirement.

7.6.1.3.1.16 LSTK Contractor to ensure that all electronic instruments shall be certified by CMRI & have valid DGMS approval. For imported equipment, DGMS approval no. and mark must be embossed on equipment as mentioned in approval letter issued by DGMS. DGMS certification shall be done before installation.

7.6.1.3.1.17 Any other activity required to be performed in Control room or field to make the plants operational shall be LSTK contractor’s responsibility.

7.6.1.4 DESIGN PHILOSOPHY
For design philosophy of instrumentation and controls, refer Design Basis for Instrumentation enclosed elsewhere in this document.

7.6.1.5 SPARE PHILOSOPHY

7.6.1.5.1 Mandatory Spares

10% or minimum one number of each type of instrument, whichever is higher shall be provided as mandatory spares. The word “type” implies make, model number, working principle, range, size, length, rating, material etc. as applicable. Supplier to submit tag-wise mandatory spares along with the offer.

For bulk items like cables, junction box terminals, cable trays, cable glands, pipe and tube fittings, erection hardware etc., 20% spare quantity shall be provided as mandatory spares. Price list for critical spares to be included.

Spares for control system equipment shall be as specified in the relevant Technical Specification.

In any case, supplier to note that the list submitted is only for information. In an event of order, supplier shall be required to resubmit a final mandatory spare list for Owner/ PMC review based on the exact / final model nos. selected during engineering & the mandatory spares supply shall be as per the final reviewed spare list only. Any price / time implication to the Owner on account of the same shall not be entertained.

7.6.1.5.2 Commissioning Spares

Commissioning spares shall be supplied as per supplier recommendation. Supplier to submit a list of commissioning spares along with the offer. In an event of order, supplier shall be required to resubmit a final Commissioning spare list for Owner/PMC review & the commissioning spares supply shall be as per the final reviewed spare list only. Any price / time implication to the Owner on account of the same shall not be entertained.

7.6.1.5.3 Consumable Spares

All consumable spares required till a period of one year shall be provided by supplier. Supplier to submit a list of consumable spares along with the offer. In an event of order, supplier shall be required to resubmit a final Consumable spare list for Owner/PMC review & the consumable spares supply shall be as per the final reviewed spare list only. Any price / time implication to the Owner on account of the same shall not be entertained.

7.6.1.5.4 TWO YEARS OPERATIONAL SPARES

Supplier shall submit list of Two year operational spares along with the offer. Supplier shall also be required to submit final list based on final models selected & the supply shall be as per the final reviewed spare list only. Any price / time implication to the Owner on account of the same shall not be entertained.
7.6.1.6 SPECIAL TOOLS & TACKLES

The Supplier shall include all special tools & tackles (if any) necessary for the erection, testing & commissioning and maintenance of the Instruments in their quotation. Special tools & tackles shall also be those items which are commonly not available. A list of such special tools & tackles shall be submitted along with the relevant documentation.

7.6.1.7 INSTALLATION PROCEDURE

For instrument installation practices, refer Erection Specifications attached elsewhere in the bid document.

7.6.1.8 TESTING AND CALIBRATION PROCEDURE

7.6.1.8.1.1 All impulse lines shall be properly flushed after isolating instrument and the vessel/piping.

7.6.1.8.1.2 All impulse lines shall be tested hydraulically at 1.5 times the maximum operating pressure. Ensure that instrument and vessel/piping is isolated during this test.

7.6.1.8.1.3 In case of special conditions where hydro testing is not permitted due to service conditions, the impulse lines testing shall be carried out by using air or nitrogen.

7.6.1.8.1.4 All external cage type level instruments shall be tested upto 2.5 times operating pressure by using nitrogen only.

7.6.1.8.1.5 After pressure testing all these impulse lines shall be drained and dried with dry air to remove any moisture.

7.6.1.8.1.6 LSTK Contractor shall use his own oil free instrument air compressor for calibration purposes.

7.6.1.8.1.7 Instrument air lines will be service tested only for any leak after pressurising and isolating the main root valve, by soap solution.

7.6.1.8.1.8 Pneumatic signal tubes shall be flushed and tested with instrument air for any leak at a pressure of 1.5 Kg/cm² g. After pressurising the line, the source of pressure is cut off and rate of fall in pressure shall be less than 1 psi for each 100 feet during a period of 3 minutes.

7.6.1.8.1.9 All instrument cables shall be tested for continuity and insulation. While Megger is used for insulation testing, ensure that all instruments and zener barriers are isolated at both ends.

7.6.1.8.1.10 All instruments supplied by the vendor shall be calibrated using proper test equipment. The test equipments used for calibration shall have the approval of National Physical Laboratory (NPL) / Institute for Design of Electrical Measuring Instruments (IDEMI, Bombay) / Regional Electronic Test and Development
Centre (ETDC) or Agency approved by above-mentioned authorities. On demand, calibration certificates shall be submitted to Engineer-in-charge.

7.6.1.8.1.11 All instruments shall be calibrated strictly as per respective data sheets and Manufacturer’s instructions prior to installation. Calibration certificates should be maintained as per instructions of the Owner.

7.6.1.8.1.12 Detailed procedure shall be submitted to Engineer-in-charge for approval before proceeding with calibration.

7.6.1.8.1.13 All calibration readings shall be recorded in the agreed formats and submitted to Engineer-in-charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer-in-charge for corrective actions.

7.6.1.8.1.14 All instruments shall be calibrated for 0, 25 %, 50 %, 75 %, 100 % and vice versa.

7.6.1.8.1.15 Conversion from one unit to another for purpose of calibration is not allowed.

7.6.1.8.1.16 All temperature gauges shall be calibrated using temperature baths.

7.6.1.8.1.17 All thermocouple-activated instruments shall be calibrated by generating millivolts by a potentiometer.

7.6.1.8.1.18 All transmitters shall be calibrated as per instrument ranges.

7.6.1.8.1.19 The external displacer type level transmitter shall be dry calibrated as per manufacturer’s instructions and calibrated by filling the displacer chamber with water for level 0%, 25%, 50%, 75% and 100% and draining the water step by step ranges after applying suitable specific gravity corrections of the process fluid as per data sheets.

7.6.1.8.1.20 All alarm and trip switches shall be calibrated over the entire range and finally set and checked for alarm/ trip points and reset points as per the alarm/ trip set point schedule. After setting these shall be sealed.

7.6.1.8.1.21 Control valves and positioners shall be checked for hysteresis and linearity and calibrated for rated strokes. Prior to calibration, valves shall be cleaned externally. The stem is then lubricated if required, and stroked few times to extreme positions of plug to ensure the movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently the valves shall be checked for hysteresis to the accuracy of 1% FS with positioners and 5% FS without positioners. Stroke speed has to be evaluated for all trip / shutdown valves.

7.6.1.8.1.22 All on-off valves and other control valves having Solenoid valves & Limit switches shall be tested for the on-off action of SOV and Limit switch actuation.

7.6.1.8.1.23 Bubble tight shut-off control valves and shut down valves shall be checked for seat leak test and gland leak test.
7.6.1.8.1.24 Solenoid valve shall be checked functionally for its operation.

7.6.1.8.1.25 Safety valves and relief valves shall be set/ tested by using dry air/nitrogen. Leakage if any shall be removed by proper lapping of seat and disc.

7.6.1.8.1.26 All electronic/pneumatic receiver instruments (if any) shall be calibrated as per the manufacturer’s instructions. Controllers shall be aligned properly.

7.6.1.8.1.27 All special instruments like analyser shall be checked and calibrated as per manufacturer’s instruction. Prior to testing, all analyser sample lines shall be thoroughly cleaned by carbon tetra chloride or any other cleaning liquid. After cleaning, these lines shall be thoroughly purged with dry nitrogen.

7.6.1.8.1.28 After performing the calibration of all instruments, the entire loop shall be checked for proper operation.

7.6.1.8.1.29 The entire shutdown scheme shall be simulated from the process trip switches and the scheme shall be tested for its proper operation, prior to start up of the unit.

7.6.1.8.1.30 If no instrument air is available, vendor shall provide necessary N2 cylinders to carry out the above activity.

7.6.1.9 CONFLICT

In the event of conflict, actual or implied, amongst documents relating to these requirements and its attachments, related standards and codes etc., the more stringent and superior requirement(s) shall govern. The LSTK Contractor shall identify and state such conflict(s) in the course of execution of Contract to obtain Owner/PMC’s concurrence. Contractor shall refer conflicts to Owner/PMC for clarification and the decision of Owner/PMC shall be final and only after obtaining the same, manufacturing/ engineering/ execution of the item in question should proceed.

Similarly, if there is a conflict between the LSTK Contractor supplied documents, superior specification advantageous to the purchaser shall be governing.

7.6.1.10 DOCUMENTATION

7.6.1.10.1.1 The drawings accompanying the Bid document are issued for bidding purpose only. Purpose of these drawings is to enable the bidder to make an offer in line with the requirements of the Owner/PMC. However, no extra claim whatsoever shall be entertained for any variation in the “Tender/contract drawings” due to vendor items or due to other limitation at site while executing the work.

7.6.1.10.1.2 Detailed ‘approved for construction’ drawings on the basis of which actual execution of work is to proceed will be prepared by the LSTK Contractor and these detail drawings shall be submitted to Owner/PMC for review before start of work.
7.6.1.10.1.3 The drawings and documents to be submitted by the LSTK Contractor to Owner/PMC after award of the work shall be as per the “List of Deliverables” as a minimum enclosed elsewhere in this document and shall be for Owner/PMC’s review/ approval, information and record. Any other document required or requested by Owner/PMC during bid evaluation or Contract execution stage shall also be made available. The LSTK Contractor shall ensure that drawings and documents submitted to Owner/PMC are accompanied by relevant calculations, data as required and essential for review of the documents/ drawings.

7.6.1.10.1.4 All documents and drawings including those of LSTK Contractor’s sub-vendors/ manufacturers etc. shall be submitted to Owner/PMC after having been fully vetted in detail, approved and co-opted by the LSTK Contractor & shall bear LSTK Contractor’s seal/ certifications to this effect. All documents/ drawings & submissions made to Owner/PMC without compliance to this requirement will not be acceptable and the delay & liability owing to this shall be to the account of LSTK Contractor.

7.6.1.10.1.5 The review of documents and drawings by Owner/ PMC shall not be construed by LSTK Contractor as limiting any of his responsibilities to meet the requirements of specifications, drawings etc. and liability for mistakes and deviations. Upon receiving the comments on the drawings/ documents reviewed by Owner/ PMC, LSTK Contractor shall incorporate the comments as required and ensure their compliance.

7.6.1.10.1.6 Any inaccuracies, errors & non-compliance to contractual requirements will not only be rectified by the LSTK Contractor but shall also be liable for compensation by LSTK Contractor towards efforts spent by Owner/PMC in this regard. Delay occurring on this shall be to the account of the LSTK Contractor.

7.6.1.10.1.7 All instrumentation purchase specifications comprising completely filled-up instrument datasheets, selected make and model no. of the instrument item and vendor catalogs for the offered model shall be furnished for Owner/ PMC’s approval. LSTK Contractor shall not place the order without obtaining prior approval from the Owner/ PMC.

7.6.1.10.1.8 LSTK Contractor shall furnish for review/approval to the Owner/PMC a complete list of all drawings, which will be used. This schedule of drawings shall show the drawing number, title, revision number together with the proposed date of issue. A revised schedule shall be furnished periodically at least on monthly basis, until the construction/ fabrication work is completed.

7.6.1.10.1.9 Sequential submission of drawing and documents as per the schedule is essential for proper review/ approval of these by the Owner/PMC and timely completion of the project and shall be adhered to by the LSTK Contractor. In case sequential submission of the documents/ drawings is not maintained by the LSTK Contractor, any consequential delay and liabilities will be to LSTK Contractor’s account.
7.6.1.10.1.10 The documents/drawings submitted for review by Owner/PMC will be returned with comments to the LSTK Contractor subject to the compliance of all requirements.

7.6.1.11 VENDOR PRE-QUALIFICATION REQUIREMENT

All Instruments and accessories supplied shall be from the Suggested Vendor’s list attached elsewhere in this bid document. All instruments shall be field proven elsewhere both with respect to design and materials. No prototype instrument or instrument of an experimental nature shall be accepted.

For any item not mentioned in the Suggested Vendor List, LSTK contractor shall submit a list of suggested vendors and take prior approval of the Owner/PMC before placement of order.

Vendors listed in the OIL’s Approved list do not necessarily imply that all the vendors are having valid DGMS approval for their offered product. This needs to be confirmed by product vendors with valid DGMS approval at the time of bidding.

7.6.1.12 OBLIGATIONS OF THE LSTK CONTRACTOR

7.6.1.12.1.1 LSTK Contractor shall be fully responsible for design, material selection, sizing and selection of the proper instrumentation and controls for the job.

7.6.1.12.1.2 LSTK Contractor shall also supply and clearly specify the provisions and schemes which he is proposing for control panels, power panels, UPS (uninterrupted power supply) distribution panels etc.

7.6.1.12.1.3 LSTK Contractor’s proposal shall fully describe the control system design including special controls, if any.

7.6.1.12.1.4 LSTK Contractor shall be responsible for coordination with other agencies like OEMs for various instruments, Owner / PMC etc.

7.6.1.12.1.5 Proper selection of various instruments should be carried out for hazardous area zones. Barriers, cables, output meters etc. in all instrument loops to ensure that the loop meets requirements for intrinsic safety (fieldbus or otherwise)

7.6.1.12.1.6 Uniformity in selection should be maintained for makes of similar instruments and their accessories for operational convenience, ease of maintenance and spare parts inventory point of view.

7.6.1.12.1.7 Submitting the bar chart, progress report for the work done during the period, manpower and construction equipment deployment details and other such activities.

7.6.1.12.1.8 Providing proper tools and tackles, manpower (fully conversant with their job), consumables required for carrying out and completing the job correctly and within the scheduled time.
7.6.1.12.1.9 Keeping proper record of all free issue material (if any) received, used and balance and submitting the material reconciliation statement at the end of the job.

7.6.1.12.1.10 If there is any conflict in respect of specification, process data sheets, related standards, code etc., LSTK Contractor shall refer the matter to Owner/ PMC for clarification and only after obtaining the same he should proceed further.

7.6.1.12.1.11 It shall be the LSTK contractor’s to provide training to OIL personnel on the following

- DCS system & PLC system including application of simulators
- Flow computer used for Custody transfer application
- Burner management system
- Fire & Gas Detector System
- Foundation Field bus
- Gas chromatography

7.6.1.13 QUANTITY VARIATION

LSTK Contractor shall confirm that the unit price quoted will remain same throughout the term of the contract and any addition / deletion in the quantity shall be as per the unit rate quoted.

7.6.1.14 ATTACHMENTS

For List of Deliverables to be submitted by LSTK contractor, refer Annexure-1.
GENERAL INSTRUCTIONS

1 LANGUAGE

All Correspondences, drawings, calculations, engineering data etc. shall be in English.

2 MEASUREMENT UNITS

All dimensions shown on documents (such as lengths, diameters, elevations, thicknesses, corrosion allowances etc.) and all other data (such as pressures, temperatures, weights, volumes etc.) shall be in metric, except that for pipe sizes and ratings, where customary units shall be used.

3 DOCUMENT IDENTIFICATION

All documents including those of sub-suppliers' shall be identified with the following label located in or adjacent to supplier's standard title box showing document no., revision, date, signatures etc.

PROJECT : EPC IMPLEMENTATION OF 2 NOS. FGGS AND 1 NO. CGGS & OTP
OWNER : OIL INDIA LIMITED, ASSAM.
CONSULTANT : SAIPEM TRIUNE ENGINEERING PVT LTD, NEW DELHI.
DOC NO. : ______________________

4 REVISION IDENTIFICATION

All revisions shall be identified with proper revision marks.

5 PRINT / SOFT COPIES

a) Number of copies for all types of documents shall be defined in the following sheets and submitted to Owner/Consultant for approval.
b) It is essential that the LSTK submits the required number of prints/reproducibles within the stipulated time.
c) Prints shall be folded to A4 size (274 x 216 mm) and tracings shall be roled.
d) All drawings shall be prepared on Auto CAD and drawn to scale to the maximum extent possible.
e) All final documents in floppy diskettes / CD are required / not required to be submitted.

6 DEFINITION OF COLUMNS (in the following sheets)

Column (3) : Number of copies required to be furnished alongwith proposal.
Column (4) : Number of copies required to be furnished for Purchaser/Consultant's Review.
Column (5) : Time in weeks (from the Notification Of Award) within which the documents are to be submitted.
Column (6) : Number of copies required to be furnished for Purchaser/Consultant's Information
Column (7) : Time in weeks (from the Notification Of Award) within which the documents are to be submitted.
Column (8) : Number of copies required to be furnished in a data folder for Purchaser/Consultant's Record.

Column (9) : Number of reproducibles required to be furnished along with those mentioned in Column 8

Column(10) : Time in weeks (before dispatch) within which the documents are to be submitted.

Remarks:
1) Column (4) to (10) of the following sheets shall be filled by LSTK contractor & submitted to owner/consultant for approval, within 2 weeks from the notification of award.

2) LSTK contractor shall check, approve and duly stamp all sub supplier's drawings and documents before submitting to owner/consultant for review.

3) For records final documentation along with shipment shall be submitted in properly identified & demarcated manner.
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**Notes:** Dwgs / Documents submitted by LSTK contractor shall be covered with Index sheet listing out the dwgs / documents submitted.
EPMC SERVICES

FOR

CGGS & OFF TAKE AT MADHUBAN

AND

FGGS AT BAGHJAN & CHABUA

INSTRUMENTATION

DESIGN BASIS

FOR

OIL INDIA LTD., DULIAJAN (ASSAM)
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7.6.4.1 GENERAL

This document covers the general requirements for instrumentation and control design for EPC implementation of 2 Nos. of Field Gas Gathering Stations and 1 No. of Central Gas Gathering Station & Off Take Point for Oil India Limited, Assam.

This document shall be read in conjunction with other documents attached as part of the Bid document. The following priority shall be applied when any contradictions are found between the various specifications or drawings.

1st priority : Design basis for Instrumentation
2nd priority : Technical Specification for various instrumentation items
3rd priority : Other documents attached as part of the Bid document
4th priority : Industry codes & standards

Note:
The contradictions shall be brought to the notice of Owner / Consultant immediately for approval.

All design shall be done based on the Best Available Technology.

7.6.4.2 UNIT OF MEASUREMENT/ DISPLAY UNITS

a) Flow
i) Liquid : kL /Hr
ii) Gas : Sm³/Hr
b) Pressure : Kg/cm²g
c) Temperature : Degree C
d) Level : % and mm
e) Energy : BTU, kcal

7.6.4.3 POWER SUPPLY

i) Field Instruments : 24V DC (2 wire system) & FISCO power supply
ii) PLC/DCS : 230V AC from dual UPS
iii) Flow Computer : 230V AC from dual UPS
iv) Fire Alarm Panel : 230V AC from dual UPS
v) Gas Chromatograph : 230V AC in field/ 24 VDC or 230V AC in control room
vi) Fire/Gas Detectors : 24V DC
vii) Flow Meters : 24V DC
viii) Level Gauge Illumination : 230V AC
ix) Control Panel illumination : 230V AC
x) PLC Interrogation Voltage : 24V DC  
xi) Solenoid Valves, Switches : 24V DC  
xii) Coriolis meter electrical jacketing : 230 V AC  
ixii) Ultrasonic flowmeters : 230 V AC 
ixiv) Magnetic flowmeters : 230 V AC

Note

24 VDC shall be derived from 230 VAC dual UPS supply which shall be made available in the plants. The UPS shall be located in the control room and shall have 12 hour battery backup.

7.6.4.4 INST. AIR SUPPLY 
8.5 kg/cm2a (Madhuban, Baghjan & Chabua)

7.6.4.5 INST. GAS SUPPLY 
8.5 kg/cm2g (Madhuban, Baghjan & Chabua)

7.6.4.6 AREA CLASSIFICATION 
Process Area : Zone 1/2, temperature class T3, gas groups IIA/ IIB as per relevant area classification drawings 
Control Room : Safe area

7.6.4.7 TRANSMISSION AND CONTROL SIGNAL 
Electronic (in the order of preference) : Foundation Fieldbus  
HART  
4~20 mA DC 
Pneumatic : 0.2 to 1.0 kg/cm2g

Note: Wherever serial transmission of data is required, RS485 with MODBUS protocol shall be considered.

7.6.4.8 EXPLOSION PROTECTION 
Field transmitters (2 wire) – FISCO (wherever available) or intrinsically safe  
Electropneumatic positioners – FISCO (wherever available) or intrinsically safe  
Field switches, Solenoid valves, Field transmitters requiring separate power supply – Flame proof
Junction boxes – flameproof & weatherproof for flame proof instruments, weatherproof for intrinsically safe instruments

Local panels in hazardous area - Flameproof

All electronic instruments shall be certified by CMRI & should have valid DGMS approval. For imported equipment, DGMS approval no. and mark must be embossed on equipment as mentioned in approval letter issued by DGMS. DGMS certification shall be done before installation.

7.6.4.9 WEATHER PROTECTION

Field instruments / Junction boxes/
Local panels – NEMA 4/ IP 65 (The enclosure shall comply with the requirements of NEMA ICS-6)

Safe area instruments – IP 22

7.6.4.10 CERTIFICATION

All mass flowmeters and ultrasonic flowmeters shall be certified by FCRI, Palghat. Ultrasonic flowmeters used for custody transfer applications shall be wet calibrated with natural gas at NABL accredited laboratories.

All electronic instruments shall be certified by CMRI & should have valid DGMS approval. DGMS certification shall be done before installation.

7.6.4.11 FIELDBUS SPECIFICATION

All instruments shall be Foundation Fieldbus compatible, wherever possible and designed as per Fieldbus Intrinsically Safe Concept (FISCO), high powered trunk concept with the field barriers placed inside DGMS approved junction box, no live maintenance on trunk and surge protector in each trunk as well as both side of field barrier.

All Foundation Fieldbus devices shall be interoperable and shall confirm to Host Interoperability Support Test (HIST)

Chicken foot topology shall be used for wiring fieldbus instruments. Only one device/ spur shall be considered.

One fieldbus trunk shall accommodate a maximum of six instruments which includes a maximum of two control loops. Suitable terminators shall be provided at the ends of trunk. The design of H1 segments shall be done such that H1 segment shall have provision to add at least one instrument per segment in future.

Combined total length of spurs and trunk shall be limited to 1900 m. Length of each spur shall be limited to 30 m.
The limiting values of voltage, current, power, capacitance and inductance for hazardous and safe area devices shall be as per IEC 60079-27.

Fieldbus Tester with all necessary accessories for monitoring and troubleshooting of fieldbus networks, including signal levels, noise levels, power levels, wiring integrity, bus traffic etc. shall be provided.

7.6.4.12 FIELD INSTRUMENTS

Field instruments shall be as indicated in P&ID. Additionally one portable dew point meter and two nos. of portable gas detectors shall be provided for each of the three plants.

All pressure instruments shall be provided with isolation, drain and vent valves. Pressure instruments installed on the flow lines at Baghjan and Chabua FGSs shall be diaphragm seal type.

The Coriolis mass flowmeter associated with the test separator condensate measurement shall be provided with electrical jacketing to prevent clogging of the meter’s flow tube when the test separator is not in use and when the ambient temperature is low. It shall be possible to manually start the heating when required. A local on-off switch shall be provided for this purpose.

High accuracy (4 path) Ultrasonic Flowmeters shall be used for custody transfer of natural gas in Madhuban, and test separator gas flow in Baghjan and Chabua. 2 path Ultrasonic Flowmeters are envisaged for gas measurement after production separators at Baghjan & Chabua. Ultrasonic flowmeters shall also be considered for flare gas measurement.

Magnetic flowmeters working on the principle of Faraday’s law shall be provided for the measurement of formation water in Madhuban, Baghjan and Chabua.

Switches shall be hermetically sealed with potential free contacts.

Temperature elements shall be mounted on thermowells. The transmitters shall be remotely mounted from the elements.

For metering systems other than mass flowmeters, pressure & temperature compensation shall be done in the DCS as per AGA standards. For custody transfer applications, this shall be done in the respective flow computers.

All field instruments will have weather proof covers / canopies made of 3 mm thick mild steel. Gas chromatographs shall be housed in an analyzer shelter.

All field instruments shall have lightning protection circuits and shall be designed and manufactured to operate in 100% or above relative humidity environment.

Cables shall be terminated in terminal blocks. Flying leads are not acceptable.
The material of construction of the instruments shall be suitable for the process fluid and shall be inline with the relevant pipe class.

All instruments and control systems used shall have a proven track record of minimum three years of successful operation in similar applications.

Note
For the specifications relating to individual instruments and the applicable codes and standards, refer Technical Specifications attached elsewhere in the bid document.

For hookup and installation details of field instruments, refer Instrument Hookup Drawings & Installation Drawings attached elsewhere in the bid document.

7.6.4.13 INSTRUMENT PROCESS CONNECTION

Pressure/ Differential pressure instruments – ½” NPT on pipe & 1-1/2” Flgd on Vessels
Diaphragm seal instruments - 1-1/2” flanged
Temperature instruments – 1-1/2” flanged
Ultrasonic/ Coriolis/ EMF Flowmeters – Flanged (inline)
Valves/ Flame Arrestor - Flanged (inline)
Level Gauges on vessel/ standpipe – 1” flanged
Level transmitters on vessel/ standpipe - 2” flanged
Level transmitters (single nozzle) – flanged (on vessel); size as per manufacturer’s standard
Gas chromatograph/ dew point analyzer/ sand probe – 1-½” flanged (on pipe)

7.6.4.14 STANDARDS FOR INSTRUMENT CONNECTIONS & MATERIAL

Flange ANSI
Thread NPT
Material ASTM

7.6.4.15 COLOUR CODING

All panels (all sides, inside, outside) shall be RAL 7035 (grey) with black base channel.

