ADDENDUM 03

To

MRPL Tender No. 3200000490 dated 26.02.2021

TENDER FOR CIVIL AND STRUCTURAL WORKS (LSTK-B PACKAGE) MRPL MARKETING TERMINAL PROJECT AT DEVANGONTHI, BANGALORE MARKETING INFRASTRUCTURE PROJECTS, MRPL

With reference to the above tender and Addendum 01 & 02, Bidders are requested to note the following:

The items, conditions, specification and stipulations of the Bidding Documents are modified to the extent indicated as follows

i. **Annexure 1: Commercial Addendum**
ii. **Annexure 2: Technical Addendum**

The implications of the same, elsewhere in the tender shall be taken care of appropriately by the bidders. All other terms and conditions, stipulations and specifications of tender shall remain unaltered.

Note:

Bidders shall upload the copy of these documents along with the technical- commercial bid, **DIGITALLY SIGNED,** as a token of having read and understood the same.

Annexure-01: Commercial Addendum

Sl. No.	Volume	Section No./Clause No.	Page No. as per document uploaded as Addendum -01	Existing Tender Clause	Addition / Deletion / Modification/ Clarification
1.	Vol 01 Commercial	Master Index	2 of 2784		Master Index is revised and enclosed**.**
2.	Vol 01 Commercial	7 Special Conditions Of Contract (SCC) / Annexure to SCC - Contractor Safety Policy	522 of 2784		**Clarification:** Annexure V (pages from 522 to 562) and pages 617 to 656 has been repeated. Bidder shall follow Annexure V (pages from 522 to 562) and ignore pages 617 to 656.

Annexure-02: Technical Addendum

Sl. No.	Volume	Section No./Clause No.	Page No. as per document uploaded as Addendum-01	Existing Tender Clause	Addition / Deletion / Modification/ Clarification
1.	Vol 02 Technical Part 1	C.2 Engineering Design Basis			**Addition:** As per master index Section C.2 Engineering Design Basis, the following documents were not uploaded with the original tender document. Hence these documents are uploaded as a part of this Addendum. • C.2.5 - 20005-GEN-L-EDB-3104: PIPING • C.2.6 - 20005-GEN-E-EDB-5006: ELECTRICAL • C.2.7 - 20005-GEN-I-EDB-6009: INSTRUMENTATION • C.2.8 - 20005-GEN-G-EDB-9120: SAFETY REQUIREMENTS FOR CONTRACTOR • C.2.9 - 20005-GEN-G-EDB-9121: FIRE PROTECTION SYSTEM • C.2.10 - 20005-GEN-I-EDB-6011: INFORMATION SYSTEM • C.2.11 - 20005-GEN-G-EDB-9122: SURFACE PREPARATION AND PROTECTIVE COATING

2.	Vol 02 Technical Part 1	C.2 Engineering Design Basis / C2.2 Engineering Design Basis For Structural & Architectural	1282 of 2784 **to** 1323 of 2784	Section and Subsection numbers for document number 20005-GEN-SEDB-2015 is C.2.1	**Modification:** Section and Subsection numbers for document number 20005-GEN-SEDB-2015 shall be read as C.2.2
3.	Vol 02 Technical Part-05	C.3 Specifications and Data sheets / C.3.21 Specification For Raw Water Treatment Unit	2338 of 2784 **to** 2354 of 2784	Section not mentioned	**Modification:** Section for Specification for Raw Water Treatment Unit bearing document number 20005-GEN-M-SPE-4050, shall be read as C.3.21
4.	Vol 02 Technical Part-05	C.3 Specifications and Data sheets / C.3.22 Material Handling Philosophy	2355 of 2784 **to** 2366 of 2784	Section not mentioned	**Modification:** Section for Material Handling Philosophy bearing document number 20005-GEN-M-MHP-4200, shall be read as C.3.22.
5.	Vol 02 Technical Part-06	D. Drawings / D.35	2473 of 2784	Area demarcation for Site Grading and Earth Work Calculation bearing Drawing No 20005-GEN-S-DW-2328	**Modification:** Area demarcation for Site Grading and Earth Work Calculation bearing Drawing No 20005-GEN-S-DW-2328 Sheet 1 of 1 Rev 0) is being revised with document No 20005-GEN-S-DW-2328 Sheet 1 of 1 Rev 1 and enclosed.
6.	Vol 02 Technical Part-01	A General / A 1.2 HSE Management	800 of 2784	Section A.1.2, HSE Management document no 20005-GEN-G-DOC-9128	**Modification:** Section A.1.2, HSE Management bearing document no 20005-GEN-G-DOC-9128 shall be read as 20005-GEN-G-DOC-9127.

7.	Vol 02 Technical Part-05	Specification & Scheme for STP Package Unit. Part C, Section C3, Sub Section 3.15	2289 of 2784	Design Data	**Treated effluent Stream:** **Modification:** Suspended solids: <10 mg/l **Addition:** Faecal Coliform: <100 MPN/100 ml
8.	Vol 02 Technical Part-05	Specification & Scheme for STP Package Unit. Part C, Section C3, Sub Section 3.15	2290 of 2784	Proposed Scheme	**Addition:** STP Package shall be based on Sequential Batch Reactor (SBR)/Moving Bed Bio Reactor (MBBR)/ or any other technology approved by KSPCB.
9.	Vol 02 Technical Part-05	Specification & Scheme for STP Package Unit. Part C, Section C3, Sub Section 3.15	2291 of 2784	Scope of Work	**Clarification:** STP Package: Analyzers and Sensors for PH, Total Suspended Solids, BOD and COD are not in Scope of Contractor. The Contractor shall provide tapping with isolation valves for Sample lines.
10.	Vol 02 Technical part-05	Specification & Scheme for STP Package Unit. Part C, Section C3, Sub Section 3.15		New Addition as the Part of STP Package	**Addition Document:** KSPCB GUIDELINES ON STP ATTACHED WITH ADDENDUM-03. Bidder shall follow the all the guidelines of KSPCB for STP Package.
11.	Vol 02 Technical Part-01	Package Scope of work Part C, Sub Section C-1.1	1209 of 2784		**Clarification:** All the foundation Bolts/Anchor Bolts (for the Scope under LSTK-B Contract) shall be supplied and installed by LSTK-B Contractor.
12.	Vol 02 Technical Part	Interface Matrix		NEW ADDITION	**Addition:** Interface Matrix attached with Addendum-03