Instrument colour coding shall be as per manufacturer’s standard.

7.6.4.16 CONTROL PHILOSOPHY

Mode of Plant Operation : automatic, centralized control and monitoring from control room located in safe area
Type of Control/ Monitoring:
- Continuous monitoring and control through DCS.
- Shutdown operations through PLC on gas leakage and/or outbreak of fire.
- Fire detection via smoke/heat detectors connected to Addressable Fire Alarm Panel.
- Custody transfer monitoring through flow computers.
- Provision for interfacing to upcoming SCADA.
- Control of various packages via control systems provided by package vendor.

Similar hardware shall be provided in all three control rooms. Hardware shall be interchangeable.

Control systems shall be equipped to handle future instruments also, if any are envisaged.

The control room shall accommodate 4 people.
Control rooms shall be provided with glass walls for viewing the process.

Control room in Madhuban shall be provided with Plasma mimic panel for display of process. Baghjan and Chabua control rooms shall have LED based MIMIC display.

Control room shall have raised flooring at 300mm height from the floor, false ceiling, air conditioning and emergency lighting.

Access control system using smart cards shall be provided to the control room to prevent entry of unauthorized persons. The system shall be complete with punch cards, card readers, control cards, processor and 21” LCD monitor. The system shall be designed for entry of 20 persons in Madhuban and 10 persons each in Baghjan and Chabua.

Cable entry from field to control room building shall be via suitably sized MCT blocks.

The various control systems and their subsystems shall be connected to a high speed ethernet as shown in the Control System Architecture attached elsewhere in the bid document. Data communication protocol for the Ethernet shall be RS485 Modbus. Necessary software for interfacing the various systems shall be provided by the vendor/LSTK contractor. Licensed software shall be used for the control systems.

From the power generator panel, hardwired signals shall be taken to the DCS.

Zener barriers shall be used for isolation.
Printer and scanner shall be provided along with the DCS.

Emergency shutdown signals shall be hardwired.

Digital signals from PLC to solenoid valves and MCC shall be through interposing relays.

Interfacing between PLC and MCC shall be hardwired.

The ESD controls shall be made available at the control room and exit gates and also at other required locations in the plant area.

Emergency power shutdown switches shall be provided near exit gate and in control room for complete power cutoff from the station during emergency. The actuating switch shall have a protective glass cover.

All hazardous areas shall be covered by fire detection facility, addressable at control room. Detection shall be via flame detectors in hazardous area connected to ESD PLC & smoke and heat detectors in safe area connected to Fire Alarm Panel in control room. Fire Alarm Panel inturn shall provide confirmed fire, alarm and fault signals to ESD PLC via hardwired signals.

Manual Alarm call points along access ways, hooter and ESD pushbuttons at strategic locations shall be provided. Entire hazardous area shall be covered with manual alarm call points of break glass type.

Electrically operated hooter will be required in the installation. The hooter shall be powered from UPS & should be audible inside the entire installation. Hooter switches shall be provided inside the control room, at all security posts & at exit gates. Hooter shall be provided in the security barrack also.

Electrical alarm bells connecting the gate, office, barrack & watch towers shall be provided.

Fixed gas detector outputs shall be connected to ESD PLC. Two portable gas detectors (DGMS certified) shall be provided for each of the three plants.

Custody transfer metering conforming to OIML and other relevant standards shall be provided at CGGS & OP. Flow shall be monitored and controlled via flow computers installed in auxiliary metering panel in control room.

Ultrasonic flow meters shall be used for volumetric measurement of sale gas.

Each custody transfer line will have two flow meters – one main and one standby. The flowmeters shall be connected to flow computers on the metering panel. Check meters are excluded from LSTK contractor’s scope.

Gas chromatograph input shall be used for calculation of energy content of the sale gas in the flow computer.
Each flow computer shall interface with the DCS via MODBUS RS 485 serial link.

Three control systems at Madhuban, Chabua & Baghjan, should have the provision for interfacing with upcoming SCADA whose Master Control Station shall be at Duliajan.

7.6.4.17 TYPE OF OPERATOR INTERFACE

DCS: PLASMA MIMIC Panel (at Madhuban only)
Hardwired LED MIMIC display (at Chabua & Baghjan). Plasma display in the best available size to suit the control room wall in Madhuban shall be provided.

: 1 no. 21” LCD DCS Engineering/Operator station,
2 nos. 21”LCD Operator stations at Madhuban.
1 no. 21” LCD DCS Engineering/Operator station,
1 no. 21”LCD Operator station at Baghjan & Chabua.

PLC: 1 no. of 21” LCD Engineering station each at Madhuban, Baghjan & Chabua

CCTV: CCTV monitoring station in Control Room at Madhuban

Access Control System: 1 no. of 21” LCD monitoring station each at Madhuban, Baghjan & Chabua

The MMI shall display other signals connected to the DCS (flow computer data, Fire Alarm Panel data, Gas Chromatograms, package data etc.) The list of parameters to be displayed in DCS shall be finalized during detailed engineering. All required software shall be provided by the system vendor/LSTK contractor.

7.6.4.18 AUXILIARY PANELS IN CONTROL ROOM

a) ESD panel containing ESD pushbuttons, hooter switch etc.
b) Metering panel consisting of flow computers, gas chromatograph controller and printer
c) Fire Alarm panel taking inputs from heat and smoke detectors
d) Burner Control System Panel with facilities for remote ignition (for Baghjan and Chabua)

Note:
The adjoining rack room of the control room for all the three plants shall house I/O racks and marshalling panels. The DCS engineering workstation at Madhuban CGGS shall be located in the rack room.
7.6.4.19 **FINAL CONTROL ELEMENTS**

Pneumatic control valve with Electro Pneumatic Positioner. (The electropneumatic positioner shall be FF compatible)

7.6.4.20 **START UP/SHUT DOWN OPERATION**

Pump start/stop soft PB in DCS.
Interlock trip from ESD PLC.
Pump RUN, FAULT & AVAILABLE indication in DCS.
Pump to be stopped from DCS or Local at any time.
Local switch for pump Start/ Stop.

7.6.4.21 **PACKAGES**

All control/monitoring functions shall be performed by stand-alone control system provided by package supplier. Control of flare system, burners in Baghjan & Chabua and instrument air compressor shall be PLC based. (PLC to be provided by package vendor) Connectivity to DCS shall be through MODBUS RS 485 serial link.

Shutdown signals shall be hardwired from ESD PLC.

Burner Management System of indirect water bath heater shall be remote type and shall be mounted in control room. Remote ignition system for indirect bath heater to be provided.

7.6.4.22 **ALARM DISPLAY**

All alarms shall be available in operator stations and also in hardwired LED mimic display panels in Chabua and Baghjan.

7.6.4.23 **INTERLOCK**

i) Type of logic : Normally closed, open to alarm; fail safe

ii) Solenoid valves & Relays : Normally energised

ii) Logic representation : As per ISA S 5.2

7.6.4.24 **CABLING PHILOSOPHY**

All field cables shall be armoured.

Flame retardant cables shall be used for control applications and fire resistant cables shall be used for safety applications.

Separate cable runs shall be considered for analog signals, digital signals, fire detector signals, FF signals and serial link. Separate cable runs shall be
considered for flame retardant and fire resistant cables. Separate cable runs shall be considered for signals going to different systems (DCS, PLC, Fire Alarm Panel etc). Cable segregation shall be done by LSTK contractor; cable routing shall be finalized during detailed engineering. Suitable distance shall be maintained between various cable runs as per standard engineering practices to minimize interference. Supports for cable trays shall be provided at suitable intervals as per standard engineering practices.

Cables between control room and process area shall be laid in sandfilled cable trenches. In field area, all cables shall be laid in cable trays and cable trays shall be covered.

Route of the underground cabling should be properly marked with adequate nos. of markers.

The control room office building will have concealed conduit wiring with FRLS copper cable.

### 7.6.4.25 EARTHING

Control room mounted panels’ body earth (includes panel mounted bulk power supply earths) and instrument cable armour : Dirty earthing pit

Shield wires of non-IS instruments : Clean earthing pit

Shield wires of IS an instrument : IS earthing pit

### 7.6.4.26 APPLICABLE CODES & STANDARDS

The applicable National / International codes and standards are indicated below. These shall be suitably applied for the design of instruments and control systems. This list does not absolve the Contractor of his responsibility for proper design of instrumentation and controls based any other code that is relevant to the particular application, but not included in the list below. Incase of such omissions, the same shall be brought to the immediate notice of the Owner/ Consultant. The referenced standards shall be of the latest edition, including amendments, unless an edition is mentioned.

**Note:**
For the specifications relating to individual instruments and the applicable codes and standards, refer Technical Specifications attached elsewhere in the bid document.

**INDIAN STANDARDS (IS)**

IS - 319 Specification for free cutting Brass bars, rods and sections

IS – 1239 Mild steel tubes, tubulars and other wrought steel fittings
<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>IS-1271</td>
<td>Specification of Thermal Evaluation and Classification of Electrical Insulation</td>
</tr>
<tr>
<td>IS – 1554 Part-I</td>
<td>PVC Insulation (heavy duty) electric cables-working voltage upto and including 1100V</td>
</tr>
<tr>
<td>IS – 3624</td>
<td>Specification for pressure and vacuum gauges</td>
</tr>
<tr>
<td>IS – 5831</td>
<td>PVC insulation and sheath of electric cables</td>
</tr>
<tr>
<td>IS – 7358</td>
<td>Specifications for Thermocouples.</td>
</tr>
<tr>
<td>IS2147</td>
<td>Degree of protection provided by enclosures for low voltage switchgear and control gear</td>
</tr>
<tr>
<td>IS 2148-1981</td>
<td>Flameproof enclosures for electrical apparatus Rev. 2nd and. 5th</td>
</tr>
<tr>
<td>IS 5</td>
<td>Indian std. for colours for ready mixed paints and enamels 4th rev. amd. 1.</td>
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</tbody>
</table>

**AMERICAN GAS ASSOCIATION (AGA)**

- Report No 3: Gas custody metering based on orifice metering
- Report No 7: Gas custody metering using turbine meters
- Report No 8: Compressibility and Super-compressibility for Natural Gas and other Hydrocarbon Gases. Transmission Measurement
- Report No 9: Gas custody metering using Ultrasonic flow meters

**AMERICAN PETROLEUM INSTITUTE (API)**

- API-RP-520: Sizing, selection & installation of pressure relieving system in part I and II refineries.
- API 521: Guide for pressure and depressurising system.
- API 526: Flanged steel safety relief valves. Design and manufacture as per ASME section VIII and orifice calculation as per API -RP-520 part I and II, appendix C
- API 527: Commercial seat tightness of safety relief valves with metal-to-metal seat.
- API RP 551: Process Measurement Instrumentation
- API RP 552: Transmission System
API 2000  Sizing of pressure / vacuum relief valves on storage tanks.
API 600  Steel Valves - Flanged & Buttwelding Ends
API 6D  Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)
API 598  Valve Inspection & Testing
API 607  Fire Test for Soft-Seated Quarter-Turn Valves
API 609  Butterfly Valves, Lug-Type and Wafer Type
API 6FA  Fire Safe test
API 670  Vibration, Axial Position and bearing temperature Monitoring System

AMERICAN NATIONAL STANDARDS INSTITUTE/ AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ANSI/ASME)

ANSI/ ASME  Boiler and Pressure Vessel Code, including all mandatory addenda
a) ASME Boiler and pressure vessel code section I
   - Design, manufacture and calculation for steam services in fired pressure vessels.
b) ASME Boiler and pressure vessel code section VIII
   - Design, manufacture and calculation for steam, gas, vapour and liquid services in unfired pressure vessels

ANSI/ ASME B1.20.1  Screw Threads - Pipe Threads, General Purpose (Inch)
ANSI/ ASME B16.5  Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24
ANSI/ ASME B16.11  Forged Steel Fittings, Socket-Welding and Threaded
ANSI/ ASME B16.20  Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed
ANSI/ ASME B16.25  Buttwelding Ends
ANSI/ ASME B16.34  Valves – Flanged, Threaded and Welding End
ANSI/ ASME B16.47  Large Diameter Steel Flanges NPS 26 Through NPS 60
ANSI/ ASME MC96.1  Thermoelectric properties and limits of error
ANSI/ ASME PTC 19.3  Temperature Measurement
Part 3

**AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)**

ASTM A193/ A193M  Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A194/ A194M  Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both

ASTM A320/ A320M  Alloy-Steel Bolting Materials for Low-Temperature Service

ASTM A350/ A350M  Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components

ASTM A352/ A352M  Steel Castings Ferritic and Martensitic for Pressure-Containing Parts Suitable for Low-Temperature Service

**ETHERNET STANDARDS**

IEEE 802.3  Carrier Sense Multiple Access With Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

IEEE 802.4  Token Ring Access Method and Physical Layer Specifications

IEEE 802.5  Token Ring Access Method and Layer Specifications

**FLUID CONTROL INSTITUTE (FCI)**

FCI 70-2  Control Valve Seat Leakage

**INSTRUMENTATION, SYSTEMS AND AUTOMATION SOCIETY (ISA)**

ISA S-5 .1  Instrumentation Symbols and Identification

ISA S-5.2  Binary logic diagrams for process operation

ISA S-5.3  Graphic Symbols for Distributed Control/ Shared Display Instrumentation, Logic and Computer Symbols

ISA 50.1  Compatibility of Analog Signals for Electronic Industrial Process Instruments
ISA 75.01 Flow Equations for Sizing Control Valves
ISA 75.02 Control Valve Capacity Test Procedure
ISA 75.03 Face-To-Face Dimensions for Integral Flanged Globe-Style Control Valve Bodies (ANSI Classes 125, 150, 250, 300, and 600)
ISA 75.04 Face-To-Face Dimensions for Flangeless Control Valves (ANSI Classes 150, 300, and 600)
ISA 75.16 Face-To-Face Dimensions for Flanged Globe-Style Control Valve Bodies (ANSI Classes 900, 1500, and 2500)
ISA 75.19 Hydrostatic Testing of Control Valves
ISA 12.01.01 Definitions and Information Pertaining to Electrical Apparatus in Hazardous (Classified)
ISA S 18.1 Specifications and guides for the use of general Annunciators
ISA S 84.1 Reliability calculation.
ISA S 75.11 Flow characteristics & rangeability
ISA SP 75.17 Aerodynamics noise prediction

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60079 Electrical Apparatus For Explosive Atmospheres
IEC 61131(Parts1-4) Programmable controller
IEC 61508 Functional safety programmable electronic systems
IEC 61511 Functional safety – Safety instrumented systems for the process industry sector.
IEC 801 Electromagnetic compatibility for industrial process measurement & control equipment
IEC 68 Environmental testing
IEC 584 Thermoelectric properties and limits of error
IEC 585 Insulation limit of impurities
IEC 1285 Design of purged enclosure
IEC 534.8.3 Aerodynamics noise prediction
EN 60950-1992 Power supply
EN 50081/82 Electromagnetic compatibility
EN 50-014 / 020 Electrical Apparatus for Potentially Explosive Atmosphere.
IEC 534 Industrial - Process Control Valves
IEC 654 Measurement and Control equipment
IEC 751  Industrial Platinum Resistance Thermometer Sensor
IEC 902  Industrial Measurement and Control Terms and Definitions
IEC 529  Environmental Protection of equipment
IEC 61158  Digital Data Communication for Measurement and Control – Fieldbus for use in industrial control systems
IEC 61158-2  Physical Layer specification & service definition

INTERNATIONAL ORGANISATION FOR STANDARDISATION (ISO)
ISO 4200  Plain End Steel Tubes, Welded and Seamless - General Table of Dimensions and Masses per Unit Length.
ISO 5167  Calculation & construction standard for Orifice
ISO 5167.1  Calculation & construction standard for Venturi

MANUFACTURER'S STANDARDIZATION SOCIETY (MSS)
MSS SP 67  Butterfly Valves
MSS-SP-61  Pressure Testing of Steel Valves

DIN
DIN 43760  Measurement Standard for RTD.
DIN 19243  Measurement and Control Electrical Sensors, Electrical Position Sensors and Signal Converters used for Intrinsically safe two-wire DC System

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)
NACE MR-175  Sulfide stress cracking resistant metallic materials for oil field equipment.
-2002

BRITISH STANDARDS
BS – 1042  Measurement of fluid flow in closed conduits
BS – 4368  Compression couplings for tubes
BS – 5308 Part-2  Specification for PVC insulated cables

INTERNATIONAL ORGANIZATION FOR LEGAL METROLOGY (OIML) STANDARDS
R 6 - EN  General provisions for gas volume meters
R 32 - EN  Rotary piston gas meters and turbine gas meters
R 34 - EN  Accuracy classes of measuring instruments
R 137-1 – EN  Gas Meters. Part 1: Requirements

FIELDBUS FOUNDATION STANDARDS

FF-103  Common File Format
FF-581  System Architecture
FF-586  Ethernet Presence
FF-588  Field Device Access Agent
FF-589  HSE System Management
FF-593  HSE Redundancy
FF-801  H1 Network Management
FF-803  HSE Network Management
FF-806  H1 Data Link Bridge Addendum
FF-816  31.25 kbit/s Physical Layer
FF-821  H1 Data Link Services
FF-822  H1 Data Link Protocol
FF-830  31.25 kbit/s Physical Layer Conformance Test
FF-831  Fieldbus Power Supply Test Specification
FF-870  Fieldbus Message Specification
FF-875  Fieldbus Access Sublayer
FF-880  H1 System Management
FF-883  Software Download Addendum
FF-890  Function Block AP Part 1
FF-891  Function Block AP Part 2
FF-892  Function Block AP Part 3
FF-893  Function Block AP Part 4
FF-894  Function Block AP Part 5
FF-900  Device Description Language
FF-902 Transducer Block Common Structure
FF-903 Pressure Transducer Block
FF-940 Communication Profile
FF-941 HSE Profile

NATIONAL FIRE PROTECTION ASSOCIATION
NFPA 70 National Electric Code
NFPA 72 National Fire Alarm Code

NATIONAL ELECTRICAL MANUFACTURER’S ASSOCIATION
NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS-6 Industrial Control and Systems: Enclosures

OIL INDUSTRY SAFETY DIRECTORATE (OISD)
OISD-RP-147 Inspection & Safe Practices during Electrical Installations
OISD-RP-149 Design Aspects for Safety in Electrical Systems
OISD-RP-152 Safety Instrumentation for Process System in Hydrocarbon Industry

OIL MINES REGULATION (OMR) - 1984
7.7 SCOPE OF WORK FOR CHEMICAL LABORATORY
7.7 Scope of Work For Chemical Lab

The Contractor is to set up Chemical Laboratories in the Control Room Buildings at FGS at Chabua and CGGS at Madhuban. The laboratories should have all the Instruments, Equipment and other items required for Gas Station and shall be under the scope of supply and installation of the Contractor.

The Contractor is to develop complete Plan for Laboratory layout showing location of all the Instruments, equipments and other laboratory items required to set up a standard Lab to meet ISO/ ISRS requirements.

Proper sitting arrangement for laboratory tester is to be provided in both the laboratories. Further one room is to be provided for the Lab In-charge (Senior Level Officer) with proper furniture.

The Gas Chromatograph (GC) should be able to analyze trace presence of H₂S in addition to other normal Gas Components. The GC should have the capability and configuration for compositional analysis of condensate required for phase behavior study.

The laboratory at FGS Chabua will be set up mainly for analyzing the discharge water quality. Proper sitting arrangement is to be provided for Laboratory testers.

The requirements of various Laboratory Equipment but not limited to for CGGS at Madhuban and FGGS at Chabua are given below.

For Gas Laboratory at Madhuban

1. Gas Chromatograph
2. Clarus 500 Simulated Distillation
3. Hydrogen Generator
4. Air & Nitrogen Generator
5. Nitrogen Generator
6. Air Generator
7. Dew Point Meter
8. “O” grade Air Cylinder
9. Nitrogen Gas Cylinders, High Purity
10. Hydrogen Gas Cylinders, High Purity
11. Helium gas cylinder, High Purity
12. Liquid Carbon Dioxide gas cylinder
13. Liquid Nitrogen with Canister

For Analytical Laboratory at Madhuban and Chabua

1. Digital pH meter
2. Dissolved Oxygen meter
3. Oil Content Analyzer
4. Automatic Digital BOD Analyzer
5. Flame Photometer
6. Photometer SQ118

In addition to the above instruments and cylinders the contractor will arrange and supply all required Reagents and Glass wares like Burettes, Pipettes, Glass rods, Porcelain basin, Conical flasks, Volumetric flasks, cylinders and other consumables like Tissue/ filter papers etc.
7.8 SCOPE OF WORK FOR OPERATION AND MAINTENANCE
7.8 **SCOPE OF WORK: O&M**

The Scope of Work (SoW) for O&M contractor should cover, but not limited to, the following points:

7.8.1 Guarantee on the plant/ installation performance at desired level (as per the design rating), as stipulated in the Technical Tender Documents, which shall entail amongst others, the functioning of power generation and distribution system, instrument air supply system, fuel gas system, fire fighting system, water supply system, effluent treatment system, flare system, condensate handling system, gas well testing system, communication system, field and control room instrumentation & control system, control room computer system, HVAC system, online measurement systems, laboratory equipment etc. etc. of the plant for 365/366 days at desired rating. Contractor to ensure Operation and maintenance of the PLANT on round the clock.

7.8.2 Participate in Preparation of OPERATION AND MAINTENANCE SUPPORT INFORMATION (OMSI) by EPMC.

7.8.3 The total man power required for complete operation and maintenance of the stations should be provided by the O&M contractor for which separate organization charts (function wise) showing qualifications of the persons to be provided along with the BID. The contractor shall provide adequate skilled and experienced staff capable for operation and maintenance of the stations. This shall include experienced staff under a station manager. The person deployed by contractor has to be as per agreed organization chart. The experience of the persons has to be got certified by the Engineer-In-Charge. **MINIMUM QUALIFICATION & EXPERIENCE:**

a) Skilled / Semi-skilled labor shall have minimum 2-3 years experience in similar works, preferably in a similar industrial unit

b) Supervisors shall be ITI pass with working knowledge of English, Hindi and local language and 4-5 years experience in a similar industrial unit.

c) Operators shall be Diploma in Engineering in their respective discipline and 2 – 3 years experience in an industrial unit.

d) Shift Engineers (3-4 years experience) and Engineer- in- Charge (7-8 years experience) shall have Bachelor Degree in Engineering from a recognized university.
7.8.4 The O&M contractor shall guarantee that minimum no. of personnel per day and/or per shift shall be deployed strictly as per the agreed organization chart and there shall not be any deviation from that under any circumstances. OIL may terminate the contract in case the O&M contractor deviates from above.

7.8.5 House keeping of the station in totality including External Housekeeping, covering grass cutting, gardening, watering the pots, vests and gardens, all type of house cleaning viz. carpet cleaning, window & door cleaning, floor cleaning including toilet & kitchen cleaning etc. etc. shall be the responsibility of the contractor to keep it in the tip top environmentally safe condition.

**External Housekeeping shall also cover the following:**

i) Cleaning & sweeping of external areas of plant site and collection of garbage / waste including disposing it to the designated locations inside the plant premises.

ii. Cutting and removal of all trees of various sizes & girth under the H.T lines inside plant premises.

iii. Miscellaneous works like cleaning of storm water drains, tunnels & trenches etc. as and when required.

iv. Deployment of dumpers / trucks for handling / disposal of the garbage, debris, trees etc.

v. Cleaning of entire inside surface of fresh and fire water reservoirs manually by providing labour, tools and tackles, ladder / scaffolding, other devices etc. required to remove completely the algae growth, silt deposits and greasy substances and dispose off the same to a designated location.

vii. Other labour oriented jobs on exigency to meet O&M requirement.

7.8.6 The preventive maintenance schedule (monthly/quarterly/yearly) for all equipments & instruments, machines, sheds, roof & buildings (exterior and interior) would be O&M Contractor’s responsibility. (Standard schedules for each and every item to be provided along with the BID).

7.8.7 Accordingly, the routine maintenance schedule (monthly /quarterly /yearly) for each and every item would be at the contractor’s responsibility. (Standard Schedules for each and every item to be provided along with the BID).
7.8.8 All requirements (procedures, monitoring, analysis and record keeping etc) for an ISO/ISRS installation will be maintained and carried out by the Contractor.

a) All report generation and reporting shall be in specified OIL approved Performa. Reports shall be inclusive of Environmental record – Tracking of discharge levels (air and water) and non-compliance situations. **Reports shall include Quarterly Reports to DGMS also or any other essential report not spelt out here.**

b) The O&M contractor shall maintain all necessary documentation and records such as log sheets, charts, performance registers, inventory registers, equipment history, laboratory test reports, daily, weekly, monthly, performance reports, chemicals and reagents consumption reports. These documents shall be developed in consultation with OIL. Relevant important data shall be computerized for easy scrutiny of various parameters as well as given in graphical form wherever possible to facilitate monitoring of the performance on a monthly basis by first week of every month.

c) The daily report, weekly report, monthly report & annual reports in triplicate are to be issued. Clearly showing the daily consumption chemical rate, cumulative chemical consumption/spares details with tabular & graphical representation, preventive maintenance & breakdown maintenance details, deviations from the design value, online instrument status etc. as decided by the Engineer-In-charge.

d) The O&M contractor shall maintain accounts for receipt, consumption and inventory of all chemicals, spares and consumables.