MASTER INDEX

VOLUME I : COMMERCIAL SECTION

PART I : TECHNO-COMMERCIAL PART

ADDENDUM 2 ADDED DOCUMENTS

ADDENDUM 3 ADDED DOCUMENTS

Sl. No.	DESCRIPTION	Page No.
1	INTERFACE MATRIX	Addendum 3 367-374
2	KARNATAKA STATE POLLUTION CONTROL BOARD – OFFICE MEMORANDUM ON STPs DATED 01-MAR-2021	Addendum 3 375-381

C-2	ENGINEERING DESING BASIS
C-2.5	PIPING

MRPL Marketing Terminal Project at Devangonthi, Bangalore

PROJECT : Marketing Infrastructure Projects, MRPL

OWNER : MANGALORE REFINERY AND PETROCHEMICALS LTD

PMC : Nauvata

JOB NO. : JBG20005

Rev. No	Date	Purpose	Prepared By	Checked By	Approved By
0	22.01.2021	ISSUED FOR BID	SCB	SDK	SDK

CONTENTS

S. No. DESCRIPTION PAGE

1.0 Scope

This Design Basis briefly covers the basic requirements for the design of Piping systems for Refinery covered by ASME B31.3 (latest). These shall be adhered to by Engineering / EPCC Contractor(s) or his subcontractor(s) during the course of engineering, procurement & construction.

2.0 Design Philosophy / Criteria: General

2.1 EQUIPMENT LAYOUT

2.1.1 Basis of Equipment Layout

Equipment layout shall be developed based on the following data:

- P&IDs
- Overall Plot Plan
- Wind direction
- Equipment Data Sheets
- Indicative Equipment Layout from Process Licensor/Engineering consultant - Process package

2.1.2 Development of Equipment Layout

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

- Process Requirement - i.e. proper interconnection between equipment as per P&IDs to achieve the intended process parameters.
- Economy of Piping material- Minimise the quantity of costly piping.
- Erection & Construction requirement -Erection scheme and schedule of all equipment must be considered during equipment layout to have smooth erection mainly in case of tall columns, heavy equipments like thick walled reactors, space for laying tall column, approach road for cranes / derrick for lifting the column or reactors and requirement of special foundation / pile etc.
- Safety Requirements-As a minimum, 'OISD Std. 118' shall be followed.
- Fire fighting facilities shall be provided as per 'TAC', 'OISD' norms and M.B.. Lal committee recommendations. Safety shower location shall be marked in equipment layout. For detailed guidelines refer General Civil-Design basis for fire protection.
- Constructability, Operation and Maintenance Requirement:
    - Overhead and side clearances for exchangers and pumps
    - Provision of exchangers tube bundle pulling area
    - Provision for Column / vessel drop out area
    - Horizontal & overhead clearances for easy movement of working personnel

- Crane approaches for air coolers/fired heaters.
- Provision of catalyst loading / unloading facilities
- Provision of monorail for pumps and exchangers
- Provision of EOT/HOT crane for compressors
- Provision of operator's cabin

- Similar equipment grouping - All columns, exchangers, pumps etc. should be grouped together for convenience of maintenance and safety wherever feasible.
- The technological structures should be inter-connected for easy movement of operational personnel.
- U/G piping corridors for main headers should be marked in equipment layout for all underground piping.
- All areas requiring crane access for erection or specific maintenance purpose e.g. catalyst loading etc. shall be marked on the equipment layout.

Clearance, maintenance and safety requirements as specified are applicable to new units; for revamped units existing norms shall be followed to the extent possible.

2.1.3 Pipe rack

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

The total width of pipe rack shall include 25% extra space for future expansion/modifications in unit, during planning stage.

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, in which case an intermediate structural member shall be provided in pipe rack for tier.

- For Units, clearance beneath pipe rack shall be 3.0M minimum both in longitudinal and transverse directions.
- For Offsites, clearance beneath pipe rack shall be 2.2M minimum both in longitudinal and transverse directions.
- Road clearance shall be 7M minimum for main road and 5 M for secondary road.
- Water lines more than 30" dia. size shall not be routed over pipe rack, these shall be routed underground.
- Lower most main pipe track tier level shall be at 5 M for new units.

2.1.4 Towers and Vertical Vessels

Towers and vertical vessels shall be arranged in a row with common centre line, 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 platforms of adjacent towers shall not overlap (minimum 100 mm horizontal gap shall be provided between platform of adjacent towers) and that a minimum 900mm is left between tower plinths. The gap between vertical vessels shall allow full opening of manhole covers without restriction. Efforts shall be made to provide interconnecting platforms at suitable levels for adjacent towers and/or adjacent technological structures & rack walkways etc. Interconnections, wherever feasible shall be done after taking thermal expansions of towers into considerations All level switches, level gauges etc including their isolation valves shall be accessible from ladders or platforms.

To handle heavy items (like blinds etc.) a davit shall be provided. The davit shall be on the side of the vessel away from the pipe rack. The area at grade shall be kept clear for a dropout. All safety valves above 3" inlet shall be accessible by mobile crane.

All chemical dosing shall be of skid-mounted packages. It shall be located close to the dosing point to the extent possible, specially ammonia & corrosion inhibitors. These shall be preferably located at one place with escape routes.