7.8.9 The systematic training module for imparting on the job training to OIL personnel to be provided along with BID.

7.8.10 All routine checks and other activities as and when required to ensure safe operating practices as per OMR/ OISD and other statutory regulations. This is applicable to all other materials handling also.
7.8.11 Care for environment protection as per standard practice and regulations during operation and maintenance of the plant is contractor's responsibility. The bidder should be well aware of the Environmental Regulation Acts and comply to the requirement fully.

7.8.12 Maintenance required for structures, buildings, roofs, roads, drains etc. shall be carried out by the contractor (as per agreed schedule).

7.8.13 Schedule of change of lube oil of the prime movers is at contractor's scope. However the lube oil for this purpose will be issued by OIL.

7.8.14 The painting schedule of all the items inside the stations viz. equipments, instruments, building, structure etc. are in contractors scope(as per agreed schedule).

7.8.15 Spares:
   • Management and supply of spares and lube oil for plant (based on the agreed list of items and quantity) is OIL's scope. However, such supply shall be based on the timely and advance indication received from the O&M contractor on the status of actual plant operating conditions
   • The quantities and list of items shall be agreed by both OIL and O&M contractor and shall form basis of O&M spares.
   • O&M contractor's scope includes preparation of specifications and Purchase proposals in OIL's procedural formats for OIL to purchase the spare according to O&M schedule.

7.8.16 Report on Backlog of corrective maintenance shall be generated by O&M contractor as an indicator of workload issues and effectiveness of preventive/predictive maintenance programs.

7.8.17 Safety record generation by O&M contractor. Commonly tracked either by number of loss-of-time incidents or total number of reportable incidents.

7.8.18 Energy use reports as a key indicator of equipment performance, level of efficiency achieved, and possible degradation.

7.8.19 WORKMANSHIP: The workmanship shall be one of best class achievable in the industry and acceptable to the OIL Engineer –in –Charge. Rectification on account of poor workmanship shall be done by the contractor to the satisfaction of Engineer. During inspection, because of poor workmanship, if an area is not found to the satisfaction of the OIL Engineer –in –Charge, he may deduct a suitable amount from the bill of the contractor.

7.8.20 Daily Attendance of all personnel shall be taken by Contractor and verified by the OIL Engineer –in –Charge or his authorized representative. The
contractor shall indicate daily wage rate of each individual as per the agreed organization chart.

7.8.21 INSPECTION & CHECK: All the works is subject to the inspection of the OIL Engineer—in—Charge. The work shall be carried out in a manner, acceptable to the Engineer. The contractor shall rectify any shortcoming pointed out by the Engineer or his authorized representative.

7.8.22 HEIGHT PASS: In case the work is required to be executed at higher elevations above the ground, the contractor shall arrange height pass for each and every such person employed by him in the work for working at height.

7.8.23 EQUIPMENT & MATERIAL TO BE USED IN WORK: The contractor shall arrange the following items at his own cost for carrying out the job.

a. Safety gear to be used by workers such as helmets, face / dust masks, hand gloves, gumboot, tie-ropes, spades, axes, ghamela, hard broom, wire brush etc.

b. General and special Tools & tackles required for this job.

c. Dumpers / Trucks as and when required including cost of diesel, driver etc. Payment shall be made separately for hiring charges of Dumpers / Trucks.

7.8.24 All arrangements and operations required to carry out detailed gas well testing in FGS Chabua are in O&M contractor’s scope of work. Contractor is required to quote price for a single gas well test with major stepwise breakup. Payment shall be based on actual number steps and test carried out successfully.

7.8.25 The contractor shall be responsible for handling and solving local problems and disputes.

7.8.26 Developing the O&M Structure

The O&M contractor should agree to the following while discharging their duties,

Operations:

- **Administration** – To ensure effective implementation and control of operation activities.
- **Conduct of Operations** – To ensure efficient, safe, and reliable process operations.
• **Equipment Status Control** – To be cognizant of status of all equipment.
• **Operator Knowledge and Performance** – To ensure that operator knowledge and performance will support safe and reliable plant operation.

### Maintenance:

• Administration – To ensure effective implementation and control of maintenance activities.
• Work Control System – To control the performance of maintenance in an efficient and safe manner such that economical, safe, and reliable plant operation is optimized.
• Conduct of Maintenance – To conduct maintenance in a safe and efficient manner.
• Preventive Maintenance – To contribute to optimum performance and reliability of plant system and equipment.
• Maintenance Procedures and Documentation – To provide directions, when appropriate, for the performance of work and to ensure that maintenance is performed safely and efficiently.

### Engineering Support:

• Engineering Support Organization and Administration – To ensure effective implementation and control of technical support.
• Equipment Modifications – To ensure proper design, review, control, implementation, and documentation of equipment design changes in a timely manner.
• Equipment Performance Monitoring – To perform monitoring activities that optimize equipment reliability and efficiency.
• Engineering Support Procedures and Documentation – To ensure that engineer support procedures and documents provide appropriate direction and that they support the efficiency and safe operations of the equipment.

### Training:

• Administration – To ensure effective implementation and control of training activities.
• General Employee Training – To ensure that plant personnel have a basic understanding of their responsibilities and safe work practices and have the knowledge and practical abilities necessary to operate the plant safely and reliably.
• Training Facilities and Equipment – To ensure the training facilities, equipment, and materials effectively support training activities.
• Operator Training – To develop and improve the knowledge and skills necessary to perform assigned job functions.
• Maintenance Training – To develop and improve the knowledge and skills necessary to perform assigned job functions.

Administration:

• Organization and Administration – To establish and ensure effective implementation of policies and the planning and control of equipment activities.
• Management Objectives – To formulate and utilize formal management objectives to improve equipment performance.
• Management Assessment – To monitor and assess station activities to improve all aspects of equipment performance.
• Personnel Planning and Qualification – To ensure that positions are filled with highly qualified individuals.
• Industrial Safety – To achieve a high degree of personnel and public safety.

Plant Operation:-

• The O&M contractor shall collect and analyze all outgoing streams (including effluent) samples including composition of gas in a shift as per agreed periodicity and record the online instrument readings for the same time. This analysis can be carried out at the laboratory inside Control Room Building. This shall also include air quality monitoring as per agreed periodicity.
• The O&M contractor shall identify the process variables that need to be adjusted on a day to day basis for optimum plant operation based on inlet stream parameters in consultation with engineer-in-charge.

Maintenance:

• The O&M contractor shall carry out all on line maintenance / repair jobs required to keep the plant at maximum productivity level, along with the equipment condition monitoring of all such electrical and related instrumentation. These shall include maintenance of all equipment and other facilities within the PLANT as per the maintenance schedule approved by OIL (Pl. refer to Instrumentation Equipments, Mechanical Equipments, Electrical Equipments and the report has to be submitted as per the report format of the plant.
• The maintenance of all the mechanical, electrical equipments and related instrumentation is in the scope of the O&M contractor. Equipments beyond repair will be replaced by OIL.
• The O&M contractor shall carry out corrective maintenance job as and when problems / defects are noticed.
- The O&M contractor shall periodically check/calibrate the various instruments and ensure their proper working. Master instruments shall be provided by OIL at its laboratory.
- The O&M contractor shall periodically check equipment, lubrication, adjustments etc to ensure proper performance.
- The supplier should maintain its own tools & tackles for carrying out all maintenance jobs.
- Spares & consumables required for operation and maintenance of Plant will be provided by OIL. The quantities and list of items shall be agreed to by both OIL and O&M contractor.
- The house keeping and keeping the Plant in good condition shall be the responsibility of the O&M contractor. However the consumables for house keeping of Plant have to be supplied & arranged by the contractor.
- The number of equipments and instruments in Plant has been shown in the tender document.
- All the maintenance has to be carried out with the help of duly approved procedure of OIL and after obtaining necessary work permit as per OIL procedure.

7.8.27 Exclusions:

- OIL shall provide the following:
  a) Provide the contractor to use intercom phone as per OIL centralized infrastructure.
  b) To give access to the areas of the plant as per functional requirement.
  c) All spares and lube oil/chemicals required for the O&M contract.
  e) Necessary work permits as required for the staff, and visiting experts for carrying out work over the system.
  f) Insurance of all the facilities and spares.

7.8.28 Guarantee Parameters:

The O&M contractor shall operate and maintain the installation as per the required specification on atleast 365 days in a year. Maintenance schedules shall be mutually worked out stream-wise so as to ensure availability.

Supplier shall guarantee to achieve the following:

a) Quality and Quantity: The supplier shall be responsible towards operation & maintenance of the system to achieve the specified quality as per the design standards and quantity as per requirement of the Plant.
b) Compliance to Maintenance Schedule: The supplier shall offer services to achieve the overall maintenance schedules.

7.8.29 Penalty for O&M contractor’s shortfall in performance:

- Incase of any short supply of gas from the stations to main trunk line and/or customers from the stations due to fault solely attributable to O&M contractors; penalty shall be levied as follows:
  - deduction of daily payment on prorate basis and
  - any penalty that is imposed by customers on OIL, on account of the short supply due to fault of the O&M contractor, shall be recovered from O&M contractor.
  - any action/penalty by Environment and Pollution board will be sole responsibility of the bidder and they shall bear and take appropriate remedial actions.
Organisation chart with designation and qualification to be deployed has to be submitted, (a skeleton organisation chart is shown below). The supplier has to fulfill the detail organisation chart and attached as annexure.

<table>
<thead>
<tr>
<th>Plant Manager</th>
<th>Qualification – Experience --- Year</th>
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<tbody>
<tr>
<td>GENERAL SHIFT</td>
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<td>Maintainer-</td>
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<tr>
<td>Qualification – Experience --- Year</td>
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<tr>
<td>Maintainer-</td>
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<td>Qualification – Experience --- Year</td>
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<tr>
<td>Helper</td>
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<td>Qualification – Experience --- Year</td>
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<td>ROUND THE CLOCK SHIFT</td>
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<tr>
<td>Operator-1</td>
<td>Qualification – Experience --- Year</td>
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<tr>
<td>Operator-2</td>
<td>Qualification – Experience --- Year</td>
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</tbody>
</table>
PROOF OF ABILITY OF TENDER

Tenderer shall submit, along with their tender, details of their present and past experience in the execution of similar works, including cost of each work and the name of client, place etc. as per the given format along with documental evidence. Separate form for each work carried / being carried out shall be filled up. The supplier who has already executed similar type of job only will be considered. The supplier who can execute the job will not be considered ie. only the experienced supplier will be considered. Under the name of work one has to clarify mention the nature of the work, such as : a) Operation of Plant, b) Maintenance of the Plant, c) Operation & Maintenance of Plant.

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<tbody>
<tr>
<td>1</td>
<td>Name of work</td>
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<td>2</td>
<td>Brief detail of nature of work</td>
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<td>3</td>
<td>Name of the firm/project for whom the project done</td>
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<td>4</td>
<td>Address of the firm or reference and total value of work</td>
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<td>5</td>
<td>Work order no. and date</td>
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<td>6</td>
<td>Duration of work</td>
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<tr>
<td>7</td>
<td>Details of organization structure of manpower deployed for the execution work</td>
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</tbody>
</table>
# Detail of Past Experience

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>NATURE OF JOB</th>
<th>CAPACITY</th>
<th>NAME OF THE CLIENT</th>
<th>DOCUMENTARY EVIDENCE (MENTION ANNEXURE NO.)</th>
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(If space is not sufficient additional sheets may be attached mentioning the annexure no. here)
Schedule of Deviations from Technical Specifications

All deviations from the Technical Specifications shall be filled by the Tenderer, clause by clause, in this schedule.

The TENDER hereby certify that the above mentioned are the only deviations from technical specification of the enquiry and the bid conforms to the specifications in all other respects.

<table>
<thead>
<tr>
<th>Section</th>
<th>Specification No.</th>
<th>Clause No.</th>
<th>Deviation</th>
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SIGNATURE __________________

NAME _______________________

DESIGNATION ________________

COMPANY __________________

DATE ______________________

COMPANY SEAL
Schedule of Deviations from General conditions

All deviations from the general conditions shall be filled by the Tenderer, clause by clause, in this schedule.

<table>
<thead>
<tr>
<th>Section</th>
<th>Specification No.</th>
<th>Clause No.</th>
<th>Deviation</th>
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The TENDER hereby certifies that the above mentioned are only deviation from general conditions of the contract.

SIGNATURE __________________

NAME _______________________

DESIGNATION ________________

COMPANY ________________

DATE _______________________

COMPANY SEAL
SCHEDULE OF RECOMMENDED SPARE PARTS:

The Tenderer shall give below a list of spare parts recommended for three years trouble free performance of each and every equipment identified in the tender document.

<table>
<thead>
<tr>
<th>SI No</th>
<th>Manufacturer and Part No</th>
<th>Delivery Periods (Weeks)</th>
<th>Description</th>
<th>Item No.</th>
<th>Material</th>
<th>Quantity per Unit Equipment</th>
<th>If set Nos. per Set</th>
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</thead>
</table>

SIGNATURE

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NAME _______________________
DESIGNATION _________________
COMPANY ___________________
DATE _______________________
# Preventive Maintenance Schedule of Instrumentation

<table>
<thead>
<tr>
<th>SL NO</th>
<th>UNIT</th>
<th>UNIT TAG</th>
<th>EQPT SHORT NAME</th>
<th>EQ PT SERIAL NO.</th>
<th>TAG DESCRIPTION</th>
<th>Initial calibration date</th>
<th>Frequency: Monthly/Quarterly/Yearly</th>
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# Preventive Maintenance Schedule of the Mechanical Equipment

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>EQUIPMENT</th>
<th>TAG NO</th>
<th>Frequency: Monthly/Quarterly/Yearly</th>
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## PREVENTIVE MAINTENANCE SCHEDULE OF THE ELECTRICAL EQUIPMENT

<table>
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<tr>
<th>SL NO.</th>
<th>EQUIPMENT</th>
<th>TAG NO</th>
<th>Frequency; Monthly/Quarterly/Yearly</th>
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</table>
8.0 PROJECT MANAGEMENT

8.1 The project management services shall include planning, scheduling, monitoring, progress reporting, quality assurance and quality control and overall project management functions.

8.2 CONTRACTOR shall nominate a Project Manager who will be responsible for the scope of work under this contract and shall report to Owner / EPMC on all matter relating to this contract.

8.3 The CONTRACTOR is expected to execute the work / services under this contract on TASK FORCE concept with a dedicated team of specialists who will be responsible and respond to the Project Manager. The task force shall be so organized so as to give effective management and control of various services to the Project Manager. The details of the Task Force Structure shall be forwarded along with the Bid.

8.4 PROJECT EXECUTION

8.4.1 The CONTRACTOR is required to organize his services in a systematic manner to ensure execution and completion of the unit as per schedule.

8.4.2 Soon after the award of job, a kick-off meeting will be held to give final shape to the modalities and procedures to be adopted for execution of the contract based on the bid document, commitments made by the CONTRACTOR and subsequent agreements reached between Owner / EPMC and CONTRACTOR during the negotiations. The kick-off meeting will be attended by key members of Owner / EPMC and CONTRACTOR. This meeting will address all necessary details and arrangements between Owner / EPMC and the CONTRACTOR.

8.4.3 English Language and Metric Units shall be used in all documents, drawings reports, correspondences etc.

8.4.4 Of the total drawings, a broad list of drawings / documents required to be prepared by the CONTRACTOR for review and approval by Owner / EPMC is given elsewhere in this bid document. Such approvals shall be the responsibility of the CONTRACTOR and the same is included in the scope of work. The CONTRACTOR shall submit the required documents to Owner / EPMC and comments if any, shall be taken care by the CONTRACTOR at his own cost and without any time implication. Such review and approval by Owner / EPMC shall, however, not relieve the CONTRACTOR of his responsibilities as per Contract.

8.4.5 CONTRACTOR shall prepare a detailed schedule for preparation and submission of drawings at the beginning of the contract which shall be
approved by Owner / EPMC. The approval shall be used for engineering activities.

8.4.6 For achieving the contract schedule it may be necessary in some cases to prepare the drawings in stages and release it for construction so as to take up simultaneous execution of detail engineering and construction. Any revision involved for the above is included in the scope of work of the CONTRACTOR. Also, any change required meeting site conditions / statutory requirements shall have to be carried out by the CONTRACTOR at no extra cost.

8.4.7 The CONTRACTOR is required to organize task force of dedicated specialists from each discipline for smooth execution of engineering. This should be read in conjunction with para 8.3.

8.4.8 The CONTRACTOR shall actively participate in the weekly / monthly review meetings with OWNER / EPMC. The CONTRACTOR shall present the highlights of the job along with constraints, if any, with action plan on how they propose to overcome the constraints and complete the job as per agreed schedule in the contract.

8.5 PLANNING AND PROJECT CONTROL PROCEDURE

8.5.1 CONTRACTOR shall prepare and issue prior to the kick of meeting, as part of his detailed Project organogram, the details of his Project organization necessary to cover Planning and Project control services as per the details herein.

During the design, engineering and procurement phase, CONTRACTOR shall appoint a dedicated Project control representative to act as a liaison contact on all matters related to Planning and Control Services. Throughout Project phases, the person allocated for these services shall be sufficient to address all the activities related to services and should be capable to produce necessary reports and other documents.

During construction phase CONTRACTOR shall appoint a dedicated site based Project Control representative, who will have interface with his HO based counterpart.

8.5.2 Project Control Procedure

Project Procedure Manual shall include all Project control procedures necessary for performing these activities. The procedures shall be subject to Approval by OWNER/ EPMC, and shall include as a minimum:

- Definition of content, format and extent of coverage
- Organization and responsibilities
- Overall coordination
- Analysis (Progress, Performance)
- Reporting formalities and format
- CONTRACTOR’s proposal for a Work Breakdown Structure
- Progress measurement procedure

Separate Project Control Procedures shall be prepared for HO and Site. Project control procedure for HO phase shall be completed and submitted for OWNER/ EPMC approval within three (3) weeks NOA. Procedure for the Construction phase shall be submitted for OWNER/ EPMC approval at least four (4) week prior to start of mobilization.

8.5.3 PROJECT PLANNING AND SCHEDULING

This shall include production of the following:

**Overall Project Master Schedule:**

CONTRACTOR shall prepare the Overall Project Master schedule for the OWNER/ EPMC review and approval. The key milestones and completion dates of Project master schedule must be consistent with the CONTRACTOR’s schedule submitted at the bid stage.

The OWNER/ EPMC approved master schedule shall serve as the Target schedule for the duration of the Project. The CONTRACTOR will update the Level 1 schedule monthly showing the current progress achieved and forecast status compared to the original target schedule.

Any change made to the overall Project Master Schedule requires prior review and approval of the OWNER/ EPMC.

8.5.4 Progress “S” Curves:

CONTRACTOR shall submit Progress “S” Curves showing Plan Vs Actual progress and a forecast also must be shown.

8.5.5 Overall Manpower Planning and Histogram

CONTRACTOR will implement manpower planning and reporting to achieve effective resource planning and leveling. Resource leveling may be necessary to modify the manpower histogram to an acceptable level to the OWNER/ EPMC.

Manpower histograms shall be issued to OWNER/ EPMC on a monthly basis or OWNER/ EPMC may decide as from time to time.
8.5.6 Look Ahead Schedule

8.5.7 CONTRACTOR shall submit a 90 days Look Ahead Schedule showing discipline wise activities to be performed. First Look Ahead Schedule shall be submitted within three (3) weeks of NOA and then 90 days Look Ahead Schedule shall be made and issued to OWNER/ EPMC every month.

8.5.8 Detailed Bar Chart Schedule for HO, Manufacturing/ Delivery and Construction Activities.

8.5.9 CONTRACTOR shall prepare and submit a Detailed Level 2 Bar Chart Schedule for OWNER/ EPMC approval within four (4) weeks from the date of NOA. In this schedule all the activities shall be logically linked and sequenced and grouped phase wise and discipline wise showing “Critical path”.

8.5.10 Control Level Schedules

The contractor shall prepare detailed list of deliverables for each discipline. A weight factor is assigned to each deliverable and there should be predetermined and agreed milestones and % progress attached to it. Plan dates will be given to these milestones in line with the bar chart schedule. Plan Vs Actual progress shall be calculated for each deliverable.

8.5.11 Physical Progress Measurement Procedure

The progress measurement for the work will be carried out from 0% to 100% based on the system explained below:

The system will comprise estimating and reporting progress at 4 (Four) levels shown below:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Weight Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level – 1</td>
<td>Overall Progress of LSTK contract</td>
<td>100%</td>
</tr>
<tr>
<td>Level – 2</td>
<td>Phase wise Progress</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Detailed Engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Procurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Construction &amp; Hook-ups</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Pre commissioning/Commissioning</td>
<td>Weight factors to be assigned based on effort/ cost (as applicable)</td>
</tr>
</tbody>
</table>
**Level – 3**

<table>
<thead>
<tr>
<th>Discipline wise progress</th>
<th>Weight factors to be assigned based on effort/ cost (as applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each phase to be divided into disciplines</td>
<td></td>
</tr>
<tr>
<td>- Structural</td>
<td></td>
</tr>
<tr>
<td>- Civil/ Arch./ Safety</td>
<td></td>
</tr>
<tr>
<td>- Mechanical</td>
<td></td>
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<tr>
<td>- Piping</td>
<td></td>
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<tr>
<td>- Electrical</td>
<td></td>
</tr>
<tr>
<td>- Instrumentation</td>
<td></td>
</tr>
<tr>
<td>- Painting &amp; Insulation</td>
<td></td>
</tr>
</tbody>
</table>

**Level – 4**

| Deliverable/ Work Items | Weight factors to be assigned based on effort/ cost (as applicable) |

- CONTRACTOR shall submit WBS and Progress Measurement System for OWNER/ EPMC approval.

- Weight factors shall be given based on effort/ cost (as applicable) and shall be approved by OWNER/ EPMC.

- At Level – 1, Overall Progress shall roll from Level – 2 and at Level – 2, progress shall roll up from Level – 3, at Level - 3 progress shall roll up from Level – 4.

- At Level – 4, the deliverables / work items shall be listed discipline wise and each of these shall be assigned a weight factor based on efforts / man-hours (as applicable) required to complete the same. All the weight factors when added will get a total of 100 for each discipline/ work package.

- At Level - 4, for planning and monitoring

**a. Detailed Engineering**

I. A detailed, discipline wise Documents Control Schedule (DCS) covering all the deliverables will be prepared by Contractor.

II. Weight factor will be assigned to each discipline based on the share of that discipline in total effort/ man hours

III. Weight factor will be assigned to each deliverable based on effort / man hours.

IV. Earn value will be calculated based on percentage progress assigned to each milestones agreed by Client.
b. **Procurement**

I. A detailed discipline wise item list will be prepared by the Contractor.

II. Weight factor will be assigned to each discipline based on Cost.

III. Weight factor will be assigned based on the Cost of each individual item.

IV. Earn values will be calculated based on the percentage progress assigned to each milestone.

c. **Construction**

I. A detailed tender package wise list will be prepared and weight factor will be assigned based on Cost of each package.

II. Each tender package shall be detailed by discipline and weight factor shall be assigned to each discipline.

III. Each discipline shall be detailed into individual item.

IV. Progress of individual item shall be calculated based on quantity and earn value shall be calculated.

d. **Pre commissioning/ Commissioning**

8.5.12 **Progress Reporting**

The CONTRACTOR shall prepare a detailed Monthly report at the end of every month. Cut of date for the month will be 25th of every month and Report should be submitted by 30th of every month.

Monthly progress Report shall include following as minimum:

- Executive Summary
- Status of Key milestones
- Discipline wise progress details for the month
- Discipline wise Progress Planned for next month
- Holdups and remedial actions taken

Along with the Monthly Progress Report following attachments are also required as minimum:

- Updated Bar chart schedule
• Overall Progress “S” Curve
• Phase wise “S” Curve
• Detailed discipline wise progress summary
• Material Status Report
• Detailed Shortfall analysis
• Look ahead schedule for next three month

At the end of every week CONTRACTOR shall prepare a Weekly Progress Report. Cut off date for the weekly report will be Friday of the week and submission will be on Monday of next week.

Weekly progress Report shall include following as minimum:

• Executive Summary
• Status of Key milestones
• Discipline wise progress details for the week
• Discipline wise Progress Planned for next week
• Holdups and remedial actions taken

When Project will be at construction stage, along with Monthly and Weekly report, Daily progress report showing progress of construction quantities shall also be prepared and submitted by CONTRACTOR.

CONTRACTOR shall submit the typical Progress Reporting formats for the approval of OWNER/ EPMC.

Irrespective of above details contained in this document any matter that turnout to be absolutely essential for the project and required to be executed by the CONTRACTOR for the successful completion of the project shall be carried out at no extra cost to OWNER.

Progress Report generation and other Project Management activities of the EPC Contractor shall be analyzed through OIL’s existing ERP system (SAP). Any requirement found beyond the capability of ERP Project Management Module shall be carried out in mutually agreed format

9.0 SAFETY

9.1 All measures required for safe construction including OISD norms are to be taken care and the schemes are to be approved by Owner / EPMC before commencement of works. Besides, all personnel employed on the job are to follow safety requirement of Owner/ EPMC and State Regulations as applicable form time to time. As the work is to be carried out for FGS & CGGS & OTP at , Chabua and Madhuban, the CONTRACTOR is required to follow the safety stipulations laid down by Owner in this regard.
9.2 A list of the safety implements / equipment propose to be used by the CONTRACTOR are to be indicated. Safety report generation for different situations as per rules and required by Owner / EPMC are to be adhered to.

10.0 WASTE DISPOSAL AND SCRAP

10.1 All waste, muck, scraps generated which could be surplus earth, surplus construction materials etc will be disposed by the CONTRACTOR from time to time to the place intimated by Engineer in charge.

10.2 The CONTRACTOR shall endeavour to maintain clean and neat working enclosures devoid of wastes / scraps as a good safety practice for easy movement of construction personnel and machinery.

11.0 DOCUMENTATION

Contractor shall submit a list of documents along with the document numbering system to be generated during the course of the execution of the project to Owner / EPMC for review. Documents to be reviewed, approved by Owner/EPMC shall be clearly identified.

Contractor shall submit 4 copies for Owner and 6 copies for EPMC review at the design review center. Owner/EPMC shall return 2 copies of the same duly reviewed / approved.

Reviewed documents shall be returned to the Contractor within Ten working days from the date of receipt of the document, in following categories:

Code-1- Approved

Code-2- Approved with comments, document to be re-submitted for final Approval

Code-3- Not approved, to be re-submitted

Code-4- Retained for information

Approval by Owner / EPMC shall not absolve the Contractor of his responsibilities under the terms of the contract.

11.1 FINAL DOCUMENTATION

Contractor to submit the following documents:
- Soft copies of all the “AS BUILT” drawings in three different sets of CD’s.
- Three complete set of all “AS BUILT” drawings inclusive of P&IDs for all the facilities.
- Three complete set of all “AS BUILT” drawings pertaining to civil (including structural and architectural), mechanical, piping layout, electrical, and instrumentation job.
- Six sets of equipment folders containing “AS BUILT” tracings, design drawings, specifications, and detailed fabrication drawings, stage wise inspection reports. Third party inspection release notes, Guarantee/Warrantee Certificates complete in all respects.
- Six sets of Operating and Maintenance manuals for all the bought out items.

Following documents shall be submitted in hard binder in three sets (one original):

- Welder Qualification Report.
- Radiographic Procedure Qualification.
- Radiographic Reports along with Radiographs (Radiographs only with originals)
- Heat treatment charts.
- Material test certificates.
- Hydrostatic and other test results and reports.
- Pre-commissioning and commissioning checklist
- All other requirement as specified in the respective specifications.

Drawings shall be generated using Auto Cad 2000. All drawings (A4 to A0) shall be on white prints. CONTRACTOR shall submit the 3 sets each of as-built drawings and documents in soft file in the form of CD to OWNER and EPMC.

11.2 SPECIAL REQUIREMENT:

a. Interactive 3D modeling of the Installations shall be generated and 6 sets of drawings of such model shall be provided in hard copy of A0 size and framed in laminated hard boards suitable for mounting on walls.

b. One three dimensional model of each of the Installations (As-Built) shall be made ready immediately after mechanical completion of the project. These models shall be kept with proper supporting arrangement at a suitable place in the respective Control Room Building for demonstration to visitors. Proper Transparent Unbreakable Glass coverage and protection shall be provided to keep the models clean and safe.
The CONTRACTOR within his Lump Sum quoted rate shall provide the above.
12.0 **STANDARDS AND SPECIFICATIONS**

12.1 Clauses in job specification shall supersede the clauses in the EPMC standard specification in case of clash.

12.2 Various activities mentioned in EPMC standards / specifications shall be carried out by the CONTRACTOR.

12.3 Indian standards wherever mentioned can be superseded by International standards subject to prior approval by Owner / EPMC.
13.0 ENVIRONMENT MANAGEMENT SYSTEM

In order to ensure adherence to environmental management system, major works to be taken up must conform to Environmental policies and objectives laid down elsewhere in the bid document. Further, CONTRACTOR shall adhere to the applicable Govt. regulations during the currency of the CONTRACT.
14.0 OWNER’S OBLIGATIONS

OWNER's obligations shall include as under:

14.1 Providing space for temporary office, storage as per clause 6.5 above.

14.2 Issue of Gate Pass after proper verification to contractor's and their subcontractor’s engineers, supervisors and workman wherever necessary.
15.0 CONSTRUCTION SUPERVISION AND MANAGEMENT
15.0 CONTRUCTION SUPERVISION AND MANAGEMENT

15.1 GENERAL

15.1.1 CONTRACTOR shall construct the Plant Facilities and hook up with existing facilities in accordance with the requirements of the approved documents, Technical Standards, with proven / generally accepted / good industry practices and procedures. Such Facilities shall be safe, reliable and suitable for their intended purpose.

15.1.2 CONTRACTOR shall provide all supervision, labour, arrange boarding and lodging facilities for his personnel, construction equipments, tools & tackles, materials and consumables, temporary facilities, construction utilities, etc. and render all support services necessary for the construction.

15.1.3 CONTRACTOR shall plan, execute, manage and control all the construction activities for the Facilities forming a part of this contract. Frontline construction supervision is to be provided by CONTRACTOR.

15.1.4 CONTRACTOR to ensure mechanizing the construction activities to a great extent.

15.1.5 CONTRACTOR is deemed to be having full knowledge of the applicable laws and regulations, conditions of labour, local conditions, the SITE conditions, environmental aspects and shall comply with the requirements thereof.

15.1.6 CONTRACTOR'S work during construction shall include but not be limited to the following:

- Prepare and submit all the Plans, Procedures and documents to OWNER/EPMC as specified in the contract.
- Establish requisite site organization staffed by competent and experienced specialists, supervisors and inspectors.
- Update Overall Project Schedule on monthly basis.
- Supervise Co-ordinate and manage the activities performed at site by the CONTRACTOR himself and by his sub-contractors for execution of work and render all technical/specialist services.
- Plan and schedule the construction work, monitor and take timely corrective action when required to adhere to approved execution schedule.
• Plan and allocate required resources, manpower, and construction equipment/materials, commensurate with construction plan/schedule.

• Quality Control and Quality Assurance as per approved Quality Assurance Plan.

• Report beforehand and take approval from OWNER/EPMC regarding use of any equipment and/or material not conforming to the contract, drawings and specifications.

• Execute and supervise all additional works and modification works as required or suggested by OWNER/EPMC as a part of approved change orders.

• Erect and install the equipments and materials according to the approved specifications and procedures.

• Establish required Field Inspection and Testing Laboratories at site to carry out tests as specified in the standards/specifications of the contract.

• Organize and obtain all applicable clearances/approvals from Statutory bodies/authorities, as required by the laws of land for the work executed at site by the CONTRACTOR at site under the contract.

• Carry out inspection, non-destructive tests and analyze and certify acceptability of all welds and materials in accordance with specified Technical Standards/International Standards. Carry out inspection and testing of incoming materials as per agreed procedures.

• Carry out material Traceability during all the phases of Pre-fabrication and Installation as per the procedure approved by Owner/EPMC.

• Organize and conduct Positive Material Identification (PMI) of incoming materials and after erection of facilities as per procedure approved by OWNER/EPMC.
• Prepare detailed schemes for ODC/Heavy/Critical Equipments' movement / erection / lifting / rigging and submit the same for review / approval to OWNER/EPMC before undertaking such Critical/Heavy lifts/movements. Any modifications required including dismantling and re-erection of structures/piping, etc for the existing facilities for smooth flow of such heavy equipment shall be carried out by the CONTRACTOR at his own cost. However, prior approval for such modifications will be required from the OWNER.

• Organize and conduct Weekly Project Review meeting related to site construction activities.

• Provide detailed Weekly and Monthly Progress Reports summarizing percentage completion of the work including status of drawings, materials and effects on approved schedule, areas of concern and corrective actions required thereof. CONTRACTOR will also identify any foreseeable delays in any aspect of the WORK and take corrective actions to eliminate/minimize the effect on Overall Completion Schedule. All progress shall be quantified.

• Prepare and submit the Daily Progress Report along with the schedule for the following day at the end of every day.

• Prepare and submit records of all site meetings and any other related documents to all parties concerned within two (2) days of the meeting.

• Prepare and submit safety and Labour Relation Procedures in line with all applicable codes, regulations.

• Supervise and monitor all Safety and Labor Relations functions as per agreed procedures and applicable laws of the land and report to OWNER immediately for any violations and injuries.

• If any part of the facilities is completed and is under operation, while other parts of the facilities are under construction, it is essential that rigid safety rules be prepared and maintained for all WORKS in accordance with the requirements of OWNER/EPMC.
• Keeping all the records generated during project execution up-to-date and in first rate condition to be made available to OWNER/EPMC whenever requested. These records shall be handed over to OWNER on completion of the work.

• Carry out warehouse management and material control in accordance with approved procedure.

• Take all necessary precautions and required actions to protect construction work and materials from damage by local weather conditions and ongoing construction activities in the vicinity, theft and pilferage etc.

• Take insurance policies for materials in transit and storage-cum-erection risk and other insurance covers required for men and materials at site at his own cost.

• Undertake housekeeping including sweeping, clean up to maintain cleanliness, sanitation, removing excess materials, temporary facilities, scaffolding, etc. on regular basis.

• Prepare and submit to OWNER/EPMC the following daily log for construction activities:
  i)  Weather
  ii)  Manpower deployment highlighting expatriates
  iii) Construction Equipments
  iv) Work Progress

• Ensure the control of all works with regard to its impact on the surrounding environment.

• Ensure all hot / cold works are performed outside hazardous areas and in compliance with OWNER’S Safety Permit System requirements wherever applicable.

• Arrange and co-ordinate the visits of vendor(s) representative/specialists at site.
• All material handling equipment, tools, tackles, hoisting and lifting equipments/ machineries should be subjected to require load test initially and then periodically, to ensure safe/stable operation.

• Execute all the tie-ins for the project as per the terms of contract and schedule fixed by OWNER/EPMC.

• Organize field engineering work, wherever required and provide assistance to OWNER/EPMC in timely resolving interface problems / site constraints.

• Prepare and certify material reconciliation statement on completion of work to enable OWNER to take over the balance store materials, if applicable as per contract.

• Organize the handing over of balance surplus materials (as applicable) and spares/ tools and tackles to the OWNER on completion of work.

• Develop a phased mechanical completion program to facilitate sequential Pre-commissioning/ Commissioning activities in a logical manner to meet the Overall Project Schedule.

• Remove / demolish all temporary structures/ establishments/ facilities created by the CONTRACTOR / his sub-contractors during the execution of the work and restore the site to its original condition.

15.1.7 The CONTRACTOR is required to organize and mobilize Construction Management Services in a systematic and sequential manner to ensure that the PLANT installation is carried out in accordance with the approved engineering drawings, specifications, Standards, QA/QC procedures etc. and its mechanical completion is achieved within targeted time schedule. Construction Management and Supervision is to be carried out by the CONTRACTOR himself by deploying persons on his rolls and this activity is not to be sub-contracted in any case.

15.1.8 For this purpose, the CONTRACTOR shall deploy a Construction Management Team headed by a Resident Construction Manager (RCM) at site. The Construction Management team shall include engineers/ specialists in QA/QC, Project Control (Planning, scheduling, monitoring), contracts, construction supervision, progress measurement/billing, safety,
warehousing, purchasing etc. Key personnel including RCM should have sufficient experience and should not be changed without concurrence from OWNER/EPMC.

15.1.9 The construction supervision, co-ordination and management activities shall be carried out by the CONTRACTOR in accordance with the construction procedures developed and submitted by the CONTRACTOR and approved by OWNER/EPMC. CONTRACTOR will prepare construction schedules within the framework of overall contract schedule and submit to OWNER/EPMC for approval. CONTRACTOR shall plan, execute, monitor and control construction activities as per the approved construction schedule.

15.1.10 Construction management team headed by a **Resident Construction Manager** (RCM) will be deployed at site by CONTRACTOR for construction supervision and management of their contractual scope of work. CONTRACTOR shall extend all necessary assistance and provide all necessary data/documents as required by OWNER/EPMC for review and monitoring of the jobs performed by the CONTRACTOR. The CONTRACTOR shall ensure delegation of adequate and sufficient powers (including financial) to his RCM for effective and smooth functioning of the construction management. HO support shall be provided to the RCM at site during construction on all matters of project execution including the following:

- Field engineering.
- Vendor specialists required during construction.
- Rectification/replacement of defective supplies, if any, noticed during construction.
- Inspection/expediting of replacement orders/ field purchase orders for items ordered by Field Purchase Cell.
- Expediting replacement of imported items found short/damaged.
- Material receiving inspection at site and the required documentation
- Statutory requirements and the required documentation

CONTRACTOR will depute a project team at site during construction phase under a project co-ordinator for providing above-mentioned support to RCM. The CONTRACTOR shall establish and maintain a material testing laboratory for carrying on field tests during execution of contracts under different disciplines by subcontractor’s, at no extra cost to OWNER. All the test
equipments deployed shall have valid test/calibration certificates. CONTRACTOR is deemed to be having full knowledge of the applicable laws and regulations, conditions of labour, local conditions, the site conditions and environmental aspects and shall comply with the requirements thereof.

15.1.11 Construction supervision and management functions to be performed by the CONTRACTOR will include the following as key functions for effective execution, monitoring and control:

- Planning, scheduling, monitoring & reporting.
- Construction supervision, discipline wise.
- Quality assurance and quality control, discipline wise.
- Shipping, custom clearances, inland transportation
- Warehouse management and material control.
- Field engineering/Purchase.
- Health, Safety and Environment (HSE) Management
- Statutory clearances and enforcement of statutory rules / regulations and Labour Laws
- Personnel/administration/Industrial Relations
- Billing and Invoicing
- Finance and Accounts
- Security

15.1.12 SUB-CONTRACTING PLAN

If CONTRACTOR proposes to engage sub-contractor(s) for the execution of various activities at site, a preliminary sub-contracting plan along with the identified scope of work for each sub-contract shall be furnished by the CONTRACTOR at the time of bid submission. However, the credentials of proposed Sub-contractor(s)’s will be submitted by the contractor on award of work, which will be evaluated by OWNER/EPMC for acceptance before hand in case of award of the work to the bidder. CONTRACTOR shall not be permitted to change the sub-contractor under any circumstances without prior approval of OWNER/EPMC. Non-compliance of the above will be strictly dealt within relevant provision(s) of the contract.
15.1.13 CONSTRUCTION MANAGEMENT PLAN

CONTRACTOR shall submit Construction Management Plan to OWNER/EPMC for approval during kick-off meeting. The Plan shall detail the management methodology to be applied during the construction phase of the PROJECT, along with a list of procedures to be utilised in undertaking the work. All reference procedures and detail work plans referred to in this document must be submitted for review and approval by OWNER/EPMC at least (4) four weeks in advance of actual commencement of the activity concerned.

15.2 CONSTRUCTION EXECUTION PLAN

CONTRACTOR shall submit Construction Execution Plan to OWNER/EPMC for review/approval during kick-off meeting. The Plan shall detail the execution methodology of the CONTRACTOR during construction phase of the PROJECT covering following aspects as minimum –

CONTRACTOR’S Construction Execution Plan shall include:

15.2.1 CONTRACTOR’S manpower and man-hour histogram by major section and discipline and their manpower deployment schedule on monthly basis with distribution of Foreign / Indian / Local Personnel

15.2.2 Major equipment mobilisation plan on monthly basis with short description. CONTRACTOR to develop this plan with due consideration to maximize the mechanization of construction activities. Other plans of CONTRACTOR and procedures to be submitted at least four (4) weeks prior to start of respective activity at site, include the following as a minimum:

a. Temporary facilities, etc.
b. Piling plan (if applicable)
c. Scaffolding plan
d. Excavation and underground work plan
e. Heavy transport and heavy lifting plan (Rigging Plan)
f. Pre-fabrication plan
g. Hydro-test plan
h. Other activity plans e.g. piping, equipment and steel structure erection plan etc.
i. Instrument loop check plan
j. Monsoon counter measures and preparation
k. Emergency Evacuation Procedure
l. Storm Management Plan

Sub-Contracting
Contractor’s Construction Execution Plan shall include the following in continuation to Clause No. 15.1.12 above:

1. Sub-contracting philosophy and plan
2. List and scope of work of each subcontract
3. Subcontract administration plan
4. Organisation chart of each sub-contractor.

The list and major scope of each subcontract shall not be changed from those of the CONTRACTOR’S plan unless specially approved by OWNER.

**Temporary Facilities**

CONTRACTOR’S Construction Execution Plan shall include:

1. Exact location of temporary work area, access and general layout inside the area.
2. Plan and description of the temporary facilities for CONTRACTOR/Subcontractors such as:
   a. Identification of borrow earth area (if required)/excess earth dumping yards
   b. CONTRACTOR/sub-contractors Site office and Fabrication yards, Open storage area and Warehouse
   c. Miscellaneous work shops
   d. Temporary roads including access road to Plant, fencing and gates
   e. Security, watch & ward, security gates, watch towers
   f. Utility supply systems viz. Construction power, construction water, drinking water etc.
   g. Area lighting
   h. Fire fighting equipments
   i. Area Barricading
   j. Drainage and Sanitation
   k. Camp Accommodation
   l. Field Testing Laboratory
   m. Communication facilities viz. Telephone, Fax, E-mail, etc.
   n. Canteen for staff and workers
   o. Vehicle parking area
   p. First aid arrangement/ medical and health care facilities

CONTRACTOR will develop the temporary facilities layout for approval of OWNER/EPMC.
15.3 CONSTRUCTION, PLANNING, SCHEDULING, MONITORING & REPORTING

The CONTRACTOR will be responsible for construction Planning, Scheduling, Monitoring and Reporting activities at site in line with the overall master schedule and details stipulated else where in this document. Following activities are also to be performed by the CONTRACTOR at site –

15.3.1 Construction Master Schedule

**Construction Master Schedule** will be prepared and submitted by the CONTRACTOR for OWNER/EPMC review covering following aspects –

1. Clearly identify activities in the Master Project Schedule
2. Indicate major milestones
3. Show critical path and activity float time
4. Apply activities conforming to the CONTRACTOR’S Work Breakdown Structure
5. Take monsoon and holiday seasons into consideration
6. Detailed activity schedule will be required for each activity identified in Master Project Schedule two months after award.

15.3.2 Schedule Control

CONTRACTOR shall prepare:

1. Monthly and weekly construction schedule
2. Construction progress measurement method, which is to be based on physical progress measurement at Site as approved by OWNER/EPMC.
3. Reference to schedule change procedures.
4. Areas of concern & Catch up plans
5. Hold up reports in respect of drawings, materials and front, etc.
6. Weekly and Monthly Progress Reporting Format to OWNER/EPMC.

15.4 QUALITY ASSURANCE AND QUALITY CONTROL

The CONTRACTOR will be responsible for ensuring quality of construction carried out by the CONTRACTOR/their approved sub-contractors in accordance with the requirements given in Annexure-I.

15.5 WAREHOUSE MANAGEMENT & MATERIAL CONTROL

The CONTRACTOR will be responsible for carrying out the Warehouse Management and Material Control.
15.6 FIELD ENGINEERING

CONTRACTOR will be responsible for controlling and issue of technical drawings and documents, preparation of field sketches, field modifications, checking/preparation of as-built drawings, technical assistance for field purchase & field tendering etc. Specialist engineers from HO will also be deployed at site as per requirements. Site should have facilities to incorporate field changes, prepare As-built drawings at site itself.

15.7 FIELD TENDERING

CONTRACTOR will be responsible for carrying out field tendering activities, as required.

15.8 FIELD PURCHASE

CONTRACTOR will be responsible for carrying out field purchase activities, as required. The bulk of procurement action will be done from Contractor’s HO. Field Purchase items are restricted to those required for running and maintenance of the field offices, items required to expedite construction work and items found short, missing or damaged against the main order when received at the site. Any material purchased from field for usage in the plant should have proper inspection certificate and should be purchased from OWNER/EPMC approved vendors.

15.9 HEALTH, SAFETY AND ENVIRONMENT (HSE) MANAGEMENT

The CONTRACTOR will be responsible for Health, Safety and Environment (HSE) Management at construction site for the construction activities to be carried out by the CONTRACTOR/their approved sub-contractors in accordance with the requirements given at Annexure - II

15.10 HOUSE KEEPING

It is the responsibility of the CONTRACTOR to maintain general cleanliness and proper housekeeping at work site. CONTRACTOR shall organize disposal of excavated earth/garbage/rubbish/scrape, etc. on day to day basis to identified disposal areas/safe areas and forward daily report for the same indicating the details of men and machinery deployed for the purpose.

15.11 INDUSTRIAL LABOUR RELATIONS

CONTRACTOR will be responsible for industrial relation functions and implementation of labour laws at site. Contractor’s staff shall be suitably trained and experienced in Labor Relation functions so as to ensure a
good relationship with labour and to prevent the occurrence of industrial disputes resulting in subsequent delays or work stoppages. In particular, CONTRACTOR shall maintain close liaison with OWNER/EPMC and with Official Union Representatives (if any) of Contractor's work force. CONTRACTOR shall maintain proper liaison with Statutory Authorities and local bodies and will be responsible to implement and observe all statutory laws at site.

CONTRACTOR shall report immediately to OWNER/EPMC any problems including labor disputes, fight, and work stoppages. A written report shall be submitted to OWNER/EPMC within 24 hours after the incident.

15.12 CONSTRUCTION EQUIPMENT

The CONTRACTOR is required to organize and mobilize the construction equipment and other tools/tackles in a sequential manner to ensure that plant installation is carried out in a mechanized manner and its mechanical completion is achieved within targeted time schedule. The CONTRACTOR shall, without prejudice to his responsibility to execute and complete the work strictly as per the specifications and other laid down procedures, execute all the work by mechanizing the construction activities to the maximum extent by deploying all necessary construction equipments/machinery of adequate capacities and numbers.

CONTRACTOR shall ensure deployment of the following construction equipment as per requirement to the maximum extent:

i. Batching plants
ii. Concrete pump cars
iii. Transit mixers
iv. Automatic welding machines
v. Cranes of different capacities
vi. X-ray and Radiography sources
vii. Stress Relieving Equipments with Recording facility
viii. All weather fabrication sheds
ix. Blast cleaning and Painting Shop

CONTRACTOR shall carry out 'Positive Material Identification (PMI)' of materials and welds after erection/installation but prior to hydro-testing as per instructions of the OWNER / EPMC.

CONTRACTOR shall be responsible for arranging all facilities for torque tightening/tensioning of bolts/fasteners as specified. CONTRACTOR shall ensure that stud bolts are ordered extra long by one diameter to facilitate tensioning. In order to minimize fabrication at site, major fabricated equipment like Separators, Slug Catchers, Filter Separators, Gas Filters, KOD, CBD Vessels, Flare KOD etc shall be transported in single piece /
minimum no. of pieces. CONTRACTOR shall carry out the route survey for transportation of 'Over Dimensioned Consignments' including water ways from source of manufacture/supply to site well in advance of placement of order to ensure unhindered transportation of the same to construction site. CONTRACTOR shall arrange Cranes of suitable capacities to match with the erection requirements and inform the source and ownership of the same.

Crane movement roads are to be clearly identified and marked on the plot plan before planning of such movement. Construction of hard stands for positioning of crane in the fabrication yard and at erection site/locations including approach roads to the hard stands from the plant roads shall be CONTRACTOR'S responsibility. The hard stands shall be suitable for the crane loads provided by the crane manufacturer.

For the purpose of Equipment Erection, the CONTRACTOR shall deploy a Rigging team headed by a Rigging Foreman/Engineer reporting to concerned Area Engineer. Area Engineer should be well conversant with various erection techniques and shall be responsible for preparing Erection Schemes in accordance with the approved procedures and based on crane manuals and suiting to plant layout. Area Engineer shall have to foresee various other construction activities in the surroundings areas while planning erection schemes including safety aspects of man and machinery also. CONTRACTOR shall prepare erection schedule in line with the overall project schedule of the Plant in phased manner with erection schemes of various equipments, vessels and submit to OWNER/EPMC for approval. Monitoring and control of erection schedule and erection activities shall be carried out by the contractor as per the approved construction procedures. For efficient working and maintenance of construction aids, CONTRACTOR shall establish and maintain crane yard / workshop equipped with regular maintenance facilities for various construction aids for carrying out routine field maintenance during performance of the contract. Temporary approach road and hard stands, wherever required for the movement of the Cranes and other vehicles for equipment erection and transportation of material shall be properly planned and made by the CONTRACTOR. Weekly/fortnightly maintenance shall be planned in such a way that the same does not hamper the erection schedule.

CONTRACTOR shall ensure the timely augmentation of the men, equipments and machinery depending upon the exigencies of the work to meet the overall project schedule and as per instructions of Engineer-in-Charge. During performances of the work, CONTRACTOR must ensure that structures, materials and equipments are adequately braced with Guys, Struts or any other means as deemed fit & approved by Engineer-in-Charge. Such means shall be supplied and installed by the
CONTRACTORS as required till the erection works is satisfactorily completed. Such guys, shoring, bracing, strutting, planking supports etc. shall not interfere with the work of other agencies and shall not damage or cause distortion to works executed by other agencies. All lifting tools, tackles and cranes shall be tested periodically by statutory/competent authorities for their load carrying capacity. Such relevant valid/test certificates shall be submitted to OWNER/EPMC for review before actual use of the tools, tackles and cranes.

CONTRACTOR shall submit the construction equipment deployment schedule. Daily construction equipment deployment report will also be submitted by the CONTRACTOR to OWNER/EPMC in the Performa approved by the Engineer-in-charge.

15.13 CONSTRUCTION MANPOWER

The CONTRACTOR is required to organise and mobilise construction staff/manpower in a sequential manner to ensure that Plant installation is carried out in accordance with the construction schedule defined elsewhere in this Bid package. Mobilization of construction staff should be such that the progress achieved in phased manner should match with the overall Project Schedule.

For this purpose, the CONTRACTOR shall clearly indicate in his construction methodology whether work shall be done departmentally or by engaging sub-contractor or the combination of both. CONTRACTOR will prepare detailed methodology for the work to be carried out departmentally as well as through sub-contractors clearly, defining the scope and responsibility of CONTRACTOR and his sub-contractors.