2.1.5 Reboiler

Reboilers shall be located next to the tower they serve except fired heater type. The elevation of reboiler shall be as given in the P&IDs. Horizontal thermosiphon exchangers are located at a minimum elevation. Vertical thermosiphon types are usually supported by the tower and are located away from rack so that it is accessible for maintenance. Large vertical types may require an independent supporting structure that cannot be supported from the tower/column. Reboiler piping shall be checked for pressure drop before finalisation. For vertical reboilers adequate space to be kept so that there should be no obstruction for bundle pulling/rodding. Suitable swinging type davit of adequate capacity to be provided for removal/handling of the cover flange of vertical reboiler.

2.1.6 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 adjacent horizontal vessel shells shall be minimum 2M or 900 mm clear aisle whichever is higher.

2.1.7 Pumps

Wherever practicable pumps shall be arranged in rows with the centre line of the discharge nozzle on a common straight line. Pumps shall be kept outside the pipe rack with pump

discharge nozzle kept at a distance of minimum 1metre from pipe rack and motor towards rack.

Gap between each pump foundation/ and foundation of technical structure should be sufficient for easy removal of equipment after piping.

Clearance between two adjacent pumps shall be such that clear 900 mm aisle is available.

All pumps having motor rating >=75 KW and not accessible by mobile equipment shall be provided with monorail. No monorail should normally be provided for pumps open to sky or having sufficient clear space below rack for maintenance and accessible by mobile equipment.

2.1.8 Exchangers

In most of the cases floating head of exchangers are placed on a line 4M away from pipe rack. Shell and tube type exchangers may have a removable shell cover with flanged head. Tube pulling or rod cleaning area must be allowed at the channel end. This shall be minimum the tube bundle length + 1M from the channel head. In case of vertical exchanger suitable platform shall be provided below the top flange of channel or bonnet. For vertical exchanger cover, davit shall be provided for it's removal. Minimum clearance in between two horizontal exchangers shall be 2M or 900mm clear aisle whichever is higher. Like wise Heat Exchanger train should be suitably spaced such that shell/ tube inlet/ outlet piping do not foul with floating Head Covers creating maintenance problem.

2.1.9 Air coolers

Air coolers shall be located over the main pipe rack or on technological structure. For air coolers located on technological structure/rack, RCC blind floor shall be provided. Blind floor is generally not required if pumps handling hydrocarbons or equipment are not placed below them. The width of the structure from where Air cooler assembly is supported shall be about 2.0m more than the Air cooler tube bundle length so that proper supporting of inlet/outlet piping manifolds can be done from the main members of pipe rack/technological structure to transfer piping load to main structural members. Davit shall be provided for lowering the gear boxes etc. along with mobile trolley with retractable jacking arrangement of suitable load carrying capacity.

2.1.10 Furnaces

Furnaces are located upwind or sidewind of process units to blow any combustible leaks away from the open flame. They are located minimum 90M away from hydrocarbon tanks and 30M away from control room. Distances for equipments handling hydrocarbon from the furnace shall be as per OISD norms. Vessels / reactors directly connected to furnace are exception. Furnaces shall be arranged with centreline of the stacks on a common line in case of circular

furnace and wherever a common stack is furnished to cater more than one furnace the stacks shall be located at the end or side, which is away from the unit. In case of individual box furnaces, the edge of the furnaces on the rack side shall be matched. F.D. fans shall be located at one corner of furnace area away from equipments handling hydrocarbons. It shall be ensured that there are no working platforms within an elevation of 6M below the tip of stack and within a 25M radius of stack. However, the stack height is governed by the clearances from statutory authorities like Director General of Civil Aviation and Pollution Control Board. For maintenance, vertical tube furnaces must have access to permit a crane to remove and replace tubing. Horizontal tube furnaces must have horizontal free space equal to tube length plus crane parking space for tube pulling / maintenance / cleaning. In case of bottom floor fired heaters, there shall be adequate headroom clearance underneath the furnace for removal of burners. In case of wall fired furnaces min. 2M wide platform with escape route at each end is necessary.

Pits and trenches are not permitted under furnace or any fired equipment. Underground drain points and manhole covers shall be sealed within furnace vicinity. All OWS points in the vicinity of heater area shall be connected to a common header & in turn the header shall be routed to CRWS system or Storm water drain. In no case they shall be connected to OWS system. Condensate funnels can be connected to condensate header and in case of non feasibility/ non existence of U/G condensate header these can be routed to CRWS/Storm Sewer.

Air Pre-heaters should be located in such a way that the modules can be removed by crane.

2.1.11 Compressors and their Prime Movers

Following types of compressors are used in process plants:

a. Centrifugal compressors
b. Reciprocating compressors.
c. Liquid ring compressors
d. Screw compressors
e. Diaphragm compressors

Compressors shall be located to keep suction lines as short as possible. The gas compressors shall be located downwind side of furnace so that leaks are not blown towards furnace. In general compressors are to be located under shed. When compressors are located under shed, sides to be kept fully open for the low shed or partially closed from top for high shed to avoid accumulation of heavier gases in the shed, however, in case of hydrogen compressors located under the sheds provision for top venting from compressor sheds shall be provided.

In case of a turbine driven compressor, if exhaust steam is condensed, turbine and compressor need 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.

Intercoolers & Knockout pots may be kept within/outside the Compressor house shed, but, shall be kept near compressor house.

For compressors Electrically Operated Travelling Crane to handle heaviest removable piece shall be provided for each compressor house. Maintenance bay for compressors shall be provided. Maintenance bay shall be accessible from road to facilitate unloading & loading on to truck etc. For removal of bundles of exchangers located within building monorail arrangement shall be provided.

Compressor manufacturer may be consulted for recommended layout and additional requirement for maintenance. Licensor's requirement, if any, shall also be taken into consideration.