The works of all sub-contractors will be managed by the construction staff of the main CONTRACTOR who will perform the duties of construction management and will administer, co-ordinate, and inspect the works of the sub-contractor(s) and be responsible for the Quality and timely completion of respective works. The CONTRACTOR will establish the pre-requisites for successful completion of sub-contractor(s) work. However, by deploying the sub-contractor(s), as approved by OWNER/EPMC for any discipline, does not absolve the CONTRACTOR for his total responsibility under the subject contract.

The CONTRACTOR must note that in case of any sub-contractors' failure to execute the works as per standards/specifications/drawings and/or negligence & disobedience in carrying out any order or instruction of OWNER/EPMC, the same will be viewed very seriously and any action as deemed fit in accordance with provision(s) of the contract, will be taken by OWNER/EPMC.
Daily construction manpower deployment report will also be submitted by the CONTRACTOR to OWNER/EPMC on approved format. Any additional manpower of any category required to be deployed during the actual execution of the work to meet the Project time schedule and as instructed by OWNER/EPMC, shall be mobilized by the CONTRACTOR within a reasonable time. Mobilization of such additional manpower by the contractor will not entitle him for any additional compensation at all.

All construction supervision, coordination and management activities shall be carried out by the CONTRACTOR. CONTRACTOR will prepare construction schedules based on the Overall Project Schedule of the PLANT and submit the same to OWNER/EPMC for approval. Monitoring and control of the construction activities will be carried out as per the approved construction schedule & procedures.

During the execution of works at site, if the CONTRACTOR engages sub-contractor(s) for execution of works at site as per approval obtained from OWNER/EPMC in line with contract provision(s) and in the event sub-contractor complains in writing to the OWNER with regard to the non-payment of their dues from the CONTRACTOR for the works executed by them (excluding final payments and payments due after termination of subcontractors' services by the main CONTRACTOR), OWNER/EPMC reserves the right to make such payment to the sub-contractors directly based on approved measurements with due notice to the CONTRACTOR. OWNER/EPMC shall release such payments to sub-contractor at the cost and risk of the CONTRACTOR in order to ensure smooth execution of work at site. All such payments made by OWNER/EPMC to the subcontractor(s) shall be deducted from the running account bills or any other payments due to the CONTRACTOR.

The above provisions will be applicable in case of construction materials procured at site by the Contractor from the suppliers.
QUALITY ASSURANCE

AND

QUALITY CONTROL DURING

CONSTRUCTION PHASE
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QUALITY ASSURANCE AND QUALITY CONTROL DURING CONSTRUCTION PHASE

01.00 The CONTRACTOR will be responsible for ensuring quality of construction carried out by the CONTRACTOR/their approved sub-contractors in accordance with the approved QA/QC procedures, and management of material testing laboratory.

02.00 Requirements for Construction Quality Management/ Quality Control are given in attached as Annexure-I.

03.00 CONTRACTOR will carry out Inspection, Non-destructive Tests and analyze and certify acceptability of all welds, materials and works in accordance with specified technical standards/International standards and carry out inspection and testing of incoming materials as per agreed procedures.

04.00 The role of Owner/EPMC is broadly envisaged as surveillance, auditing and participation in inspection of critical activities as identified. Contractor shall develop a detailed procedure for Field Inspection Notice and obtain the approval of the same from Owner/ EPMC for implementation.

05.00 A procedure for identification and boxing-up of flange joints not subjected to hydrostatic tests at site shall be developed by Contractor and submitted to OWNER / EPMC for approval prior to implementation.

06.00 CONTRACTOR is required to prepare and submit documents as evidence of the tests performed and quality of works to OWNER/EPMC as per the contract.

07.00 All Inspections and QA/QC Test Records are to be kept up to date by the CONTRACTOR and shall be made available to OWNER/EPMC, whenever requested. These documents shall be handed over to OWNER by the CONTRACTOR on completion of the Commissioning.

08.00 All work/services to be performed by the CONTRACTOR under this contract shall be of specified/approved quality and the CONTRACTOR shall have a QUALITY ASSURANCE/QUALITY CONTROL(QA/QC) system during the performance of various activities at Construction Site.

09.00 Review/approval of the activities by Owner/EPMC shall not dilute the responsibility of the CONTRACTOR for maintaining quality.
Requirements for Construction Quality Management/ Quality Control

PURPOSE

The purpose of this document is for uniform understanding and implementation of quality management and quality control by contractor during construction to produce the product by combination of various activities and role of Owner/EPMC in verification. The management of quality shall also cover co-ordination, review, approval audit and proper documentation of the works performed. **Inspection and Test Plans (ITPs)** shall be submitted by Contractor at the time of execution of the job for review by Owner/EPMC.

SCOPE

This document shall be applicable for all construction works to be followed by contractors as well as Owner/EPMC for achieving overall objective of quality of various activities during construction.

RESPONSIBILITY

It is contractor's prime responsibility to arrange/produce the product conforming to contract specifications and inspect all equipment, materials and works at various stages of execution as per the approved QA Plans. In addition, they are to coordinate all efforts in this regard directly with the Owner/EPMC and other involved agencies to give adequate confidence that the activities have been performed as per agreed ITPs and necessary documentation are available. Verification by Owner/EPMC at any stage shall not relieve contractor of his responsibility for the quality of the product.

METHODOLOGY

The management of construction quality control is divided into the following categories:-

1. Procurement of materials required for the construction works.
2. Execution of works
3. Documentation
4. QA/QC Audits

4.1 Procurement of Materials Required for the Construction Works:

The Contractor shall develop list(s) defining the items to be procured by the Contractor along with likely Vendors for approval of Owner/EPMC. The list of these items shall comprise of all items except vessels, equipments,
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pumps, electrical/ instrumentation panels etc. which may be available directly ready for installation or requiring small fabrication as per requirement like bolts, nuts. The vendor list shall be in line with the contract document. In case, no vendor list exists in the contract for a particular item, the contractor will propose a list of Vendors. Contractor has to satisfy himself with the capability of the vendor to deliver the product in time with quality before proposing him as a prospective vendor. Contractor shall submit the QA/QC plans for all major items and carry out their procurement in line with approved plans. The contractor can either provide his own adequate qualified staff for inspection or employ a separate third-party inspection agency to carry out these functions. Involvement of Owner/EPMC in the quality control plan, if required, shall be defined during approval of the same.

4.2 Execution of Works

(i) The QA plans for execution shall be developed by the contractor. Owner / EPMC’s approval shall be taken well before start of the work for the same. The final Inspection & Test Plans (ITPs) shall be developed by contractor as per contract specifications for approval by Owner/EPMC. For the activities which are identified as Witness or Hold point, specific inspection call shall be raised by contractor with Owner/EPMC in the requisite format well before time.

It is intended that the contractor shall be completely responsible for management of approved quality plans and Owner / EPMC involvement will be only of surveillance in nature to randomly check the works at selective/critical junctures. Their role shall be to monitor that the Contractor is executing the quality plans as per the approved drawings, employing adequately qualified staff and other resources for various items of works. Any deviation to the specifications shall be brought to the notice of Owner / EPMC in proper formats by contractor for approval.

(ii) It is likely that the contractor may engage sub-contractor(s)/vendors for performance of the work. Contractor shall be responsible for ensuring the implementation of approved QA plan, contract specifications and contract conditions through their sub-contractors to achieve the quality during all stages of construction. It shall be the responsibility of the contractor to ensure proper coordination between his sub-contractor(s) and other agencies working at site.

The sub-contractor(s)/vendors selection shall be done after evaluation by the contractor inline with contract requirements and shall be got approved by Owner/EPMC before engaging them for the works.
(iii) **Source Selection/Vendor approval**

All the material which are naturally available and which will be used in the respective works, shall be identified and approved by Owner/EPMC on the request of the contractor. The source(s) shall be capable of giving good quality materials meeting to the requirement of contract document and various relevant Code/Standards, and supplying without interruption the entire quantity required for the works. After the source(s) are identified, the samples shall be collected and the same shall be got tested in a reputed laboratory. The test results shall be reviewed and approved. After getting approval of the source/vendor only, the material shall be brought to the work site. Without approval of the source/material/vendor, the same shall not be procured by the contractor.

All other materials shall be bought from approved vendors given in the contract only. If there is any deviation from the approved vendor list given in the contract, specific approval from Owner/EPMC shall be taken in the proper format. For any bought out items where approved vendor list is not given in the contract and which are readily available in market, reputed vendors/brand/product shall be identified by contractor and approval for the same shall be taken from Owner/EPMC before their procurement. Wherever the case demands, samples and/or manufacturer’s recommendation of their products shall also be produced, preferably along with the item for inspection and approval by Owner/EPMC.

(iv) **Storage**

All the material procured as above shall be stored/stacked as per the standard norms and as recommended in various clauses of relevant I.S. codes and contract document. The storage of material shall be such as to avoid damage to life/properties (physical and chemical) of the material. The storage shall not cause deterioration, rusting, mix-up etc. and hamper the other related works in any way. The colour coding & markings shall be provided by vendors/contractor for piping and other fittings. PMI for alloy steel/stainless steel materials shall be carried out on receipt at stores. Contractor shall submit his detailed warehouse plan for Owner/EPMC approval to manage the above in open/covered areas.
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The cement bags shall be kept in a room with minimum openings and be leak proof. The bags shall be kept sufficiently away from the wall and some gap shall be maintained from floor to keep the moisture away from it. Not more than 10 cement bags shall be kept one above another. The bags which have burst/torn or in which the cement has got hardened shall be rejected and removed from cement godown. Reinforcement steel, structural steel, piping materials, cable drums etc shall be kept in a separate yard. Wooden/Concrete sleeper dunnage shall be provided below structural steel members, piping materials, etc.

Aggregates shall be stacked separately to avoid intermixing of different sizes and to allow proper drainage of water. Chemicals for anti-termite treatment shall be kept separately.

The materials susceptible to fire shall be kept away in a separate protected place. In general, the materials shall be kept systematically in order of their class, batch number and identification number, so that they are accessible for the inspection by Owner/EPMC whenever required and to avoid the mix up in those materials.

(v) Use

The materials shall be stacked in such a way that the lot, which is procured first will be consumed first. No material beyond its expiry date/ shelf life shall be used. If any materials’ expiry date has elapsed or its properties have changed, it shall be removed from site. Wherever there is any doubt, such materials shall be sent to reputed approved laboratory for testing and acceptance.

(vi) Inspection

a) Before collecting the samples of naturally available materials, the sources shall be identified by contractor and on their request inspected by Engineer - in-charge or his representative team. The samples shall be collected in good clean bags/ containers etc. in sufficient quantities, sealed and sent to identified laboratory for testing.

b) The testing, selection of source/vendor/brand for each material shall be done as per relevant code. Frequency of testing during the course of the work shall be identified and documented as per specs/code and strictly adhered to.

c) If any of the test is carried in the field laboratories set up by the contractor, all the stages of testing shall be done in presence of
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contractor’s competent representative and test results shall be reviewed by EPMC/Owner for acceptance.

d) The frequency and type of tests listed out in various specs are the minimum for which the material shall be tested. However, if at any time Owner/EPMC feels that the quality of any particular batch of materials is not good or has deteriorated, such materials shall be subjected to testing as directed by Owner/EPMC. Till such time, the results of such tests are received and duly reviewed, batch of materials in question shall not be used in works. The cost of such tests shall be borne by contractor.

e) As and when requested by Owner/EPMC, the contractor shall arrange, at his own cost, for witnessing the testing of the materials sent to the reputed approved laboratories by his competent representative. In addition, contractor will co-ordinate, if Owner/EPMC desire to witness such testing at the designated laboratories.

f) Owner/EPMC shall be free to inspect the storage yard of different materials at any time. Owner/EPMC reserves the right to check the store records also as and when required.

g) For all the bought out items which are accompanied with manufacturer’s test certificate (MTC), Owner/EPMC shall be free to check the co-relation between MTC and the materials received at site at any time. Records of supplier, total quantity supplied etc. shall be maintained by the contractor for review by Owner/EPMC. If it is not possible to co-relate the materials with MTC to the satisfaction of Owner/EPMC, tests as per relevant codes shall be arranged by contractor at his own cost as per defined frequency for acceptance of material, before their use in the works.

h) Wherever MTC is furnished, it should cover all the properties of the materials in accordance with relevant Codes/Contract Specifications.

i) Contractor shall prepare MRR (Material Receipt Report) of each material received at site which will include any third party inspection report on behalf of contractor, supplier’s name, total quantity received, date of receipt, site inspection report covering physical verification of quantity and quality and acceptance thereof.
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j) All, MRR, MTC, test results shall be reviewed by contractor’s competent person first and then offered to Owner/EPMC for final review and acceptance.

k) In process and final Inspection Contractor shall be responsible to arrange verification of products during in process and final inspection. Relevant checks and tests shall be arranged for the works performed and records maintained. Tolerances achieved with respect to contract specification and execution drawings for various activities/processes shall be ascertained and submitted to Owner/EPMC for approval. Efforts shall be made to keep checks and controls in such a way that getting a non-conforming product is avoided. However, if in an isolated case, the tolerances are variant beyond the acceptable values given in the contract/execution drawings, nonconformance resolution/waiver need to be raised by the contractor and got approved/resolved from Owner/EPMC. For alloy and special piping materials and welds, PMI shall be arranged by contractor after installation but before final acceptance.

4.3 Documentation

The documentation plays a very important role in quality management control. All the necessary documentation shall be maintained by contractor till completion of project and handed over to Owner/EPMC in requisite copies as a part of completion documents. Wherever Owner/EPMC personnel were directly involved particularly in witness, the copies of the records shall also be provided to personnel on completing inspection of those activities. The documentation shall include the following as a minimum but not limited to:

i) Approved Quality Assurance Plan

ii) Approved Inspection and Test Plans

iii) Inspection and test documents covering:

a) Manufacturer Test Certificate

b) Material Receipt Report including Inspection Release Note, if applicable and Site Inspection and acceptance Report on quality and quantity of material

c) Site test/laboratory test Report reviewed by contractor for acceptance vis-a-vis to contract/code requirements for materials/including PMI report at warehouse

d) In process Verification reports of contractor representative and Owner/EPMC as applicable

e) Final verification report including any test checks done for compliance
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f) As-built vis-a-vis to contract/drawings including tolerances

g) As-built for erection

h) Non conformance resolution raised by contractor/Owner/EPMC

i) Deviation approval by Owner/EPMC

j) Waiver approval by Owner/EPMC incase there is variation from contract/drawings

4.4 QA/QC Audits

4.4.1 During the execution of the works, contractor will carry out periodical Quality Audits in all areas of work. These audits will be conducted by a team of specialists in respective areas.

4.4.2 The contractor shall prepare an Audit Plan and Procedure and submit the same to Owner/EPMC for approval. While preparing the Audit Plan, the contractor will ensure that the frequency of audit does not exceed six months for a particular facility.

4.4.3 A copy of the Audit Report containing the findings of the Audit team will be submitted to Owner/EPMC within 3 days of completion of an Audit. Contractor to make action plan for compliance of the audit findings and submit to Owner/EPMC for concurrence before initiating compliance action on the same. A Compliance Report must also be generated by the contractor after completion of rectification/modifications/corrective actions taken by the contractor on issues indicated in Audit Report. A copy of this Action Plan and the Compliance Report shall be submitted to Owner/EPMC for review.

4.4.4 Over and above the contractor's Internal QA/QC Audits outlined above, Owner/EPMC shall also conduct periodical QA/QC audits. The programme along with the scope of such Audits, will be informed to the contractor well in advance. Contractor shall participate and provide full support to the Audit Team and furnish all documents/reports/records as desired by the Audit Team. A copy of such Audit Report shall be furnished to the contractor. The contractor shall take all actions required to comply with the findings of the Audit Report and issue regular Compliance Reports for the same to Owner/EPMC till all the findings of the Audit Report are fully complied.

4.4.5 Owner/EPMC reserve the right to appoint an independent person/Third Party Agency to conduct QA/QC Systems Audit for full/part of the facilities being executed by the contractor. This audit will be in addition to the audits described above and may be carried out intermittently/continuously for all or part of the facilities being executed by the contractor. The programme, along with the scope of such Audits, will be informed to the contractor well in advance. Contractor shall participate and provide full support to the Audit Team and furnish all documents/reports/records as
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desired by the Audit Team. A copy of such Audit Report shall be furnished to the contractor. The contractor shall take all actions required to comply with the findings of the Audit Report and issue regular Compliance Reports for the same to Owner/EPMC till all the findings of the Audit Report are fully complied.

GENERAL NOTE

The approved Inspection and Test Plans (ITP) shall be followed for the works to be performed by the contractor. The provisions indicated for stage wise inspection by EPMC/Owner are the minimum and the Engineer-In-Charge may decide to increase Hold Points/ Witness Points. If the contractor has to deviate from the approved ITP for a valid reason, he shall obtain prior written approval of EPMC/Owner. Contractor to carry out 100% examination of all activities.
Health Safety and Environment

1.0 SCOPE

This specification establishes the Health, Safety and Environment (HSE) management requirement to be complied by Contractors during construction. Requirements stipulated in this specification shall supplement the requirements of HSE Management given in relevant Act(s)/legislations, General Conditions of Contract (GCC), Special Conditions of Contract (SCC) and Job (Technical) Specifications. Where different documents stipulate different requirements, the most stringent shall apply.

2.0 REFERENCES:

The document should be read in conjunction with following:

- General Conditions of Contract (GCC)
- Special Conditions of Contract (SCC)
- Building and other construction workers (regulation of employment and condition of service) Act, 1996
- Job (Technical) specifications
- Relevant IS Codes (Refer Appendix-I)
- Statutory requirements as stipulated in OMR, MINES ACT, MINES RULE, OISD STANDARDS and other applicable Rules and Regulations.

3.0 REQUIREMENTS OF HEALTH, SAFETY & ENVIRONMENT (HSE) MANAGEMENT SYSTEM TO BE COMPLIED BY BIDDERS

3.1 Management Responsibility

3.1.1 HSE Policy & Objectives

The Contractor shall have a documented HSE policy & objectives to demonstrate commitment of their organization to ensure health, safety and environment aspects in their line of operations.

3.1.2 Management System

The HSE management system of the Contractor shall cover the HSE requirements including but not limited to what is specified under para 1.0 and para 2.0 above.

3.1.3 Indemnification
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Contractor shall indemnify & hold harmless Owner/EPMC & their representatives free from any and all liabilities arising out of non-fulfillment of HSE requirements.

3.1.4 Personnel deployment

Contractor, as a minimum requirement, shall designate/ deploy the following persons at site:

a) Upto 75 persons - Designate one safety supervisor deployed by him at site

b) For 76 to 250 persons - Deploy one qualified & experienced safety officer in addition to the Safety Supervisor as described in (a) above

c) For more than 250 persons - Deploy an additional Safety Engineer/deployed by him at site Officer for every 250 persons or part thereof, in addition to (b) above

3.1.5 Implementation & Monitoring

Contractor shall be fully responsible for planning, reporting, implementing and monitoring all HSE requirements and compliance of all laws & statutory requirements. The Contractor shall also ensure that the HSE requirements are clearly understood & faithfully implemented at all levels at site.

3.1.6 Awareness

The Contractor shall promote and develop consciousness about Health, Safety and Environment among all personnel working for the Contractor. Regular awareness programmes and fabrication shop/work site meetings shall be arranged on HSE activities to cover hazards involved in various operations during construction.

3.1.7 Fire prevention & First-Aid

The contractor shall arrange suitable first aid measures such as First Aid Box, trained personnel to administer First Aid, stand-by ambulance or vehicle and install fire protection measures such as: adequate number of steel buckets with sand & water and adequate number of appropriate fire extinguishers to the satisfaction of EPMC/Owner.

3.1.8 Documentation

The Contractor shall evolve a comprehensive, planned and documented system for implementation and monitoring of the HSE requirements. This shall be submitted to EPMC/Owner for approval. The monitoring for
implementation shall be done by regular inspections and compliance to the observations thereof. The Contractor shall get similar HSE requirements implemented at his sub-contractor(s) work site/office. However, compliance of HSE requirements shall be the responsibility of the Contractor. Any review/approval by EPMC/Owner shall not absolve contractor of his responsibility/liability in relation to all HSE requirements.

3.1.9 Audit

Non-Conformances on HSE by Contractor (including his sub-contractors) as brought out during review/audit by his internal audit team as well as EPMC/Owner's representative shall be resolved forthwith by Contractor. Compliance report shall be submitted to EPMC/Owner.

3.1.10 Meetings

The Contractor shall ensure participation of his top most executive at site (viz. Resident Engineer/ Site-in-Charge) in Safety Committee/HSE Committee meetings arranged by EPMC/Owner. The compliance of any observations during the meeting shall be arranged urgently. He shall assist EPMC/Owner to achieve the targets set by them on HSE during the project implementation.

3.1.11 Accident investigation

All accidents shall be investigated by a team of Contractor’s senior personnel for establishing root cause and recommending corrective & preventive actions. Findings shall be documented and suitable actions taken to avoid recurrences shall be communicated to EPMC/Owner.

Owner/EPMC shall have the liberty to independently investigate such occurrences and the Contractor shall extend all necessary help and cooperation in this regard. If required OWNER shall carryout independent enquiry/ accident investigations.

3.2 House Keeping

3.2.1 Contractor shall ensure that a high degree of house keeping is maintained and shall ensure inter alias the followings:

a. All surplus earth and debris are removed/disposed off from the working areas to identified location(s).

b. Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas are removed to identified location(s).
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c. All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).

d. Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete, chips and bricks etc shall not be allowed on the roads to obstruct free movement of men & machineries.

e. Fabricated steel structural, pipes & piping materials shall be stacked properly for erection.

f. Water logging on roads shall not be allowed.

g. No parking of trucks/trolleys, cranes and trailors etc shall be allowed on roads, which may obstruct the traffic movement.

h. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

i. Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the plant area/ or these materials shall be transported with top surface wet.

j. The contractor shall ensure that the atmosphere in plant area and on roads is free from particulate matter like dust, sand, etc. by keeping the top surface wet for ease in breathing.

k. At least two exits for any unit area shall be assured at all times.

3.3 HSE Measures

3.3.1 Construction Hazards

Contractor shall ensure that during the performance of the work, all hazards have been identified, assessed and eliminated.

3.3.2 Accessibility

The Contractor shall provide safe means of access to any working place including provisions of suitable and sufficient scaffolding at various stages during all operations of the work for the safety of his workmen and EPMC/Owner.

3.3.3 Personal Protective Equipments (PPEs)

The Contractor shall ensure that all their staff and workers including their sub-contractor(s)'s have been issued & wear appropriate PPEs like safety helmets (made of HDPE), safety shoes, full body harness (CE, EN361), protective goggles, gloves etc. All these gadgets shall conform to applicable IS Specifications/CE or other applicable international standards. For shot blasting, the usage of protective face shield and helmets (approved by the competent authority), gauntlet and protective clothing is mandatory. Wherever applicable, DGMS approved PPE items should only be provided( eg. Helmet, shoe, Gum boot  etc.)
3.3.4 Working at height

The contractor shall issue height permit for working above 2 metres height after verifying and certifying the checkpoints to be developed during the execution of the job. He shall also undertake to ensure compliance to the conditions of the permit during the currency of the permit including adherence to personal protective equipments. The permit shall be issued initially for one week or expected duration of an activity and extended further for the balance duration. This permit shall be applicable in areas where specific clearance from Owner’s operation Deptt./Safety Deptt. is not applicable. EPMC field Engineers/Safety Officers/Area Coordinators may verify and sign this permit during the execution of the job. In case work is undertaken without taking sufficient precautions as given in the permit, EPMC Engineers may cancel the permit and stop the work till satisfactory compliance is arranged. Contractors are expected to maintain a register for issuance of permit and extensions thereof including preserving the used permits for verification during audits etc.

Contractor shall arrange (at his cost) and ensure use of Fall Arrester Systems by his workers. Fall arresters are to be used while climbing tall structures. These arresters should lock automatically against the anchorage line, restricting free fall of the user. The device is to be provided with a double security opening system to ensure safe attachment or release of the user at any point of rope. In order to avoid shock, the system should be capable of keeping the person in vertical position in case of a fall.

Contractor shall ensure that Full body harnesses conforming to EN361 and having authorized Ca E marking is used by all personnel while working at height. The lanyards should be strong enough to take the load of the worker in case of a fall. One end of the lanyard shall be firmly tied with the harnesses and the other end with a fixed & rigid structure. The FBH should have BIS marking also.

Contractor shall provide Roof Top Walk Ladders for carrying out activities on sloping roofs in order to reduce the chances of slippages. Contractor shall ensure that a proper Safety Net System is used wherever the hazard of fall from height is present. The safety net shall be located not more than 9.0 meters below the working surface extending on either side up to sufficient margin to arrest or to reduce the consequences of a possible fall of persons working at different heights.

3.3.5 Electrical installations

The contractor shall ensure that electrical systems and equipment including tools & tackles are properly selected, installed, used and maintained. The contractor shall deploy qualified & licensed electricians for proper & safe installation and for regular inspection of construction
power distribution lines/points including their earthing. A copy of the license shall be submitted to EPMC for records. Proper “Electrical Permit system” as per the IE rule should be used while working with Electrical system and Equipment.

3.3.6 Welding/ Gas cutting

Contractor shall ensure that flash back arresters conforming to BS:6158 or equivalent are installed on all gas cylinders while in use. All cylinders shall be mounted on trolleys. All welding machines shall have effective earthing. To eliminate radiation hazard, Tungsten electrodes used for Gas Tungsten Arc Welding shall not contain Thorium. Proper PPE should be used during welding, cutting, grinding etc.

5.1.2

3.3.7 Ergonomics and tools & tackles

The Contractor shall assign to his workmen, tasks commensurate with their qualification, experience and state of health. All lifting tools, tackles, equipment, accessories including cranes shall be tested periodically by statutory/competent authority for their condition and load carrying capacity. Valid test & fitness certificates from the authority shall be submitted to Owner/EPMC for their review/acceptance before the lifting tools, tackles, equipment, accessories and cranes are used.