2.1.12 Clearance and Accessibility

2.1.12.1 Crane Access & Tube bundle pulling

Equipment, structures shall be arranged to permit crane access to service air coolers, compressors and exchangers. A clear space for tube bundle removal shall be provided. Dropout bay may be considered for exchangers at elevated structures.
For high pressure exchangers, shell pulling on rails shall be provided, as required. ***Maintenance / Dropout space shall be indicated for Columns, Turbine and Compressor House.***

2.1.12.2Access to Pumps

Clear access of 3.5M vertically and 3M horizontally shall be provided centrally under main pipe ways for small mobile equipment to service pumps/motors, wherever these are installed under pipe ways with prior specific approval. Pumps outside rack shall be approachable by mobile equipments etc. from under the pipe rack.

2.1.12.3Access to lower items to grade (Lowering Area)

Clear access shall be provided at grade on the access side for lowering external & internal fittings, PSVs, Control valves etc from elevated equipment(columns, towers etc) by providing pipe davits.

2.1.12.4Layout & Access Requirements for Platforms (Ladders and Stairs)

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

- Two means of access (i.e. two ladders or one ladder and one stair case) shall be provided for any elevated platform, which serves three or more vessels & for battery limit valves operating platforms.
- Compressor House and Turbine decks shall have access staircase on either side of the bay. Staircase shall face opposite directions.
- Platforms, ladders & stairways shall be consistent with access & safety requirements.
- Stairway for tanks to be provided on upstream of predominant wind direction.

(i) Platform at elevated structure

- 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.
- Air coolers shall have platforms with interconnected walk-ways provided to service valving, fan motors and instruments. Access requirements shall be Dual access (i.e. one staircase and one ladder).
- Fired heaters located adjacent to one another shall have inter-connecting platforms at various elevations. Inter-connecting platforms between adjacent towers shall be provided, wherever feasible, taking into consideration expansion of towers.

(ii) Platforms with stair access shall be provided only for:

- Location at which normal monitoring (once a day or more) is required or where samples are taken.
- Locations where vessels or equipment items have operator attention such as compressors, heaters, boilers etc.
- Main pipe rack at battery limits

(iii) Platforms with ladder access shall be provided for

- Items that require occasional operating access including valves, spectacle blind and motor operated valves, heater stack sampling points.
- Man ways above grade on equipment.
-

(iv) Ladder Location

- Wherever practicable, ladder shall be so arranged that users face equipment or platform rather than facing open space.
- Landings shall be staggered. No ladder shall be more than 6M in one flight.

2.1.12.5 Clearances

Minimum clearances shall be as indicated in Annexure - E.

2.2 UNIT PIPING

2.2.1 Basis of Unit Piping

- Piping & Instrument Diagram
- Equipment layout
- Equipment Data sheet & Setting plan
- Line list
- Instrument Data sheet
- Structural & building drawings
- Topography of the plant
- Piping material specification
- Overall plot plan

The following objective shall be achieved during piping layout:

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

2.2.2 Pipe Ways/Rack piping

- Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.
- Predominantly process lines are to be kept at lower tier and, utility & hot process lines on upper tier.
- Generally the top tier is to be kept for Instrument cable ducts. Electrical cable trays shall be located as per Electrical design basis.
- Generally the hot lines and cold lines shall be kept apart in different groups on a tier.
- Generally the bigger size lines shall be kept nearer to the rack column.
- Minimum 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
- Actual line spacing, especially at 'L' bend and loop locations, shall take care of thermal expansion / thermal contraction / non-expansion of adjacent line. Nonexpansion / 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 pipeway) 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 be provided.
- Branches from main headers shall be preferably taken from top.
- Interconnecting platforms shall be provided between pipe rack and technological structures.
- For pipes at grade level, sufficient ground clearance shall be provided (minimum 300mm) for the flange nearest to the ground from grade, after the insulation cladding), on drain/trap connections for Operational/maintenance access.

2.2.3 Column / Vessel Piping / Control Valves

- Piping from column shall drop or rise immediately upon leaving the nozzle and run parallel and close as practicable to vessel. Reboiler outlet piping shall be as short as possible with minimum bends.
- Piping shall be grouped as far as possible for the ease of supports and shall run on the rack side of the column.
- Manholes shall be kept on the road side of the column and shall be 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 vessel as far as possible.
- Proper guides at recommended intervals shall be provided for long vertical lines.
- Access platforms/ladders shall be provided along the column for valves and instruments. Minimum clear width of platform shall be 750mm.
- For ease of operation and maintenance, column and vessels which are grouped together, shall have their platforms at the same elevation to the extent possible and should be interconnected by walkways. However each column / vessel shall have an independent access also.
- Column / vessel platforms should be designed in such a way so that all the nozzles with valves or spectacle blinds should be approachable either from platforms or ladder depends on size and elevation of item to be operated.
- Piping at columns/vessel nozzles shall be arranged so that blanks can be easily installed for hydrotesting.
- Unless specifically indicated in P&IDs control valves shall be kept at grade or on technological platforms.
- Piping intended for vacuum services shall be routed as short as possible with minimum bends and flanged joints.
- Piping support cleats for safety valves shall be independent meant for safety valves only & shall be designed considering impact loading during popping off.
- Utility Connection nozzles shall be from side/top.

2.2.4 Exchanger Piping

- Exchanger piping shall not run in the way of built in or mobile handling facilities.
- Wrench clearance shall be provided at exchanger flanges.
- Piping shall be arranged so that they do not hinder removal of shell end and channel cover and withdrawal of tube bundle. Wherever required, to facilitate the removal of tube bundles / head cover, break-up flanges shall be provided in the piping.