Contractor shall ensure installation of Safe Load Indicator (SLI) on all cranes (while in use) to minimize overloading risk. SLI shall have capability to continuously monitor and display the load on the hook, and automatically compare it with the rated crane capacity at the operating condition of the crane. The system shall also provide visual and audible warnings at set capacity levels to alert the operator in case of violations.

3.3.8 Occupational Health

The contractor shall identify all operations that can adversely affect the health of its workers and issue & implement mitigation measures. For surface cleaning operations, sand blasting shall not be permitted even if not explicitly stated elsewhere in the contract.

3.3.9 Hazardous Substances

Hazardous and/or toxic materials such as solvent coating, or thinners shall be stored in appropriate containers, which shall be labeled with the name of the materials, the hazards associated with its use and necessary precautions to be taken. Where contact or exposure of hazardous materials/Noise pollution exceeds the specified limit or otherwise have harmful affects, appropriate personal protective equipments such as
gloves, earmuffs, goggles, aprons, chemical resistant clothing, respirator, etc. shall be used.

3.3.10 Spills

Chemical and other spills shall be contained and cleaned up immediately to prevent further contamination.

3.3.11 Radiation exposure

a) All personnel exposed to physical agents such as non-ionizing radiation, ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with the type of exposure involved.

b) For ionizing radiation, requirements of Bhabha Atomic Research Centre (BARC) shall be followed.

3.3.12 Road Safety

The contractor shall ensure adequately planned road transport safety management system. The vehicles shall be fitted with reverse warning alarms. The contractor shall also ensure a separate pedestrian route for safety of the workers and comply with all traffic rules & regulations.

3.3.13 Welfare measures

Contractor shall, at the minimum, ensure the following facilities at work sites. - A crèche where 10 or more female workers are having children below the age of 6 years.

- Reasonable canteen facilities at appropriate location depending upon site conditions. Rest rooms (separate for male workers and female workers) Toilets, drinking water, adequate lighting at site and labour camps, commensurate with applicable Laws/ Legislation

3.3.14 Environment Protection

Contractor shall ensure proper storage and utilization methodology of materials that are detrimental to the environment. Where required, Contractor shall ensure that only the environment friendly materials are selected and emphasize on recycling of waste materials such as metals, plastics, glass, paper, oil & solvents.

For pipeline jobs, topsoil shall be stacked separately. This fertile soil shall be placed back on top after backfilling.
ANNEXURE - II

The hazardous waste, if generated, should be managed as per hazardous waste Management and standing rules. It shall be responsibility of the Contractor to resolve any pollution complaint from the neighboring villages, and pay suitable compensation (if any).

3.3.15 Rules & Regulations

All persons deployed at site shall be knowledgeable of and comply with the environmental laws, rules & regulations relating to the hazardous materials, substances and wastes. Contractor shall not dump, release or otherwise discharge or dispose off any such materials without the express authorization of EPMC/Owner.

3.4 Training

Contractor shall ensure that all his personnel possess appropriate training to carry out the assigned job safely. The training should be imparted in a language understood by them and should specifically be trained about

- Potential hazards to which they may be exposed at their workplace
- Measures available for prevention, recurrence and elimination of these hazards. The topics during training shall cover, at the minimum
- Education about hazardous jobs and precautions required
- Emergency and evacuation plan
- HSE requirements
- Fire fighting and First-Aid
- Use of PPEs Records of the training shall be kept and submitted to EPMC/ Owner whenever demanded.

3.5 Inspection/ Audit

The contractor shall carryout daily HSE inspection and record observations at a central location. These inspection records shall be freely accessible to Owner/ EPMC representatives. He shall also carry out internal HSE audits as well as cooperate during HSE audits by Owner/ EPMC.

4.0 Details Of HSE Management System By Contractor

4.1 On Award of Contract

The Contractor shall submit a comprehensive Health, Safety and Environment Manual or procedure and HSE Plans for approval by EPMC/Owner prior to start of work. The Contractor shall participate in the pre-start meeting with EPMC/Owner to finalize HSE Plans including the following:
ANNEXURE - II

- Job procedure to be followed by Contractor for activities covering handling of equipments, scaffolding, electric installations, etc. describing the risks involved, actions to be taken and methodology for monitoring each activity.
- EPMC/Owner review/audit requirement.
- Organization structure along with responsibility and authority, records/reports etc. on HSE activities.
- Procedures for reporting & investigation of accidents and near misses.
- HSE Training programmes.
- Reference to Rules, Regulations and statutory requirements.
- HSE reports

4.2 During Job Execution

4.2.1 Contractor shall implement approved Health, Safety and Environment management procedure/plan/ manual including but not limited to as brought out under para 3.0. Contractor shall also ensure:

- to arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc, as applicable.
- to arrange all HSE permits before start of activities (as applicable), like permits for hot / cold work, confined space working, storage of chemical/explosive materials and its use and implement all precautions mentioned therein. In this regard, requirements of Oil industry Safety Directorate Standard No. Std -105 "Work Permit Systems" shall be complied with while working in existing plants.
- to submit, timely accident reports, investigation reports etc. as per EPMC/Owner requirements. Compliance of instructions on HSE shall be done by Contractor and informed urgently to EPMC/Owner.
- display at site office and work locations caution boards, list of hospitals, emergency services available, etc.
- provide posters, banners for safe working to promote safety consciousness.
- assess, analyze & mitigate the construction hazards
- assistance & cooperation during HSE audits by EPMC/Owner, and submit compliance report.
- generation & submission of HSE records/report as per HSE Plan.
- apprise EPMC/Owner on HSE activities at site.
- carryout all dismantling activities safely, with prior approval of EPMC/Owner.

5.0 Records

The contractor shall maintain/ submit HSE records as under:

1. Monthly HSE Checklist cum compliance report
2. Accident/ Fire Report
ANNEXURE - II

3. Supplementary Accident & Investigation report
4. Monthly HSE Report
5. Permit for working above 2 metre height
6. HSE Plan
IS - CODES FOR HSE

SP:  53 Safety code for the use, Care and protection of hand operated tools.
IS:  816 Code of practice for safety & health requirements in electric and gas welding and cutting operations
IS:  1179 Eye & Face precautions during welding, equipment etc.
IS:  1860 Safety requirements for use, care and protection of abrasive grinding wheels.
IS:  1989 (Part -I & II) Leather safety boots and shoes
IS:  2925 Industrial Safety Helmets
IS:  3016 Code of practice for fire safety precautions in welding & cutting operation.
IS:  3043 Code of practice for earthing
IS:  3521 Industrial Safety belts and harness
IS:  3738 Rubber boots
IS:  3996 Safety Code of scaffolds and ladders
IS:  4770 Rubber gloves for electrical purposes
IS:  5216 (Part-I) Recommendations on Safety procedures and practices in electrical works
IS:  5557 Industrial and Safety rubber lined boots
IS:  5983 Eye protectors
IS:  6519 Selection, care and repair of Safety footwear
IS:  6994 (Part-I) Industrial Safety Gloves (Leather & Cotton Gloves)
IS:  7293 Safety Code for working with construction Machinery
IS:  9167 Ear protectors
IS:  11006 Flash back arrestor (Flame arrestor)
IS:  11016 General and safety requirements for machine tools and their operation
IS:  11226 Leather safety footwear having direct moulded rubber sole
IS:  11972 Code of practice for safety precaution to be taken when entering a sewerage system
IS:  13367 Code of practice-safe use of cranes
IS:  13416 Recommendations for preventive measures against hazards at working place.
16.0 PRE-COMMISSIONING AND COMMISSIONING GUIDELINES
16.0 PRE-COMMISSIONING AND COMMISSIONING GUIDELINES

16.1 SCOPE

The CONTRACTOR shall be responsible to carry out pre-commissioning, commissioning in association with owner’s operating personnel.

The CONTRACTOR shall be responsible for preparing and supplying pre-commissioning, commissioning documents and carrying out pre-commissioning, commissioning activities as given in various sections of this document. A procedure for detailed mechanical completion, pre-commissioning, commissioning and start up shall be developed by LSTK contractor based on the guideline provided in the document and this shall be approved by OWNER/ EPMC. The contractor has to prepare the operating manual based on the guideline provided in the document.

16.1.1 BIDDING OFFER ENCLOSURES

- An organization chart of bidder’s proposed commissioning team indicating the positions with the required qualifications and experience.
- Bio data’s of key personnel comprising the commissioning team.
- Adequate manpower should be provided in each shift to carry out pre-commissioning / startup / commissioning activities uninterrupted.

16.2 DEFINITIONS

16.2.1 MECHANICAL COMPLETION

Mechanical Completion of systems shall mean that all installation works of the system have been completed and hydro tested in accordance with approved construction drawings, approved specification, applicable code as defined in the bid package, accepted international good engineering practices and all the activities have been completed in a comprehensive manner by the CONTRACTOR.

CONTRACTOR’s competent representative shall check the system/sub-system so that plant/ system/ sub-system meets the process requirement and is constructed as per the approved drawings. After liquidating the checklist CONTRACTOR shall submit certificate stating system/ sub-system, which is mechanically completed. Checklist generated by CONTRACTOR representative and test certificates connected with the system/ sub-system will be submitted. Certificates of various statutory bodies for relevant portion of the work completed shall be made available by the CONTRACTOR as part of mechanical completion. OWNER/ EPMC representative shall check the system along with CONTRACTOR’s
representative and shall issue a list of pending activities which includes deficiencies / modifications required for the portion of the work that is declared by the CONTRACTOR as mechanically complete.

**16.2.2 PRE-COMMISSIONING ACTIVITIES**

Pre-commissioning activities are defined as those activities, which are required to be performed after completion/ installation, inspection, hydro testing etc. of an equipment/ system to make it ready for commissioning. CONTRACTOR shall inform Owner/EPMC as per format given which certifies that all checklist points are liquidated and the plant/ system/ subsystem is ready for pre-commissioning. CONTRACTOR will start pre-commissioning activities after acceptance of the above by EPMC/ OWNER. This shall include but shall not be limited to activities such as system checking as per P&IDs/ Drawings, site modifications, internal inspection of equipment/ vessels, flushing/ steam blowing, air blowing of pipelines including gasket blowing, purging of system using inert gas, leak test both for low / high pressure systems, chemical cleaning of compressor and high capacity charge pumps suction lines, lube oil circuits, calibration of instruments, checking of the electrical equipment for proper earthing, continuity, insulation resistance, conducting operability test on individual equipment/ system, charging of lubes & other chemicals. Fabrication and supply of temporary facilities, for example, temporary bypasses, spools, blinds, jump overs, vents, strainers, screens etc. which will be required to carry out pre-commissioning activities shall be the in the scope of the CONTRACTOR. Catalyst loading, if required shall also be responsibility of CONTRACTOR and it is to be done under supervision of OWNER/EPMC. All the pre-commissioning activities shall be carried out by CONTRACTOR. Before start-up of the pre-commissioning activities safety audit to be conducted by CONTRACTOR and OWNER/EPMC/ OISD for entire plant. Checklist/ deficiency generated by safety audit team shall be corrected/ rectified by CONTRACTOR.

**16.2.3 READY FOR COMMISSIONING**

The process units shall be considered 'Ready for Commissioning' when all the facilities have been completed along with their auxiliaries and support facilities in every respect including charging of lubes, chemicals, preparation of solution, any last minute modifications, if any, as recommended by the OWNER/EPMC/Process Licensor. All temporary structures, scaffolding etc. used for carrying out the pre-commissioning works shall be removed, all the blinds shall be put into position as required by P&IDs / Process Licensor and all systems as recommended by Process Licensors shall be purged and pressurised. All pre-commissioning and other documents including blinds list, set pressures of PSVs and TSVs and their test certificates etc. shall be handed over to the OWNER.
The CONTRACTOR shall issue a certificate of ready for commissioning of process unit for acceptance by the OWNER/EPMC in standard format.

After the process unit has been declared as 'Ready for Commissioning', the CONTRACTOR shall not carry out any hot work in the plant without prior written permission of the OWNER.

16.3 DOCUMENTS FOR PRE-COMMISSIONING / COMMISSIONING

16.3.1 OPERATING MANUAL

The CONTRACTOR shall prepare plant specific draft-operating manual of the unit and submit to OWNER/EPMC for review at least 120 days prior to mechanical completion. Five copies of each draft operating manuals will be submitted by the CONTRACTOR for review. This should include procedure related with package items if any. In particular the following information shall be covered as a minimum as an applicable.

- Design basis of unit.
- Detailed process / plant description.
- Pre-start checks.
- Pre-commissioning procedures
- Start-up procedure.
- Normal operating procedure.
- Shutdown procedure (normal & emergency).
- Plant trouble shooting procedure.
- Vendor instructions for all equipment for start-up, shutdown, normal operation and trouble shooting.
- Operating parameters and set points of alarms and trips.
- Operating conditions of different cases of operation.
- Effect of operating variables on the process.
- Functional description of all complex control schemes and safe shut down systems.
- Details of interlock logic, trip etc.
- List of emergencies and emergency handling procedures.
- List of equipment and their major details.
- List of all instruments like control valves, shutdown valves, flame detectors, analyzers and field instruments etc.
- Relief valve schedule including tag numbers, location, set pressure, capacity basis, failure scenarios consideration etc.
- List of blinds for shut down and start-up.
- Approved final PFDs / P&IDs, cause and effect drawings and engineering equipment datasheets etc.
- Any other special conditions / instructions / information etc.
- Feed, Product and Effluent summary.
- Summary of chemical consumption.
• Summary of utility consumption.
• Lubrication schedule (with equivalent lubricant available in India).
• Life saving devices and usage details.
• Fire and safety, gas detection system.
• Laboratory analysis requirement and procedure with sampling schedule.
• Procedure for preparation of equipment hand over.
• Work Permit Procedures.
• Safe handling of chemicals & catalysts.
• Personnel safety procedure

Review of operating manuals shall be done by OWNER/EPMC within 30 days after receipt of draft operating manuals. All the changes, additions, deletion required by the OWNER/EPMC shall be discussed with the CONTRACTOR and shall be incorporated in the final operating manuals by the CONTRACTOR. Twenty hard bound copies of final operating manual shall be submitted by CONTRACTOR. Minimum five soft copies of the same shall also be forwarded in CD. This manual shall be furnished to owner at least 60 days prior to mechanical completion. This operating manual shall be followed during start-up and commissioning of the process units. Operating manuals provided by equipment suppliers shall not form a part of this operating manual.

In case of any revisions due to any reason, the same shall be incorporated and submitted as revised sheets during the start-up and commissioning stage. However, revised operating manual incorporating changes shall be submitted as final operating manual after the commissioning has been completed.

16.3.2 PRE-COMMISSIONING AND COMMISSIONING NETWORK

The CONTRACTOR shall submit the pre-commissioning and commissioning schedule in the form of network detailing therein the sequence of all the pre-commissioning and commissioning activities and time taken by each individual activity to be carried out in each equipment / sub-system of the units. This shall be submitted to OWNER prior to start of pre-commissioning activities. CONTRACTOR shall submit weekly progress report and the status of pre-commissioning and commissioning activities, likely slippage and action being taken by the CONTRACTOR to contain this slippage.

16.3.3 PRE-COMMISSIONING DOCUMENTS

It shall be the responsibility of the CONTRACTOR to prepare detailed checklist of pre-commissioning and commissioning activities for each equipment, subsystem, system and unit/plant as a whole. The CONTRACTOR shall submit the said format for approval to the OWNER/
EPMC. This checklist shall indicate the checks / test to be carried out on each equipment / system and shall also indicate the sequence and schedule of the activities. For the purpose of execution of these pre-commissioning activities, the process units shall be divided into system and sub-systems so that pre-commissioning activities of each system/sub-system can be progressively carried out along with the construction activities. The CONTRACTOR shall submit the list of systems and prepare list of pre-commissioning activities to be performed for all applicable disciplines against each systems including flushing schemes for the piping sub-systems. The above details will be prepared and submitted to Owner at least 60 days before start of the pre-commissioning activities.

The pre-commissioning document shall contain the following as a minimum:

i) Process system identifications on P&IDs.
ii) Pre-commissioning and start-up schedule
iii) Detailed procedure for the various pre-commissioning activities i.e. flushing, blowing, purging, leak checking, system tightness and equipment operability test with forms to record the observation of each of the activities carried out.
iv) Procedure and forms for operability tests of equipment and system as a whole, wherever applicable.
v) Lube schedule indicating manufacturer (Indian equivalent to lubes, quality, initial fill recommended, and frequency of changing the lube oil).

The CONTRACTOR shall submit the draft of above mentioned pre-commissioning documents at least 120 days before the activities are to be carried out. The document shall be reviewed by the OWNER/EPMC. The CONTRACTOR shall submit, 60 days prior starting of activities, revised documents after incorporating OWNER/EPMC’s comments. The documents shall be followed till the project is completed.

Commissioning of the facilities will not be permitted till all the documents have been submitted by the CONTRACTOR to the OWNER. Any delay in commissioning on this account shall be considered as a delay in commissioning/completion by the CONTRACTOR.

16.3.4 MAINTENANCE MANUAL

CONTRACTOR shall prepare and submit draft maintenance manual to OWNER/EPMC for their review at least three months prior to the mechanical completion. Final maintenance manual incorporating all comments shall be submitted by CONTRACTOR within one month after issue of comments.
Maintenance manual shall contain the following chapters as a minimum:

i) Introduction to the plant/unit maintenance

ii) Equipment/facilities register
    Location and list of all plant equipment.

iii) Equipment record card:
    - Equipment No. and name.
    - Equipment serial No. and manufacturer details
    - Brief description including details of parameters.

iv) Maintenance guidelines:
    - Maintenance philosophy.
    - Check list of routine inspection of equipment
    - Maintenance procedures of individual equipment and system.
    - Preventive and predictive maintenance schedules.
    - Procedures and precautions to be taken for handing over of equipment for shutdown maintenance, viz., Separators, Filters, KO Drums, Vessels, Tanks, Compressors, Bath Heaters, Pumps, Generating Sets etc.
    - Details of preventive maintenance and predictive maintenance.
    - Gasket details with respect to pressure ratings and temperature.
    - Coupling details, like, type of coupling and coupling bolts with make serial No. and dimensional details. Method for alignment including optical, if required.
    - Tightening torque with respect to critical services and sizing of bolts/studs.
    - Tube extraction/tube bundle pull out procedures.
    - Reciprocating compressors
    - CE/HE clearances
    - Cross-head clearances.
    - Web deflection of crank shaft.
    - Gland packing assembly - type, material and dimensional details.
    - Permissible piston rod runs out.
    - Permissible ovality of cylinder.
    - Permissible values of drop of piston.
    - End gap and side clearance of piston rings.
    - Lift of cylinder valves.
    - Details of unloading system of cylinder, Centrifugal compressors
    - Alignment details
    - Rotor assembly - Dimensions and weights and handling procedure.
    - End floats dimensions.
- Diametrical clearances.
- Axial displacement.
- Thrust/tilting pad bearing alignment details.
- Centrifugal/screw/gear pumps
  - Shaft dimensions
  - End floats dimensions and checking procedure.
  - Diametrical clearances.
  - Clearance checking in screw pumps.
  - Setting of timing gears in screw compressors.
  - Mechanical seal maintenance
  - Dimensional details including manufacturer catalogue.
  - Methods to evaluate the surface finish of the mating surfaces of mechanical seals. Vibration
  - Normal and critical values.
  - Trip conditions including values.
- Lubrication schedule
- Plant item
- Plant number
- Location
- Points of lubrication
- Methods of application
- Recommended applications types and grades.
- Frequency of application
- Frequency of sampling and oil change.
- Valves types/specifications / materials for different service.
- Recommended inspection frequencies and items requiring inspection.
- Inspection details and activities.
- Work planning and execution techniques.
- Inspection recording systems.

v) **Maintenance trouble shooting**

Trouble shooting guide for critical equipment like compressors, generating sets, pumps, bath heaters, filters etc.

vi) **Maintenance store** :

- Identification and classification of spares and consumables.
- Stock levels to be maintained
- Spare parts requirement for at least 2 years of trouble free operation and insurance spares.
- General tools and tackles including special tools, if any.
- Inspection gadgets including tension device for bolts tightening requirement.

vii) **Information storage and retrieval system** :

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New Delhi
Sheet 386 of
- Pressure vessels records including as built drawings, data sheets, licenses, approvals etc.
- Piping - as built drawings, test records etc.
- Details of piping support system including type, size, specification and make of spring supports clearly shown on the drawings.
- Lifting tackles/equipment details.
- Lifting equipment - test programmed and schedule.
- Safety relief valve - test records & schedule including set values.

viii) Maintenance training
- Training needs and areas identified.

16.4 OTHER REQUIREMENTS

CONTRACTOR shall ensure that all safety devices like pressure safety valves (PSV), emergency shut down valves are tested, witnessed and certified in the presence of representatives of OWNER/EPMC.

These certificates are to be handed over to OWNER/EPMC prior to start-up of the plant. The CONTRACTOR shall install 'No Smoking' boards & boards for other instructions at designated areas. CONTRACTOR is required to maintain and follow all safety practices, equivalent or better than those being practiced by OWNER for the complex during pre-commissioning and commissioning.

16.5 MANUFACTURER'S REPRESENTATIVE

It shall be the responsibility of the CONTRACTOR to arrange for services of manufacturer's installation / commissioning engineer at site during mechanical completion / pre-commissioning & commissioning of all the major equipment and for any other critical propriety items for which it is felt necessary to call vendor representative for proper commissioning.

16.6 REVIEW / CHECKLISTING / INSPECTION CO-ORDINATION

A general guideline on OWNER/ EPMC interaction with respect to plant pre-start up activities is given below. However, OWNER/ EPMC reserve right to witness all works at any stage.

Review of pre-commissioning documents and network
Review of operating manual.

Check listing (system-wise)

a) Preliminary checklist on system completion.
b) Final checklist before start of pre-commissioning activities.
16.7 A TYPICAL APPROACH TO WITNESS / INSPECTION OF PRE-COMMISSIONING

The pre-commissioning and commissioning activity shall be inspected by EPMC / OWNER as indicated below:

Activities Witness/Inspection

a) Installation of safety device Complete
b) Provision of temporary strainers and blind at critical locations Complete
c) Water flushing and air blowing of pipelines Random
d) Heater refractory dryout Complete
e) Cleaning of columns and internals flushing Complete Of columns, leak tests/tightness test of system
f) Instrumentation interlock checks Complete
g) Operability test for a system/equipment Complete
h) Blind list as per start up requirement/normal operation Complete
i) chemical cleaning of compressor suction line & lube oil circuit Complete
j) Alkali boil out of steam generation systems Complete

Witness/ inspection / approval of OWNER/ EPMC are not an obligation but a right with no change in CONTRACTOR's liabilities. At the discretion of OWNER/EPMC, the extent of witness / inspection may be extended/ reduced as deemed fit.

FINAL INSPECTION BEFORE START OF COMMISSIONING

OWNER/ EPMC/ Licensor or any other third party (like OISD) shall carry out a final inspection of the plants before permitting entry of hydrocarbon into the new facility. Record of liquidation of checklist point, test record etc shall be submitted by the CONTRACTOR to OWNER/ EPMC. Any deficiency/ changes required in the offered system shall be liquidated by the CONTRACTOR.
COMMISSIONING

It shall be the responsibility of the CONTRACTOR to commission the plants/section under the scope of the CONTRACTOR. Commissioning of the unit will be carried out under necessary guidance and overseeing of representatives of OWNER/ EPMC after mechanical completion is over successfully, all pre-commissioning activities are carried out and certificate of “Ready for commissioning” is accepted by OWNER. Representatives of process designer/ process licensor shall provide necessary co-ordination during start up and technical clarification will be furnished by them. Commissioning of the process units shall mean taking the feed, passing it through the normal route; establishing the process control parameters first at turn down & then at design value stipulated in the process package along with supplementary instructions, if any, from OWNER/ EPMC.

The process units shall be considered to be commissioned successfully when all the units, with instrumentation / control systems, process, utilities and support systems have been on uninterrupted stable operation for not less those 72 hours. Whether the 72 hours operation has been successful or not, shall be decided by the OWNER based on observations recorded during 72 hours. The countdown for 72 hours operation shall start only after unit has been on stable operation with all controls and safety system in normal operation for a period of not less than 48 hours. The unit shall be considered to be commissioned successfully when the entire unit, equipment, with instrumentation / control systems, process, utilities and support systems have been commissioned.

Three months in advance of starting the commissioning, the CONTRACTOR shall submit proposal to the OWNER/ EPMC giving details of the programme to be followed during Pre-commissioning and commissioning. This shall be reviewed by OWNER/ EPMC. The CONTRACTOR shall depute trained operating team for managing the daily operating shifts comprising of commissioning coordinator, process/ operational coordinators, mechanical, electrical and instrument engineers, technicians/ semi- skilled personnel etc. to carry out plant start-up and commissioning and for process operations and maintenance. Control room DCS, Local panel and field operators shall be provided by LSTK contractor based on the requirement of the OWNER.

The CONTRACTOR in his offer shall submit the organization chart of commissioning team and the bio-data of key persons who shall be present at the time of commissioning. The CONTRACTOR shall also specify the planned duration of stay of these personnel.

The CONTRACTOR also is required to provide on the job training to OWNER’s operation personnel by associating them in all the day to day pre-commissioning, commissioning and maintenance activities and
process operations. However, responsibility for adequate manning of the plant shall be that of CONTRACTOR. After successful commissioning, Performance Guarantee Test and operation and maintenance for three months, the installations shall be handed over to the OWNER for operation.

CONTRACTOR in some cases may be required to do part commissioning of the mechanically completed sections of the plant as per directives from the OWNER.