2.2.5 Heater / Furnace Piping

- Arrange piping to permit burner removal by providing break-up flanges in the piping. *All piping to burner including the utility headers shall have clear head room. The grade shall be kept clear for maintenance and access to the heaters all around.*
- Burner valves shall be located close to the peepholes for operation so that adjustment can be made while observing the flame from working level.
- Piping to burners shall be arranged in such a way to give equal and sufficient quantity of oil/gas to all burners.
- Only flexible metallic SS (SS316/SS304) hoses shall be used for burner piping if required.
- Block valves for emergency, snuffing steam valve shall be located at the recommended distance from the heater, preferably on the upwind side of the heater.
- Piping from various passes of heater outlet nozzles should preferably be symmetrical. Transfer line from heater to column shall be as short as possible, without pockets, free draining and with minimum bends.
- No piping shall be routed in the tube withdrawal area. If unavoidable, break up flanges shall be provided in the piping for removal.

2.2.6 Pump Piping

- Pump drives shall have clear access.
- Pump suction piping shall be as short as possible and shall be arranged to avoid vapour pockets.
- Reducers immediately connected to the pump suction shall be eccentric type with flat side up to avoid the accumulation of gas pocket.
- For end suction pumps elbows shall not be directly connected to the suction flange. A straight piece minimum 3 times the line size shall 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.
- Unless otherwise specified, T-type strainers shall be used on pump suction piping for sizes 2" and above.
- Y-type strainers shall be used for all sizes in steam services and for pump suction lines below 2".
- Pump strainers shall be installed at ground level except for top suction pumps.
- All small bore piping connected to pump (drain to OWS & CBD, seat and gland leak drain) shall have break up flanges for removal of pumps.

- Piping shall be so arranged that the forces and moments imposed on the pump nozzle do not exceed the allowable values.
- Pump discharge should be preferably 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.
- Suction & discharge valves shall be located at operable height.

2.2.7 Compressor Piping

- Suction lines shall be as short as possible.
- Suction piping shall have adequate flanged joints for ease of erection and maintenance.
- Where the line between knockout drum and the compressor cannot be routed without pocket, low point drain shall be provided to remove accumulation of liquid. The system should be approved by process.
- A minimum straight length of suction pipe shall be provided as per manufacturer's recommendation.
- Strainers shall be installed at ground / platform level.
- Lube oil cooler space shall be provided in a way so 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.
- Piping shall be designed so that forces and moments imposed on the compressor do not exceed the manufacturer's recommendation.
- 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 pulsating flow. Unless requirements of no pockets are specified by the licensor, all the piping shall run at 500mm above grade level so that proper supports can be provided to minimise 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 shall be provided independent supports from grade and shall not be supported from compressor platform structure.
- The small bore branches shall be checked for requirement of braced supports.

2.2.8 Relief System / Blow down System Piping

- 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 ensure free drainage.
- Liquid-vapour phase relief valves shall discharge into the flare header at an angle 45 degrees in the direction of header flow, to minimise 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 exhaust piping shall be sized to take care of built-up backpressure due to relieving conditions. Piping shall be adequately sized to reduce built-up backpressure within limits of the Relief Valve model selected. In case built-up backpressure cannot be controlled within a limit of 10% of set pressure for conventional relief valves, either change in size of Relief valve or suitable Bellows/Pilot operated Safety relief valves may be reviewed for selection.
- In case the Relief valve is discharging to atmosphere, discharge piping shall be taken to safe location as per following:

3M	-	Above top platform of column or structure, within 6M radius for steam and 8M for hydrocarbon/toxic discharge.
25M	-	Horizontally away from furnace.
50M	-	Horizontally away from furnace, if more than one relief system of different set pressures is discharging into one common riser of vent stack.

- 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 RP520 for systems discharging to atmosphere. 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. platform 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 portion. 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.

2.2.9 Steam Piping

2.2.9.1 Indian Boiler Regulations (IBR)

Steam lines with conditions listed below fall in the scope of IBR.

- Lines having design pressure (max. working pressure) above 3.5 Kg/cm^2 (g).
- Line sizes above 10" inside diameter having design pressure 1.0 Kg/cm^2(g) & above.
- Lines with design pressure less than 1.0 Kg/cm^2(g) are excluded.
- Users of steam like steam tracing lines, jacket of the steam jacketed lines, steam heating coil within the equipment are excluded from IBR scope.
- Boiler feed water lines to steam generator, condensate lines to steam generator and flash drum shall be under purview of IBR.

2.2.9.2 IBR requirements (in brief)

- All materials used on lines falling under IBR must be accompanied with IBR Inspection Certificate in original. Alternatively, photocopy of the original certificate duly countersigned and attested by local boiler inspector is acceptable. Leading inspection authority viz. Lloyds, CEIL etc are authorised inspection authorities for IBR outside India, whereas, for Indian supply only IBR is the inspection authority.
- Drawings like 'General Arrangement Drawings' and Isometrics of lines falling under IBR must also be approved by IBR authority of State in which the system is being installed.
- All welders used for fabrication of IBR system must possess IBR welding qualification certificate.
- IBR system shall be designed to comply with IBR regulations as well as ASME B31.3. Design calculations for the same must be approved by IBR authority.
- IBR approval is obtained with requisite fees payable to Indian Boiler Board of the State concerned.
- Steam generators (boilers/heat exchangers) shall require exclusive IBR approval along with it's integral piping upto the final isolation valve.
- The discretion of IBR authority of state is final and binding for the above cases.

2.2.10 Steam Header & Supply Lines

- Steam header shall be located generally on the upper tier and at one end of the rack adjacent to columns. However, for revamp units, existing philosophy will be followed.
- Branch lines from horizontal steam header, except condensate collection points, shall be connected to the top of the pipe header.
- Isolation valves (if provided) on the branch line shall preferably be provided on the horizontal run and outside the pipe rack.
- All branch lines shall be drainable. For steam lines, sufficient no of additional drain provisions may be considered during fabrication and unused tappings may be kept blinded.

- Drip legs & steam traps shall be provided at all low points and dead ends of steam header. Drip legs at low points shall be closer to down stream riser and shall be provided to suit bi-directional flows, if applicable.
- All turbines on automatic control for start up shall be provided with a steam trap in the steam inlet line.
- All traps shall be of Thermodynamic type & shall be provided with strainers if integral strainers are not provided.
- For LP & MP Steam traps shall be suitable for 42 Bar max. op. pressure.
- For HP Steam traps shall be suitable for 62 Bar max. op. pressure.
- For SHP Steam traps shall be suitable for 120 Bar max. op. pressure.
- Steam traps discharging to atmosphere shall be connected to storm water drain/storm sewer or underground condensate collection system.
- Expansion loops are to be provided to take care of the expansions within units.
- Wherever condensate is to be drained, proper condensate draining facility shall be provided.

2.2.11 Steam Tracing

- Tracers for the individual lines shall generally be supplied from manifolds when there are two or more connections.
- Standard module for steam distribution and condensate collection manifolds with glandless integral piston valve shall be used. Number of tracers shall be 4/8/12 and tracer size ½" or ¾" depending upon the detail engineering requirement. 20% or minimum 2 tracer connections shall be kept spare for future use for both steam supply and condensate collection manifolds.
- All manifolds shall be installed in vertical position and manifold size shall be 1½".
- For steam tracing balanced pressure thermostatic steam trap suitable for 21 bar max. operating pressure (20º sub cool) with 40 mesh strainer to be used.
- Steam Manifolds shall be located at upper levels in pipe rack, accessible from a platform whereas Condensate Manifolds shall be located on grade.
- Pockets in steam tracers shall be avoided as far as possible.
- Heat tracing cement to be used to improve conductivity of heating medium from tracer piping to main piping.
- Tracers shall be limited to the following run length upstream of traps:

Following shall be used for maintaining length of 1/2" tracer in open and closed systems (excluding supply and return lines).

Size of tracer (Inch)	Length of tracer pipe (Meters)						
	Steam operating pressure						
	20 psig	50 psig	100 psig	150 psig	200 psig	250 psig	300 psig & above

0.5"	23	38	46	53	61	69	76

- Tracers shall generally be of ½". Tracers shall be of carbon steel material on the steam tracing circuit including steam station block valve. The block valve shall be of glandless piston type construction.
- Size of the lead line to manifold shall be $1^1/_2$".
- The lead line to manifold, steam supply manifold, manifold to the block valves of individual tracer shall be carbon steel of IBR quality.
- Tracers lines shall be provided with break up flanges for main line flange joints and valves.
- All tracers shall have individual steam traps before condensate manifolds. Condensate manifold including the last valve on individual tracer shall be of carbon steel.
- All steam traps discharging to a closed system shall have a block valve upstream and downstream of the trap. A bypass globe valve shall be installed around the trap. Check valve shall be installed on the downstream of the steam trap near the condensate header in case discharging to a closed system.
- All steam tracer lines shall be welded as per approved Welding Specification followed by hydrotest.
- Number of tracers required on a line shall be as follows:

Size of Line	Number of Tracers
upto 4"	1
6" to 16"	2
18" to 24"	3
26" & above	To Calculate

2.2.12 Steam Jacketing System

- A steam jacketed pipe consists of a product line which passes through the centre of a larger diameter steam line.
- The nominal size of the inner pipe (CORE) and outer pipe (JACKET) in inches shall be as per table below unless otherwise mentioned in project piping material specification (PMS) or P&ID.

Core pipe	Jacket pipe	Steam feeder to jacket
3/4"	$1\text{-}^1/_2$"	0.5”

1"	2"	0.5”
1-1/2"	3"	0.5”
2"	3"	0.5”
3"	4"	0.5”
4"	6"	0.75”
6"	8"	0.75”
8"	10"	0.75”
10"	12"	0.75”

- For jacketed lines using high pressure steam, actual calculations for core jacket and feeder pipe shall be performed before finalisation of sizing.
- Baffle plates, flanged joints or end caps shall be used to discontinue one feed length from the next. The size of steam feeder to jacket shall be generally be as per above table or as specified in job specification for jacketing.
- Flanged jumpovers shall be used in case of a flanged joint. In case of discontinuous jacketing simple jumpovers shall be employed. The length of jacket shall be 4 to 5 meters or as mentioned in job specification.
- Intermediate partial baffles shall be provided if a separate branch portion is to be heated from the main line stream.
- Steam inlet to jacket shall generally be provided from top of the pipe in case of horizontal lines. The jumpovers and condensate outlets shall be from the bottom.
- In case of vertical lines steam inlet shall be done at the topmost points and condensate outlet shall be done from the lowest possible points. Two consecutive jumpovers shall be 180 deg. apart.
- Steam feed length i.e from steam inlet point to condensate outlet point shall be equal to the tracer pipe length given in steam tracing system table.
- Each feed length shall be provided with individual trap before connecting to condensate recovery headers.
- Balanced pressure / bi-metallic type thermostatic steam traps with 40 mesh strainer shall be used in jacketing.
- To keep proper concentricity between core and jacket pipe internal guides (rods or flat bars) shall be provided at intervals depending on the size of the pipe.
- Wherever anchors are provided on jacket lines proper interconnection of jacket pipe and core pipe shall have to be provided with proper jump overs for steam.

2.2.13 Utility Stations

Requisite number of utility stations shall be provided throughout the unit to cater to the utility requirement. Utility stations shall have three connections [one for LP steam (SL), one for Plant Air (AP) and one for Service Water (WS)] each of 1"NB unless otherwise specified in P&ID. Air and water lines shall have quick type hose connection and steam line shall have flanged type hose connection and shall be directed downward. All connections shall have globe valve for isolation purpose. Inert gas hose, when required, shall have built in non return valve and quick connection coupling at piping end.