16.8 PERFORMANCE TEST RUN

After the units have been completed, put into operation and steady state operation is established, performance test of units shall be conducted based on the protocol between the OWNER and Contractor. The Contractor shall be responsible for the works executed under the contract. The performance test run shall be executed as per the procedure/guideline supplied by OWNER/ EPMC. Contractor shall provide the services of his commissioning engineers who were associated with the commissioning of the process units/sections at site during this performance test run period.

16.9 SPARES AND CONSUMABLES

CONTRACTOR shall be responsible for the supply of all spares and consumables for start-up, pre-commissioning and commissioning. Excess spares shall be handed over by CONTRACTOR to the OWNER after commissioning. CONTRACTOR shall also be responsible for supply of lubes, chemicals and other consumables in addition to commissioning and start-up requirement for six months normal operation after commissioning.

CONTRACTOR shall submit catalogues for all the lubricants and chemicals being charged for commissioning.

16.10 SAFETY

The CONTRACTOR shall follow OWNER’s safety practices during execution of pre-commissioning / commissioning works. CONTRACTOR is required to maintain and follow all safety practices equivalent or better than those being practiced by OWNER for the complex during pre-commissioning and commissioning.

16.11 PROCESS UNIT STAFFING

CONTRACTOR to identify and submit manning requirement and the plant operation organization structure to OWNER/EPMC for effective operation and maintenance of the unit. The proposed manning
requirement and organization structure to take into account the Indian condition.
FORMAT TO BE USED DURING PRE-COMMISSIONING AND COMMISSIONING

(TOTAL 5 FORMATS)
INTIMATION REGARDING SYSTEM COMPLETION

PROJECT: _________________ CUSTOMER: __________ UNIT: _______________

Following system/sub-system has been mechanically completed in all respects with exceptions noted below. The system/sub-system can be taken up for checking and preparation of checklist.

SYSTEM NO.

SYSTEM DESCRIPTION:

EXCEPTIONS:

CONTRACTOR’S CONSTRUCTION:

CO-ORDINATOR

OWNER/EPMC:

SIGNATURE DATE
# CHECKLIST

**PROJECT:**

**CUSTOMER:**

**UINT:**

**SYSTEM/SUB-SYSTEM:**

<table>
<thead>
<tr>
<th>CHECK LIST TYPE</th>
<th>PRELIMINARY/FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SL.NO.</strong></td>
<td><strong>CHECKLIST ITEMS</strong></td>
</tr>
</tbody>
</table>

**SIGNATURE**

**DATE**

**EPMC:**

**OWNER:**
READY FOR PRE-COMMISSIONING CERTIFICATE

PROJECT:_________________ CUSTOMER:_________________ UNIT:_________________
SYSTEM/SUB-SYSTEM________________________________________________

This is to certify that the following plant/system/sub-system as detailed below is completely installed and all the Checklist points are carried out except for minor details as given in the attached list.

DESCRIPTION ON PLANT/SECTION/SUB-SECTION______________________
____________________________________________________________________

SIGNATURE ______________________ DATE ______________

CONTRACTOR’S CONTRACTION

CO-ORDINATOR:

CONTRACTOR’S COMMISSIONING

CO-ORDINATOR

EPMC :

OWNER:
READY FOR COMMISSIONING CERTIFICATE

PROJECT:________________CUSTOMER:_________________ UNIT:__________

SYSTEM/SUB-SYSTEM________________________________________________

This is to certify that all the necessary pre-commissioning activities for the system/sub-system as detailed below have been completed and the system/sub-system is ready for commissioning except for the minor details as given below which will not affect the commissioning trial runs.

DESCRIPTION OF SYSTEM/SUB-SYSTEM__________________________________________

________________________________________

SIGNATURE                      DATE

CONTRACTOR’S COMMISSIONING:

CO-ORDINATOR

________________________________________

SIGNATURE                      DATE

EPMC:

OWNER:
COMPLETION OF COMMISSIONING CERTIFICATE

PROJECT: __________ CUSTOMER: ___________ UNIT: ________________

SYSTEM/SUB-SYSTEM_______________________________________________

This is to certify that the system/sub-system as detailed below has been successfully commissioned and is under operational control of Client's Production department. The minor items, which will not effect the normal operation of the system/sub-system, are given in the attached list.

DESCRIPTION OF SYSTEM/SUB-SYSTEM____________________________________

______________________________________________________________

SIGNATURE DATE

CONTRACTOR’S COMMISSIONING:

CO-ORDINATOR

______________________________________________________________

SIGNATURE DATE

EPMC’S COMMISSIONING:

CO-ORDINATOR

OWNER’S COMMISSIONING:

CO-ORDINATOR
PRE-COMMISSIONING ACTIVITIES

The checklist represents the absolute minimum work, which has to be performed by the CONTRACTOR prior to commissioning of the facilities. However, it is not intended to be a complete list of activities required to be carried

Manufacturer's/Vendor’s instructions for pre-commissioning checks, testing must also be followed for all equipment.

A. GENERAL PROCEDURE FOR PRE-COMMISSIONING

The general work procedures listed below outline the work to be performed by the CONTRACTOR. Procedures applicable to specific system or items of equipment are covered separately.

A-1 INSTALLATION OF SEALS AND PACKING

- Install mechanical seals, permanent packing and accessories, wherever required.
- Adjust and replace mechanical seals, packing and accessories, as necessary during pre-commissioning / commissioning period.

A-2 REMOVAL OF TEMPORARY BRACING

- Remove all temporary supports, bracing, or other foreign objects that were installed in vessels, transformers, piping, rotating machinery or other equipment to prevent damage during shipping, storage and erection.

A-3 ROTATION AND ALIGNMENT

- Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
- Make cold alignment to the manufacturer's tolerances along with OWNER/ OWNER's. Representative. Provide all the alignment readings records to OWNER.
- Check all lubricants and their quality, fill etc. before operating the equipment.
- Carry out no load run of motors etc.
- Check bearing temperatures, vibration, over speed trips function of different safety device and other relevant tests. Carry out adjustments as required.
- Make hot alignments and any adjustments required after equipment has been put in operation.
- Arrange for manufacturer representative for equipment as required during installation and/or pre-commissioning and commissioning.
A-4 TIE-INS AT UNIT BATTERY LIMITS

- Prepare all systems for safe tie-ins with utilities and auxiliary system. CONTRACTOR shall prepare the existing operating systems for tie-ins in consultation with OWNER and will be responsible for safety during tie-ins is being made. CONTRACTOR shall take approval of OWNER/EPMC for the safety measures to be taken by him before any tie-in work is taken-up.

A-5 SYSTEM CHECK / INSPECTION

Provide inspection facilities to the OWNER/EPMC to check that created facilities conform to the approved process and instrumentation drawings, construction drawings, vendor drawings and specifications approved for construction, verify and approve the facility check. Note exceptions, if any.

A-6 SITE MODIFICATIONS

Carry out site modifications as found necessary during system check / inspection from viewpoint of operability, maintenance and safety of the plant.

A-7 FLUSHING AND BLOWING

- Flushing schemes for various systems / subsystems / equipment should be prepared well in advance and to be submitted to OWNER/EPMC for approval.

- Perform flushing using fresh treated water and blowing using air of all above ground and underground piping to remove dirt, welding slag, etc. after hydro testing (along with gasket / sheet blasting).

- Arrange for cleaning media for carrying out flushing / blowing and disposal of the cleaning media in accordance with procedures to be adopted by the CONTRACTOR and approved by OWNER/EPMC.

Following rates of cleaning media to be maintained:

<table>
<thead>
<tr>
<th>Medium</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>8-9 ft/sec.</td>
</tr>
<tr>
<td>Water</td>
<td>3-4 ft/sec.</td>
</tr>
</tbody>
</table>

- Adequate arrangements to handle flushed streams to be created by CONTRACTOR without causing flooding of existing facilities.

- System flushed with water shall be followed by blowing with air for removal of free water. System requires to be kept under inert
pressure as recommended by licensor / vendor is to be kept under inert pressure.

A-8 TEMPORARY SPOOLS, STRAINERS, SCREENS AND BLINDS

- Provide and install all strainers, both temporary and permanent.
- Clean strainers as required during pre-commissioning and commissioning.
- Provide, install and remove all blinds required for flushing or operation. (Install and dismantle temporary pipe pools as and when required for pre-commissioning and commissioning).

A-9 LEAK AND PRESSURE TESTS

- Make non-operating leak tests and pressure tests on piping and all equipment, including field fabricated equipment.
- Conduct all tests in accordance with applicable statutory/safety/other applicable design codes and specifications. Leak tests upto 5 kg/cm²g pressure to be carried out after purging /flushing. Further leak test at higher pressure shall be carried out in steps of 5/10 kg/cm²g of gas. Detailed procedure for leak and pressure tests on piping and field-fabricated equipment shall be submitted by CONTRACTOR to the OWNER/EPMC for approval. Disposal of test media should be done as per the OWNER instructions.
- The system, which operates under vacuum, will be pressurized up to 1.5 kg/cm²g for leak testing.
- Once leak testing is over Vacuum test is to be carried out, wherever applicable. Pull maximum possible vacuum with the ejector or vacuum pump. Isolate the system and observe the rate of drop in pressure. Generally for most of the systems pressure drop of 50 Torr/hr is acceptable. Systems which are required to be vacuum tested and the detailed vacuum test procedure shall be submitted by CONTRACTOR to the OWNER/EPMC for approval.
- Notify the OWNER of test schedule at least two days in advance. All the tests are to be witnessed and the test record on satisfactory completion of the test to be signed by OWNER/OWNER's Representative.
- Provide any special media for test purpose and provide facilities for disposal
- Conduct all operational tightness testing.

A-10 SAFETY DEVICES

- Provide a list of proper settings for safety devices to the OWNER.
- Install all safety devices (including pressure relief valves) on the equipment after calibration test and adjust all safety device and seals wherever necessary or desirable.

A-11 PURGING

- Install necessary purge connections including installation of temporary purge piping or hoses to equipment connection and carry out system purging with inert gas.

A-12 DRYING OUT

Undertake system drying out operation as per approved operating procedure and guidelines for carrying out drying of major equipment, wherever dry-out is necessary.

A-13 HOUSE KEEPING

- Provide continuous clean up of the construction and operational area.
- Remove excess materials, temporary facilities and scaffolding and pick-up trash.
- Perform washing for clean up as required.

A-14 EQUIPMENT PROTECTION AND SPARE PARTS

Protect equipment from normal weather conditions, corrosion, or damage before commissioning.

A-15 CHEMICAL CLEANING/PICKLING

Perform special chemical cleaning or pickling of the piping as required by specification. (Wherever Applicable)

A-16 MISCELLANEOUS

To carry out any other check / test as required by OWNER/OWNER’s Representative and provide all test certificates as required by the OWNER/OWNER's Representative.

A-17 OPERABILITY TEST FOR A SYSTEM / EQUIPMENT
Each system / equipment shall be given operability test for sufficient duration (not less than 4 hours) to demonstrate worthiness of the system for normal operation.

The CONTRACTOR shall provide his proposal / procedures for carrying out the operability test of each equipment / system to prove that the equipment system installed meet the design specification. This shall also include the supply of log sheets wherein the operating parameters shall be recorded hourly. The operability test shall be carried out by the CONTRACTOR in presence of OWNER's/EPMC's Representative and the Vendor representative wherever applicable.

The CONTRACTOR shall make necessary checks, adjustments, repairs required for normal operation of the system / equipment.

All the safety devices shall be tried for their proper operation.

Upon completion of the operability test the log sheet with all observations shall be signed by the CONTRACTOR, Vendor, OWNER's/EPMC's Representative. The performance shall be evaluated based on the data and observations made during the operability test.

B. SPECIFIC PROCEDURES

In addition to the work to be performed in accordance with the above, the detailed procedures outlined below further define the work responsibilities of the CONTRACTOR for specific systems and items of equipment.

B-1 STATIC EQUIPMENT

Some of the Static Equipment, after erection and put in place have internals requiring field installations. These internals shall be inspected before and after installation. Open both internal and external man ways for inspection of vessel for OWNER/OWNER's Representative inspection. Head up after proper execution of closure permits.

NOTE:

Equipment that have been pressure tested in the shop may require retesting if felt necessary by the OWNER. They shall, however, be included in the testing of attendant piping systems wherever practical and approved by the OWNER/EPMC.

B-2 WATER BATH HEATERS

- Perform internal inspection / testing as required by specifications or drawings.
- Perform separate field testing, if desired by OWNER for shop tested heaters.
B-3 PUMPS, BLOWERS AND DRIVERS

- Level base plates and sole plates. Alleviate any excess piping stresses that may be imposed on pumps, blowers and drivers. Chemically clean complete lube and seal oil system when specified.
- Charge the lube oil, seal oil and cooling systems with flushing oil and circulate for cleaning purposes. Dispose of any flushing oil in accordance with the OWNER's approved procedure.
- Charge the lube oil, seal oil and oil cooling system with operating oil recommended by the manufacturer.
- Obtain service engineer for technical assistance during installation and / or pre-commissioning and commissioning as specified.

B-4 PIPING SYSTEM

- Notify the OWNER of hydro test schedule at least two days in advance system by system during mechanical construction stage.
- Orifice plates, control valves and any other online instruments should not be installed before testing and flushing. If installed, they shall be removed and necessary spool pieces shall be provided in their place wherever required during flushing to avoid damage.
- Piping system shall be thoroughly flushed and cleaned to the satisfaction of the OWNER/OWNER's Representative.
- Hydrostatically or pneumatically test all piping as required by the drawings or specifications.
- All the piping will be dried using air and boxed up.
- Check pipe hangers, supports, guides and pipe specialities for hot settings and make minor adjustments as necessary.
- Install seals on valves where necessary. Replacing dry up graphite seals with fresh ones shall be in CONTRACTOR's scope of work.
- Correct support, vibration and thermal expansion problems detected during commissioning.

B-5 INSTRUMENT SYSTEM

- The CONTRACTOR will make all non-operating checks that will ensure instrument operability i.e. remove all shipping stops, check pointer travels, and verify instrument capability to measure, operate and stroke in the direction and manner required by the process application.
- Clean all impulse lines (etc.) by blowing with cooled and filtered clean air compatible with instrument components.
- Clean all air supply headers by blowing with clean air and check them for tightness.
- Leak test pneumatic control circuits.
- Functional check of all instrument and controllers.
OIL/CCO/PDNG/GLOBAL/215/2008
OIL INDIA LTD.
DULIAJAN, ASSAM, INDIA

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Check all loops for proper functioning.
Checking and recording positions of all valves.
Check piping from instruments to process piping for tightness.
Install and connect all system components and verify their
conformance to specifications and design criteria for functional and
range using dummy transmission signals as needed.
Check all electrical signals and alarm wiring for continuity, correct
source of power and polarity.
Check thermocouple for proper joining of wires, position of
elements in wells, proper polarity and continuity of receiving
instruments.
Check bore of orifice plates and install these properly after
completion of flushing operations.
Calibrate instruments with standard test equipment and make all
required adjustments and control point settings. Fully pressurize
and energize the transmitting and control signal system by opening
process connections at primary sensors and final regulators and by
making control mode settings for automatic operation of equipment
as the process unit is charged and brought on stream.
Check setting of all alarm and shutdown switches.
Check all shutdown systems before commissioning.
The CONTRACTOR shall arrange for testing and recalibration of all
the safety valves settings at site.
Ensure that safety valve isolation valves are locked open as per
drawings.

Saipem Triune Engineering Pvt. Ltd.
New Delhi

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17.0 CONTRACT CLOSURE
17.0 CONTRACT CLOSURE

17.1 GENERAL

17.1.1 Contractor after completing the works in all respects as specified elsewhere in the contract is required to complete the following activities but not limited to the same for closing of the contract.

17.1.2 Payment against contractor’s Final Bill shall be released upon the satisfactory completion of activities pertaining to closing of the contract.

17.2 REQUIREMENTS FOR CONTRACT CLOSING

The contractor shall be required to submit the following documents but not limited to the same on completion of work along with the final bill.

- Certificate for Successful Completion of Commissioning and Performance test
- Copy of owner’s approval for final time extension.
- Completion certificate
- Submission of completion documents as per SCC.
- Reconciliation of Free Issue Material (if any) and surplus.
- Site clearing as per Contract.
- Supply of spares
- Submission of operating manuals
- Submission of any balance drawings and documents to the owner for claiming CENVAT Benefits, as applicable
- Submission of Guarantees as specified contract
- Approval from Statutory Authorities and Government bodies.
- Approval from EPMC/Owner for extra claims, if any.
- No claims certificate.
- No dues certificate.
- Detailed contract close out report.
- Any other documents to be submitted as specified elsewhere in the contract.
- No liability certificate: - Self-certification from the contractor that no payment is balance to their laborer subcontractor and vendors on account of service rendered/materials supplied by them.
- Insurance Policies required as per contract.
- Validity Extension of various Bank Guarantees required as per contract.
- Submission of as-built documentation

17.3 DOCUMENTATION

Documents as specified under clause no. 17.2 are to be submitted to EPMC/Owner along with the final bill.
17.4 TIME FRAME FOR CONTRACT CLOSURE

The contractor shall be required to submit the documents for those activities which are completed before Mechanical completion including Q.A. documents, statutory authorities approvals, as built drawings etc. concurrent to Mechanical completion but not later than one month. Balance documents such as completion certificate, performance guarantee test, No dues certificate, No claim certificate, submission of guarantees etc. excluding final completion certificate are to be submitted within seven working days after the P.G. Test.
18.0 PERFORMANCE GUARANTEE
18.0 PERFORMANCE GUARANTEE

Contractor shall be responsible for the detailed design for the entire facilities as per the basic design provided with the bid documents. All equipment and materials shall be supplied strictly in accordance with the specifications, drawings, data sheets attachments and other conditions stated in the bid document and as approved by Owner/EPMC during the course of execution of the project.

Contractor shall be responsible for the detailed design and supply, fabrication, construction, installation as per the bid document and Guarantee the performance of the Equipment as per General Conditions of Contract attached elsewhere in the Bid Document.

This shall be read in conjunction with the guarantee clause as per commercial terms and condition in the bid document.
19.0 VENDOR LIST
**VENDOR LIST**

i) The approved vendor list is furnished here. All procurement of material/equipment shall be adhered from these vendors only.

ii) In case for any item there is no vendor mentioned in the approved vendor list the contractor shall propose the name of the vendor along with complete credential, catalogue for the item, past experience, statutory approval etc. which he plans to procure from the proposed vendor. The procurement activity will start only after the Owner/ EPMC has approved the new vendor. The decision of the Owner/EPMC shall be final and binding the contractor in this regard.

iii) In case for any reasons the vendor mentioned in the approved vendor list are unable to supply item / equipment then also the contractor will furnish all the details of the proposed vendor as mentioned in the clause no. 6.3.4.

iv) Vendors must be having valid DGMS certificate at the time of placement of order & supply of items.
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<th>S.No.</th>
<th>Description</th>
<th>Index No.</th>
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<td>MECHANICAL</td>
<td>19.1</td>
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<td>2.0</td>
<td>PIPING</td>
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<td>3.0</td>
<td>INSTRUMENTATION</td>
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<tr>
<td>7.0</td>
<td>MISCELLANEOUS</td>
<td>19.7</td>
</tr>
</tbody>
</table>
| 8.0   | LIST OF APPROVED MANUFACTURERS OF
       | ARCHITECTURAL PRODUCTS                              | 19.8      |
19.1 MECHANICAL EQUIPMENT

7.3 SEPARATORS / FILTER SEPARATOR / GAS FILTER/ CONDENSATE FLASH SEPARATOR

A. M/S. NATCO, USA
B. M/S. BURGESS MANNING, UK
C. M/S. MACCHENZIE HYDROCARBONS, AUSTRALIA
D. M/S. AKER KVAERNER PROCESS SYSTEMS, SCOTLAND
E. M/S. GASTECH ENGINEERING CORP, USA

2 SLUG CATCHER

A. M/S. BURGESS MANNING, UK
B. M/S. TAYLOR FORGE, USA
C. M/S. COMART SPA, ITALY
D. M/S. BKW INC, USA
E. M/S. PETRECO PROCESS SYSTEMS, UK
F. M/S. GASTECH ENGINEERING CORP, USA

3 INDIRECT BATH HEATERS

A. M/S. MACCHENZIE HYDROCARBONS, AUSTRALIA
B. M/S. NATCO, USA
C. M/S. BURGESS MANNING, UK
D. M/S. SIGMA THERMAL, USA
E. M/S. TOTAL ENERY RESOURCES INC, USA
F. M/S. GASTECH ENGINEERING CORP, USA

4 PRESSURE VESSELS

A. M/S. INDIA TUBE MILLS, MUMBAI
B. M/S. INDUS ENGINEERING CO., MUMBAI
C. M/S. G.R. ENGINEERING, MUMBAI
D. M/S. L&T, MUMBAI
E. M/S. ISGEC, YAMUNA NAGAR
F. M/S. BHPV, VIZAG
G. M/S ANUP ENGINEERING, AHMEDABAD

5 TANKAGES

A. M/S. PATEL FILTERS, AHMEDABAD
B. M/S. UNITOP ENGINEER, BARODA
C. M/S. INDIA TUBE MILL, MUMBAI
D. M/S. MISTRY PRABHUDAS, MUMBAI
E. M/S. INDUS ENGINEERING CO., MUMBAI
F. M/S. SRINIVAS PLATES & STRUCTURES
### 6 FABRICATED TANKS

- **A.** M/S. BINODE ENGG. WORKS
- **B.** M/S. SHARAMA & CO.
- **C.** M/S. HAZIRIKA & CO.
- **D.** M/S. SWASTIK ENGG. WORKS
- **E.** M/S. STEEL & GRIP
- **F.** M/S. MECHFAB ENGG. INDUSTRES
- **G.** M/S. DEEPAK CONSTRUCTION CO.
- **H.** M/S. SUDARSHAN STEEL UDYOG
- **I.** M/S. MECH TECHNIK

### 7 CENTRIFUGAL PUMP (PROCESS)

- **A.** M/S. AKAY INDUSTRIES, HUBLI
- **B.** M/S. BPCL, NAINI, ALLAHABAD
- **C.** M/S. KSB PUMPS, PUNE
- **D.** M/S. SULZER PUMPS LTD.
- **E.** M/S. KIRLOSKAR EBARA, PUNE

### 8 CENTRIFUGAL PUMP (WATER)

- **A.** M/S. KIRLOSKAR BROS, LIMITED, PUNE
- **B.** M/S. JYOTI LIMITED, BARODA
- **C.** M/S. KISHORE PUMPS, PUNE
- **D.** M/S. MATHER & PLATT

### 9 METERING PUMPS / DOSING PUMPS

- **A.** M/S. SHAPOTOOLS, MUMBAI
- **B.** M/S. SWELLORE ENGG. PVT.LTD., AHMEDABAD
- **C.** M/S. MATZ PUMPS PVT. LTD. AHMEDABAD
- **D.** M/S. VK PUMPS, MUMBAI

### 10 POSITIVE DISPLACEMENT PUMP

- **A.** M/S. TUSHACO PUMPS
- **B.** M/S. ROTO PUMPS PVT. LTD., DELHI

### 11 SUBMERSIBLE PUMPS

- **A.** M/S. KSB, PUNE
- **B.** M/S. CALAMA INDUSTRIES PVT. LTD., MUMBAI
- **C.** M/S. GEC, KOLKATA
D. M/S. AMRIT ENGINEERING PVT. LTD., AHMEDABAD

12 RECIPROCATING AIR COMPRESSOR

A. M/S. INGERSOLL RAND INDIA LTD.
B. M/S. KIRLOSKAR PNEUMATIC CO. LTD.
C. M/S. CHICAGO PNEUMATICS INDIA LTD.
D. M/S. BHARAT PUMPS & COMPRESSORS LTD.

13 AIR CONDITIONING

A. M/S. VOLTAS
B. M/S. BLUE STAR
C. M/S. CARRIER AIR CON

14 HOT CRANE

A. M/S. BATLIBOI AND COMPANY, MUMBAI
B. M/S. EDDY CRANES ENGINEERS PVT. LTD.
C. M/S. ARMSEL MHE PVT. LTD.
D. M/S. HERCULES HOIST LTD
E. M/S. REVA ENGG. INDIA PVT.LTD.