Number of utility stations shall be such that all 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. Operating platforms having manholes must be accessible from utility station.

2.2.14 Electrical Tracing

Electrical heat tracing shall be provided for pipe lines wherever shown in P&ID's. All instruments coming on these lines shall also be electrically heat traced. The electrical heat tracing for Instruments/ valves/ flanges shall be done in such a manner that servicing of instruments/ opening of valves/ servicing of flanges is possible without disconnecting of wiring and with ease. Insulation material and thickness shall be as per 'Process design basis'.

2.2.15 Fire Fighting

All fire fighting facilities shall be as per TAC, OISD norms and M.B.Lal committee recommendations. Sprinkler system shall be provided for all hot pumps as per OISD / TAC norms.

2.3 OFFSITE & YARD PIPING

In general, offsites piping (except tankages area), electrical cable and instrumentation cable shall be laid either on pipe rack or on pipe sleepers. Wherever piping is laid on pipe sleepers, hard surfacing/gravel is provided below it, hard surfacing/gravel should be completed before start of pipe laying. Width of hard surfacing/gravel shall be about 1 meter more than the piping corridor on either side. This extra hard surfacing/gravel shall be for movement of operating personnel along the piping corridor. This movement area shall be approachable from the road at a distance of every 500 meters.

Overhead pipe bridges shall be used for pipes at road crossings. Culverts, if required, may be provided but to be minimised. Pipe bridges/culverts shall be adequately designed to take care of future requirements.

Clearances between lines shall be minimum 'C' as given below.

$C=(d_o+D_f)/2$ + 25 mm + Insulation thickness(es)

where, d_o - outside diameter of smaller pipe (mm)
D_f - outside diameter of flange(min 300#) of bigger pipe (mm)

However this 'C' spacing between the offsite piping on the rack/sleeper can be suitably increased so that the lines should not touch each other after insulation/lateral expansion.

Adequate clearance shall be provided for every long & high temperature lines to avoid clashing at the bends. See 2.2.2 also for line spacing at 'L' bends and loop locations.

Expansion loops for all lines shall generally be kept at the same location.
Vents shall be provided on all high points & drains shall be provided at all low points. Drain valves at sleeper piping shall be kept outside the sleeperway if the same is not accessible and valves shall be put in horizontal only. At all such places where piping is extended to make drain valves accessible - 2 nos. of stiffeners, irrespective of pipe rating, shall be provided as per 2.7.1. Spacing of guides on each line on a pipe bay shall not exceed the value given in clause 2.7.1.

2.4 TANK FARM PIPING

The number of pipelines in the tank dyke shall be kept minimum and shall be routed in the shortest practicable way to main pipe track outside the tank dyke, with adequate allowance for expansion. Within one tank dyke the piping connected to that tank shall only be routed.

Pipes crossing the dyke wall shall pass through a sleeve suitably sealed.

Manifolds shall be located outside the tank dyke & by the side of the roads, easily accessible by the walkway.

Plug valves whenever specified shall be of pressure balance type.

Analysis shall be carried out to prevent damage to lines and tank connection caused by tank settlement.

If exceptionally high settlement is expected, it shall be taken care during stress analysis.

For flexibility analysis and supporting refer clause 2.7.

Special consideration shall be given as regards to spacing of nozzles while installing special item like hammer blind, MOV etc.

Valves shall be operable from walk ways / platforms. Platforms shall be provided if valves are not operable from walkways.

2.5 FLARE PIPING

Flare header shall be sloped towards flare knock-out drum. Expansion loop shall be provided in horizontal plane 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 minimise the number of loops.
Flare line between knock out drum and water seal drum shall be designed for pressure fluctuations and adequately supported to avoid vibrations.

2.6 UNDERGROUND PIPING

All Underground OWS/CRWS/Sewage piping shall be of Carbon Steel (not concrete pipes).

2.7 FLEXIBILITY ANALYSIS AND SUPPORTING

2.7.1 Pipe Supporting Criteria & General Guidelines.

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

a. Sustained Loads

- Weight of Piping (Bare pipe, service fluid, valves, flanges, jacketting etc)
- Weight of Insulation (if any)
- Weight of snow (if any)
- Weight of online equipments (if any)
- Weight of instruments (if any)
- Pressure relief loads due to safety valve operation
- Dynamic loads due to pulsating flow/two phase with slug/plug flow
- Pressure-Thrust loads in case of expansion joints

b. Occasional Loads

Wind/Seismic loads (as and when required)

c. Thermal Loads

Thermal loads due to operating/design/steam out/decoking or any other possible abnormal condition**.**

All Load cases shall also be checked and qualified in corroded condition for Design code stress checks.

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 be restricted to max. 18.0 metres. 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. 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 based upon detailed analysis of piping system to restrict the forces on nozzles of critical equipments like pumps, compressors, turbines, exchangers, Air coolers etc.

A permanent support, either resting or spring support shall be provided for lines which do not need any supporting otherwise but require supporting during maintenance. Small bore piping (1-1/2"and below) shall be provided with wear pads for underside corrosion protection. Uninsulated piping of 2"upto 6"shall be provided with shoe supports. Refer attached MRPL drawing for standard details.

Adequate care shall be taken for small bore ($1^1/_2$ and below) branch from piping. As a rule, for all lines in 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, e.g. vents, drain, orifice taps, pressure tapings, temperature tapings, sample connections, PSV inlet, TSV inlet etc. shall be provided with 2 number stiffeners at 90º to each other from the main pipe to impart adequate stiffness to the branch connection. The stiffeners shall be made of 6mm thick, 40 mm wide 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 tapings from PSV inlet / outlet lines and all small bore tapings 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 with slug/plug flow in piping is expected, and for Transfer Lines, piping design shall be checked by dynamic stress analysis to prevent vibrations.