15 FIRE FIGHTING PUMPS

A. M/S. KIRLOSKAR BROTHERS
B. M/S. MATHER & PLATT

16 RECIPROCATING PUMPS

A. M/S. BHARAT PUMPS & COMPRESSORS LTD.
B. M/S GOMA ENGINEERING, INDIA
C. M/S NATIONAL OILWELL VARCO, USA
D. GARDNER DENVER, USA
19.2 PIPING

1 CS PIPES (ERW)

A. M/S. TISCO, NEW DELHI
B. M/S. ZENITH STEEL PIPES AND INDUSTRIES LIMITED, MUMBAI
C. M/S. JINDAL PIPES LIMITED, DELHI
D. M/S. STEEL AUTHORITY OF INDIA, DELHI
E. M/S. SAW PIPE LIMITED, DELHI
F. M/S. INDUS TUBE LIMITED, GHAZIABAD
G. M/S. SURYA ROSHI

2 CS PIPES (SEAMLESS)

A. M/S. TISCO, NEW DELHI
B. M/S. MAHARASTRA SEAMLESS
C. M/S. BHEL
D. M/S. INDIAN SEAMLESS METAL TUBES

3 SS PIPES

A. M/S. RAJENDRA MECHANICAL INDUSTRIES (P) LTD., MUMBAI
B. M/S. NEEKA TUBES LIMITED, AHMEDABAD
C. M/S. CHOKSI TUBE CO LIMITED, AHMEDABAD
D. M/S. RATNAMANI METAL TUBE, AHMEDABAD

4 CS & SS PIPE FITTINGS

A. M/S. EBY MUMBAI
B. M/S. ECHJAY INDUSTRIES PVT. LIMITED, MUMBAI
C. M/S. TEEKAY TUBES (P) LIMITED, MUMBAI
D. M/S. STEWART AND LLOYDS, KOLKATTA
E. M/S. M.S.FITTING
F. M/S. COMMERCIAL SUPPLYING AGENCY

5 CS AND SS FLANGES

A. M/S. AJAY FORGINGS PVT. LTD. FARIDABAD
B. M/S. PUNJAB STEEL, NEW DELHI
C. M/S. ECHJAY INDUSTRIES PVT. LIMITED, MUMBAI
D. M/S. GOLDEN IRON AND STEEL, NEW DELHI
E. M/S. METAL FORGING PVT. LIMITED, NEW DELHI
F. M/S. CHOU DHARY HAMMER, GHAZIABAD
6 GASKETS
A. M/S. MADRAS INDUSTRIES PRODUCTS, CHENNAI
B. M/S. IGP ENGR (P) LIMITED, CHENNAI
C. M/S. UNI KLINGER

7 BOLTS AND NUTS
A. M/S. NIREKA ENGINEERING CO. PVT. LIMITED, KOLKATTA
B. M/S. PRECISION ENGINEERING INDUSTRIES BARODA
C. M/S. FIX FIT FASTENERS, KOLKATTA
D. M/S. PRECISION TAPS AND DIES, MUMBAI
E. M/S. GKW, MUMBAI
F. M/S. ECH JAY INDUSTRIES

8 GATE VALVE (API 6D/600)
A. M/S. L&T
B. M/S. AUDCO
C. M/S. PECO ENGINEERING
D. M/S. BHEL, TRICHEY

9 BALL VALVE (API 6D)
A. M/S. AUDCO
B. M/S. PECO ENGINEERING
C. M/S. MICROFINISH
D. M/S. XOMOX

10 GATE / GLOBE / CHECK (API & other standards)
A. M/S. L&T
B. M/S. NITON
C. M/S. PECO
D. M/S. FOURRESS ENGINEERING (I) PVT LTD

11 STRAINER (FAB/CAST/FORGED)
A. M/S. J.N. MARSHAL & CO.
B. M/S. OTOKLIN FILTERS OF INDIA LTD.
C. M/S. GREAVES COTTON & CO.
D. M/S. MULTITEX FILTRATION ENGG. PVT.LTD.
E. M/S. VARALL ENGINEERS
19.3 INSTRUMENTATION

1 PRESSURE / DP / TEMPERATURE GAUGES
   A. M/S. WIKA
   B. M/S. GENERAL INSTRUMENTS
   C. M/S. ASHCROFT

2 LEVEL GAUGES
   A. M/S. LEVCON
   B. M/S. CHEMTROL.
   C. M/S. KLINGER
   D. M/S. BLISS ANAND

3 PRESSURE / TEMPERATURE SWITCHES.
   A. M/S. SWITZER
   B. M/S. SOR
   C. M/S. ASHCROFT
   D. M/S. INDFOSS

4 ORIFICE PLATES AND FLANGES AND RESTRICTION ORIFICE
   A. M/S. MICRO PRECISION
   B. M/S. ABB
   C. M/S. EMERSON (DANIEL)

5 TEMPERATURE ELEMENTS & THERMOWELLS
   A. M/S. GENERAL INSTRUMENTS
   B. M/S. DETRIV INSTRUMENTATION
   C. M/S. NAGMAN
   D. M/S. ALTOP INDUSTRIES.

6 PRESSURE TRANSMITTERS
   A. M/S. EMERSON (ROSEMOUNT)
   B. M/S. HONEYWELL
   C. M/S. YOKOGAWA
   D. M/S. ABB

7 DP TRANSMITTERS
   A. M/S. EMERSON (ROSEMOUNT)
   B. M/S. HONEYWELL
   C. M/S. YOKOGAWA
   D. M/S. ABB

8 TEMPERATURE TRANSMITTERS
9  DISPLACER LEVEL TRANSMITTERS
   A. M/S. EMERSON (ROSEMOUNT)
   B. M/S. HONEYWELL
   C. M/S. ABB
   D. M/S. YOKOGAWA

10  RADAR LEVEL TRANSMITTERS
    A. M/S. EMERSON
    B. M/S. ENDRESS+HAUSER
    C. M/S. MAGNETROL

11  INTERNAL DISPLACER SERVO LEVEL TRANSMITTER
    A. M/S. ENDRESS + HAUSER
    B. M/S. ENRAF

12  CORIOLIS MASS FLOW METERS
    A. M/S. EMERSON
    B. M/S. KROHNE
    C. M/S. ENDRESS + HAUSER
    D. M/S. RHEONIK, GERMANY

13  ULTRASONIC FLOW METER (CUSTODY TRANSFER & SEPARATOR GAS MEASUREMENTS)
    A. M/S. EMERSON (DANIEL)
    B. M/S. KROHNE
    C. M/S. SICK ENGINEERING GMBH
    D. M/S. INSTROMET, BELGIUM
    E. M/S. RMG, GMBH

14  ULTRASONIC FLOW METER (FLARE GAS MEASUREMENT
    A. M/S. PANAMETRICS
    B. M/S. KROHNE
    C. M/S. CONTROLOTRON, USA

15  FLOW COMPUTER
16 SELF ACTUATED VALVES
A. M/S. EMERSON (FISHER)
B. M/S. DRESSER MASONEILAN
C. M/S. HOPKINSON

17 PRESSURE SAFETY VALVE / RELIEF VALVE
A. M/S. BAILEY BIRKIT
B. M/S. TYCO SANMAR
C. M/S. BHEL, TRICHY
D. M/S. FARRIS

18 CONTROL VALVES
A. M/S. FISHER
B. M/S. DRESSER MASONEILAN
C. M/S. BLAKE BOROUGH
D. M/S. INSTRUMENTATION LIMITED

19 SHUTDOWN VALVES
A. M/S. PETROL VALVES
B. M/S. VALVINOX
C. M/S. VERSA

20 AIR FILTER REGULATOR
A. M/S. FISHER
B. M/S. SHAVO NORGREN
C. M/S. PLACKA

21 SOLENOID VALVES
A. M/S. ASCO
B. M/S. ROTEX
C. M/S. HERION

22 LIMIT SWITCHES
A. M/S. HONEYWELL
B. M/S. TYCO

23 GAS DETECTORS
A. M/S. CROWCON DETECTION INSTRUMENTS  
B. M/S. DETECTOR ELECTRONICS CORPORATION  
C. M/S. DRAGER SAFETY  
D. M/S. GENERAL MONITORS  
E. M/S. ZELLWEGER.

24 FLAME DETECTORS
A. M/S. CROWCON DETECTION INSTRUMENTS  
B. M/S. DETECTOR ELECTRONICS CORPORATION  
C. M/S. DRAGER SAFETY  
D. M/S. GENERAL MONITORS  
E. M/S. ZELLWEGER

25 SMOKE/HEAT DETECTORS
A. APOLLO  
B. THORN  
C. ZELLWEGER

26 MANUAL ALARM CALL POINTS
A. M/S. MEDC  
B. M/S. BALIGA

27 HOOTER
A. M/S. SAFEWAY  
B. M/S. KHERAJ

28 DEW POINT METER
A. M/S. GE SENSING  
B. M/S. SHAW  
C. M/S. ALPHA MOISTURE SYSTEMS

29 GAS CHROMATOGRAPH (ON LINE)
A. M/S. ABB  
B. M/S. INSTROMET, BELGIUM  
C. M/S. RMG, GERMANY  
D. M/S. DANIEL

30 FLAME ARRESTERS
A. M/S. GROTH EQUIPMENT CORPORATION  
B. M/S. GPE CONTROLS  
C. M/S. SHAND & JURS
D. M/S. MARVAC  
E. M/S. SAFETY SYSTEM  

31  DCS  
A. M/S. EMERSON  
B. M/S. ABB  
C. M/S. HONEYWELL  
D. M/S. YOKOGAWA  
E. M/S. INVENSYS  

32  PLC  
A. M/S. ROCKWELL  
B. M/S. ABB  
C. M/S. HONEYWELL  
D. M/S. SIEMENS  
E. M/S. GE FANUC  

33  ZENER BARRIER  
A. M/S. MTL  
B. M/S. PEPPERL+FUCHS  

34  EMERGENCY PUSH BUTTONS  
A. M/S. BARTEC  
B. M/S. FONDISONZO  

35  PLASMA MIMIC PANEL  
A. M/S. SAMSUNG  
B. M/S. PANASONIC  

36  CONTROL PANELS  
A. M/S. RITTAL  
B. M/S. PYROTECH  

37  JUNCTION BOXES & CABLE GLANDS  
A. M/S. FLEXPRO ELEC. PVT LTD  
B. M/S. BALIGA LIGHTING EQUIPMENT LTD  
C. M/S. EX PROTECTA  
D. M/S. FLAMEPROOF CONTROL GEARS  

38  FIELDBUS JUNCTION BOXES  
A. M/S. PEPPERL & FUCHS  
B. M/S. MTL
39  INSTRUMENT CABLES
   A. M/S. ASSOCIATED CABLES (P) LTD.
   B. M/S. POLYCA B WIRES PVT LTD.
   C. M/S. DELTON CABLES LTD
   D. M/S. KEI INDUSTRIES

40  INSTRUMENT FITTINGS (SS-TUBE, TUBE FITTING, TUBE VALVES)
   A. M/S. SWAGELOK
   B. M/S. PARKER
   C. M/S. HOKE
   D. M/S. ANDERSON GREENWOOD

41  CABLE TRAYS
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   B. M/S. SADHANA ENGINEERING CORPORATION
   C. M/S. INDIANA CABLE TRAYS CORPORATION

42  ERECTION HARDWARE
   A. M/S. HYDAIR ENGG WORKS
   B. M/S. TECHNOMATIC CONTROLS PVT LTD
   C. M/S. EBY FASTENERS
19.4 ELECTRICAL

1 RELAYS
A. M/S. GEC ALSTHOM LIMITED (ENGLISH ELECTRIC)
B. M/S. L&T
C. M/S. SIEMENS

2 INSTRUMENT TRANSFORMER (FOR METERING AND PROTECTION)
A. M/S. AUTOMATIC ELECTRIC PRODUCT
B. M/S. KAPPA ELECTRICALS
C. M/S. CROMPTON GREAVES LIMITED

3 AIR CIRCUIT BREAKERS
A. M/S. LARSEN AND TOUBRO LIMITED
B. M/S. SIEMENS LIMITED
C. M/S. GEC ALSTHOM LIMITED (ENGLISH ELECTRIC)

4 POWER CONTROL CENTRES (PCC)/ MOTOR CONTROL CENTRE
A. M/S. LARSEN AND TOUBRO LIMITED
B. M/S. GEC ALSTHOM LIMITED (ENGLISH ELECTRIC)
C. M/S. CROMPTON GREAVES
D. M/S. SIEMENS LIMITED

5 H.T. SWITCHGEARS
A. M/S. CROMPTON GREAVES
B. M/S. SIEMENS LTD.
C. M/S. GEC
D. M/S. ALSTOM POWER

6 DISTRIBUTION BOARDS (WITH MCB/ELCB)
A. M/S. MDS SWITCHGEAR LIMITED
B. M/S. MERLIN GERIN

7 FLAMEPROOF LIGHT-FITTINGS (DBS/JBS/PBS)
A. M/S. BALIGA
B. M/S. FLEXPRO
C. M/S. FLAME PROOF CONTROL GEARS
8 CABLE TRAYS

A. M/S. EQUIP TECH PVT. LIMITED
B. M/S. INDIAN ENGINEERING WORKS PVT. LIMITED
C. M/S. PILCO MARKETING AND MANUFACTURING CORPORATION
D. M/S. TECHNO ENGINEERING CO.
E. M/S. SLOTCO STEEL PRODUCTS PVT. LIMITED

9 MOTORS

A. M/S. BHARAT BIJLEE LIMITED (LT ONLY)
B. M/S. CROMPTION GREAVES LIMITED
C. M/S. SIEMENS LIMITED ONLY
D. M/S. KIRLOSKAR ELECTRIC COMPANY

10 SWITCH / FUSE / SWITCH FUSE / THERM O/L RELAY / CONTRACTOR / MCCB

A. M/S. LARSEN AND TOUBRO LIMITED
B. M/S. SIEMENS LIMITED
C. M/S. GEC ALSTHOM ENGLISH ELECTRIC

11 LIGHTING & FIXTURES

A. M/S. BAJAJ ELECTRICAL LIMITED
B. M/S. CROMPTON GREAVES LIMITED
C. M/S. PHILIPS

12 INSTRUMENT AND METERS

A. M/S. AUTOMATIC ELECTRICAL LIMITED
B. M/S. INDUSTRIAL METER LIMITED
C. M/S. MECO INSTRUMENTS PVT. LIMITED

13 KW/KWHR METER (ONLY ELECTRONIC)

A. M/S. GEC ALSTHOM LIMITED
B. M/S. SIMCO ENGINEERING LIMITED
C. M/S. JAIPUR METALS AND ELECTRICAL LIMITED

14 LIGHTING TRANSFORMER (DRY TYPE)

A. M/S. AUTOMATIC ELECTRICAL LIMITED
B. M/S. POWER MASTER ELECTRICAL
### C. M/S. VOLTAMP

#### 15 CABLE / PVC POWER AND CONTROL
- A. M/S. CABLE CORPORATION OF INDIA LIMITED
- B. M/S. NICCO CORPORATION LIMITED
- C. M/S. UNIVERSAL CABLES LIMITED
- D. M/S. NECAB
- E. M/S HAVELL'S

#### 16 INDUSTRIAL PUSH BUTTON STNS. (FLP)
- A. M/S. BALIGA
- B. M/S. FLAMEPROOF CONTROL GEARS
- C. M/S. FLEXPRO

### NON-FLP

#### A. M/S. BCH
- B. M/S. SIEMENS
- C. M/S. CROMPTON
- D. M/S. L & T

#### 17 TERMINALS
- A. M/S. ELEMEX
- B. M/S. TOSH
- C. M/S. TECHNOPLAST
- D. M/S. CONNECT WELL

#### 18 TERMINATION KITS
- A. M/S. CCI
- B. M/S. M SEAL
- C. M/S. RAYCHEM

#### 19 UPS SYSTEM
- A. M/S. DB ELECTRONICS PVT. LTD.
- B. M/S. GUJARAT HI-REL CONTROLS
- C. M/S. GUTUR
- D. M/S. TATA LIEBERT

#### 20 CABLE GLANDS FOR HAZARDOUS AREAS
- A. M/S. BALIGA
- B. M/S. FCG
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<td>M/S KIRLOSKAR BROTHERS/ AUTHORISED DEALERS OF KIRLOSKAR</td>
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28 LIGHTING HIGH MAST
   A. M/S. PHILIPS
   B. M/S. BAJAJ ELECTRICALS
   C. M/S CROMPTON GREAVES, NEW DELHI

29 AIR-CONDITIONER
   A. M/S. VOLTAS
   B. M/S. BLUESTAR
   C. M/S. CARRIER

30 WIRING ACCESSORIES
   A. M/S. MK
   B. M/S. ANCHOR
   C. M/S. LEGRAND
   D. M/S. CRABTREE

31 CRIMPING LUGS
   A. M/S. DOWELL’S
19.5 LABORATORY INSTRUMENTS

1. GAS CHROMATOGRAPH
   A. M/S. PERKIN ELMER INC., NETHERLANDS
   B. M/S. DANIEL MEASUREMENT & CONTROL (I) PVT. LTD.
   C. M/S. CHEMITO TECHNOLOGIES PVT. LTD.

2. SIMULATED DISTILLATION
   A. M/S. CHEMITO TECHNOLOGIES PVT. LTD.
   B. M/S. PERKIN ELMER INC., NETHERLANDS

3. HYDROGEN GENERATOR
   A. M/S. PARKER HANNIFIN CORPORATION
   B. M/S. CHEMITO TECHNOLOGIES PVT. LTD.

4. AIR GENERATOR
   A. M/S. CALIND S.R.L. ITALY.
   B. M/S. CHEMITO TECHNOLOGIES PVT. LTD.

5. NITROGEN GENERATOR
   A. M/S. CALIND S.R.L. ITALY.
   B. M/S. CHEMITO TECHNOLOGIES PVT. LTD.

6. DEW POINT METER
   A. M/S. SHOW MISTURE METERS (UK) LTD.
   B. M/S. PANAMETRICS

7. DIGITAL pH METER
   A. M/S. EUTECH INSTRUMENTS (Pte.) LTD., SINGAPORE.

8. DISSOLVED OXYGEN METER
   A. M/S. YELLOW SPRING INSTRUMENT CO. INC., USA.
   B. M/S. EUTECH INSTRUMENTS (Pte.) LTD., SINGAPORE.

9. OIL CONTENT ANALYSER
   A. M/S. G SCHMIED ABWASSERTECHNIK, GMBH.
10. **AUTOMATIC DIGITAL BOD ANALYSER WITH INCUBATOR**
   A. M/S. WTW GMBH, GERMANY

11. **FLAME PHOTOMETER**
   A. M/S. SYSTONICS, AHMEDABAD, GUJARAT
   B. M/S. CHEMITO TECHNOLOGIES PVT. LTD.

12. **PHOTOMETER**
   A. M/S. EMARK (I) LTD., MUMBAI
19.6 PACKAGES

1 EFFLUENT TREATMENT
A. M/S. Enviro Control Associates
B. M/S. Paramount Pollution Control
C. M/S. Geo Miller
D. M/S. Degremont India Limited
E. M/S. V A Tech
F. M/s. Neel Water Treatment Systems Pvt. Ltd.

2 WATER TREATMENT
A. M/S. Degremont India Limited
B. M/S. Ion Exchange
C. M/S. Thermax
D. M/S. V A Tech
E. M/s. Neel Water Treatment Systems Pvt. Ltd.

3 ATMOSPHERIC GAUGE TANK
A. M/S. Gauging Systems Inc., Texas
B. M/S. Varec Inc., California

4 DATA HEADER
A. M/S. Power Well Services, Houston, Texas

5 CORROSION INHIBITOR INJECTION
A. M/S. Positive Metering Systems International Limited, U.K.
B. M/S. Petrosavis Engineering Company, Tehran (IRAN)

6 FUEL GAS HEATER
A. M/S. EXHEAT® U.K./ Singapore

7 FLARE SYSTEM
A. M/S. AIOIL FLARE GAS, AHEMEDABAD
B. M/S. ADOR SAMIA, PUNE
C. M/S. ARGO FLARE SERVICES
D. M/S. JOHN ZINK COMPANY
E. M/S. NORINCO PVT. LTD.
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| **2** | **S.S. PLATE** |
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| C. | M/S. JINDAL STEEL |
| D. | M/S. ESSAR STEEL |

| **3** | **INSULATION** |
| A. | M/S. LLOYD INSULATIONS |
| B. | M/S. LAPINUS ROCKWWOL |
| C. | M/S. MINWOOL ROCK FIBRES LTD. |
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| **4** | **PAINTS** |
| A. | M/S. ASIAN PAINTS (I) LTD. |
| B. | M/S. BERGER PAINTS |
| C. | M/S. GOODLASS NEROLAC PAINTS LTD. |
| A. | M/S. JENSION & NICHOLSON (INDIA) LTD. |
| B. | M/S. SHALIMAR PAINTS |
| C. | M/S. ICI |

| **5** | **CEMENT** |
| A. | M/S. CENTURY |
| B. | M/S. GRASIM |
| C. | M/S. AMBUJA |
| D. | M/S. L&T (ULTRATECH) |
| E. | M/S. CCI |

| **6** | **STRUCTURAL STEEL** |
| A. | M/S. SAIL |
| B. | M/S. TISCO |
| C. | M/S. INDIAN IRON STEEL CO. |
| D. | M/S. RASHTRIYA ISPAT NIGAM |
19.8 LIST OF APPROVED MANUFACTURERS FOR ARCHITECTURAL PRODUCTS

GENERAL NOTES

i) ONLY “FIRST” QUALITY MATERIALS SHALL BE USED.

ii) OWNER / STEP RESERVES THE RIGHT TO CHOOSE ANY OF THE APPROVED MAKE/VENDOR AS PER THIS VENDOR LIST.

iii) SPECIFICATION OF MANUFACTURER’S ITEM SHALL BE CHECKED AGAINST TENDER ITEM / SPECIFICATIONS BEFORE SELECTING ANY PRODUCT OR BRAND NAME. IN CASE OF ANY DISCREPANCY, TENDER ITEM/SPECIFICATIONS SHALL PREVAIL, AND ANY SUCH BRAND OF ITEM SHALL NOT BE USED WHICH IS NOT CONFORMING TO TENDER SPECIFICATIONS EVEN IF IT IS LISTED IN THIS VENDOR LIST.

iv) IN CASE OF NON AVAILABILITY OF ANY MATERIAL AMONG APPROVED VENDORS/MAKES IN A PARTICULAR SITE/REGION, ALTERNATE VENDOR/MAKE CONFORMING TO BIS ETC. SHALL BE USED SUBJECT TO APPROVAL BY OWNER/STEP.

v) THE VENDOR LIST IS SUBJECT TO REVISION, IF REQUIRED BASED ON SITE FEED-BACK REPORTS AND AVAILABILITY OF MATERIAL.
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| 2.3 | PARTICLE BOARD (EXTR. GRADE) VENEERED / LAMINATED | a) BHUTAN BOARD  
b) BEST BOARD  
c) NOVAPAN INDIA LTD.  
d) THE BOMBAY BURMAH TRADING CORPN LTD. | . BHUTAN  
. DELHI  
. HYDERABAD  
. DELHI | BHUTAN BOARD  
HIBOND  
NOVATEAK  
EASYLAM |
| 2.4 | MDF BOARD / MD PARTICLE | a) NUCHEM LTD.  
b) MANGALAM TIMBER PRODUCTS LTD.  
c) WESTERN BIO SYSTEMS LTD. | . DELHI  
. DELHI  
. PUNE | NUWUD MDF  
DURATUFF  
ECOBOARD |
| 2.5 | DECORATIVE LAMINATES | a) THE BOMBAY BURMAH TRADING CORPN. LTD.  
b) GREENPLY INDUS. LTD.  
c) BAKELLY HYLAM LTD.  
d) RAMMICA INDUSTRIES | . DELHI  
. DELHI  
. DELHI | FORMICA  
Lucky  
GREENLAM  
DECOLAM  
DECOLITE  
RAMMICA |
| 2.6 | MARINE PLYWOOD | a) PLYWOOD INDIAN MFG.CO.LTD.  
b) SWASTIK PLYWOOD | . DELHI  
. DELHI | ANCHOR  
SWASTIK |
| 2.7 | DOORS & WINDOWS FITTINGS | | | |
| 2.7.1 | MORTICE LOCKS WITH HANDLES | a) GODREJ & BOYCE  
b) EVERITE AGENCIES (P) LTD.  
c) GOLDEN INDUSTRIES | . BOMBAY  
. DELHI  
. DELHI | GODREJ  
EVERITE  
GOLDEN |
| 2.7.2 | CYLINDRICAL PIN TUMBLER LOCK WITH KNOBS | a) SECURINDUSTRIES  
b) GOLDEN INDUSTRIES  
c) GODRJ & BOYCE | . DELHI  
. DELHI  
. BOMBAY | SECUR  
GOLDEN  
GODREJ |
| 2.7.3 | HYDRAULIC DOOR CLOSER (OVER HEAD/FLOOR) | a) DOORKING INDUSTRIES  
b) EVERITE AGENCIES(P)LTD  
c) HARDWYN TRADERS | . DELHI  
. DELHI  
. BOMBAY | DOORKING  
EVERITE  
HARDWYN |
| 2.7.4 | MISC. DOOR FITTINGS e.g. HINGES, TOWER BOLTS, LATCHES, STOPPER, STAYS, ALDROPS ETC. | a) EVERITE AGENCIES (P) LTD.  
b) EBCO INDUSTRIES  
c) ECIE Z(P) LTD.  
d) NU-LITE INDUSTRIES  
e) HARDWYN TRADERS | . DELHI  
. DELHI  
. BOMBAY  
. DELHI  
. BOMBAY | EVERITE  
EBCO  
ECIE  
NU-LITE  
HARDWYN |
| 2.7.5 | THREE WAY BOLTING-CUM LOCKING DEVICE WITH HANDLE | a) SIRMA SALES & SERVICES  
b) DHIMAN INDUSTRIES | . BOMBAY  
. DELHI | SRIMA SALES  
DHIMAN STEEL |
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<td>b) HUNTER DOUGLAS</td>
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<td>b) U.P. TWIGA F.G. LTD. . DELHI</td>
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<td>a) UNITILE . DELHI</td>
<td>b) SPECTRUM PAINTS . DELHI</td>
<td>c) BAKELITE HYLAM . DELHI</td>
</tr>
<tr>
<td>10.8 PVC PLUMBING FITTINGS</td>
<td>a) PRAYAG POLYMERS (P) LTD. . DELHI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.9 REINFORCED FIBREGLASS WATERPROOFING FELT</td>
<td>a) RGP LIMITED . DELHI</td>
<td>b) U.P. TWIGA F.G. LTD. . DELHI</td>
<td></td>
</tr>
</tbody>
</table>

Saipem Triune Engineering Pvt. Ltd.
New Delhi
Sheet 442 of
20.0 ATTACHMENTS

20.1 BASIC ENGINEERING PACKAGE - BOOK –I
20.2 SOIL INVESTIGATION REPORT – BOOK – II
20.3 RISK ANALYSIS REPORT – BOOK-III