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

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

In the heaters where steam air decoking provision is there, the main lines and decoking lines should be supported in such a way that either of the lines should not be in the hanging position when not in operation.

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

High density PUF blocks shall be considered for cold piping supports. Wooden blocks may be used for load taking supports on vertical lines or as anchor supports.

All pipes supports shall be so designed that there is no undue tension on equipment flanges.

2.7.2 Flexibility Analysis Criteria & General Guidelines.

Piping shall be analysed for expansion, contraction, differential settlement, relief valve reaction and effects mentioned in para 2.7.1.

- The design of piping systems shall take into account the different conditions expected during operation, start-up, shut-down, cold branch in case of standby pump, tracing, etc. Hydrocarbon lines shall be designed for steam-out conditions, if so specified in Process document. System where combination of different operating conditions are envisaged, such system shall be analysed 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 the same is exceeded, categorical written confirmation of acceptance of the higher loads shall be obtained from the equipment supplier.

2.7.3 Method Of Analysis

Following lines shall be considered critical and for these formal analysis is mandatory. 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 compressor and blower
- All lines to and from turbines
- All pump lines (6" & above and analysis temp > 120°C & less than -60°C) & air cooler lines.
- Reboiler piping, Flare header/sub headers, Jacketted lines, Non metallic Piping
- All other lines as below:

  6" to 8" analysis temp above 300°C & less than -100°C
  10" to 14" analysis temp above 150°C & less than -80°C
  16"& above analysis temp above 100°C & less than -80°C

- Lines requiring composite stress analysis (Piping along with Structure and Equipments), Dynamic/Wind/Seismic analysis
- Lines requiring Flange leakage check, i.e.

  26” & above except air & water lines (upto 600 rating)
  4” & above for hydrogen lines (900 rating and above)
  8” & above, other lines (900 rating and above)

- All other critical lines (connecting to sensitive equipments). Such as Plate fin exchangers, Cold boxes (sizes 6” and above and analysis temp. > 120°C & less than -60°C)
- Only CAESAR-II software package shall be used.

All lines shall be analysed at analysis temperature. In the absence of analysis temperature, lines shall be analysed at operating temperature if difference between operating & design temperatures is less than or equal to 30 degC, otherwise it shall be analysed at design temperature. However, analysis of flare line & calculation of thermal growth of tall equipments shall be done as per Process input. All hydrocarbon lines shall be analysed at Steam out temperature. Steam out temperature to be taken as per the line list and in case of non-availability of line-list, it shall be taken as 30 deg.C less than the saturation temperature of type of steam.

For lines involving pulsating flow such as those connected to reciprocating pumps & compressors, in addition to thermal analysis, analog study for acoustic & mechanical vibrations shall be done along with equipments, by approved vendor/ Agency.

Dynamic analysis shall be performed wherever two phase with slug/plug flow in piping is expected as per the process requirement, and for Transfer Lines. "The fundamental frequency

of the piping system shall be well above the imposed frequencies, if any, to avoid resonance. The minimum acceptable frequency for transfer lines shall be 7 Hz and for remaining lines with slug/plug flow, it shall be 6 Hz".

Seismic and wind forces shall be based on recommendations of "Seismic design basis" and "Wind design basis" respectively covered elsewhere.

2.8 MATERIALS

Basic material selection of particular line depending on its service, temperature and corrosivity shall be as spelt out in process package. Detailed material specification shall follow the requirements stated herewith, except wherever specified as per Licensor's requirement.

2.8.1 Pipe

2.8.1.1 Wall Thickness

- Calculation of pipe thickness and branch reinforcement shall be based on requirements of ASME B31.3 / IBR as applicable. Proper corrosion allowance and mill tolerance shall be considered while selecting nominal thickness.

- For carbon steel and low alloy steel pipes minimum pipe thickness shall be as follows:
  'S160' up to 0.75"NB (for other than steam tracing),
  'XS' up to 0.75"NB (for steam tracing),
  'XS' for 1" to 2" NB,
  'STD' for above 2" NB.

- For stainless pipes minimum pipe thickness shall be as follows:
  '80S' up to 0.75"NB,
  '40S' for 1" to 2"NB,
  '10S' for above 2"NB

- The philosophy of minimum thickness/schedule is applicable for both seamless and welded pipes.

- All pipes (seamless & welded) shall have uniform negative wall thickness tolerance of 12.5% for wall thickness calculations purpose.

- For thicknesses exceeding minimum thickness/schedule criteria, schedule XS shall be selected for CS & AS classes (for 2" & above). Intermediate schedules between STD & XS shall be ignored. Similarly for SS classes (2" & above) S10, S20, S30 & 40S may be selected beyond minimum thickness/schedule criteria.

- If, the thicknesses exceed XS in CS &AS classes and 40S in SS classes, only then, the thickness shall be calculated based on actual service conditions subject to a minimum of 80% class rating. Maximum 10% of corrosion allowance may be reduced in special cases, to optimise the pipe schedules.
- In general, the pressure-temperature combination to calculate wall thickness shall be as follows:

Material	Class	Size	Design Condition
C.S. (A106 GR.B, API-5L GR.B, A672) LTCS (A333 GR.6), Low Alloys, 1.25% Cr-0.5% Mo, 2.25% Cr- 1.0% Mo, 5%Cr-0.5% Mo, 9%Cr- 1.0% Mo	150	upto 24"	Class condition
		above 24"	Line condition (#)
	300	upto 14"	Class condition
		above 14"	Line condition (#)
	600	upto 8"	Class condition
		above 8"	Line condition (#)
	900	upto 8"	Class condition
		above 8"	Line condition
	1500 & 2500	upto 4"	Class condition
		above 4"	Line condition
SS (A312 TP304, 304L, 316L, 321,347) OR (A358 TP304, 304L, 316, 316L, 321, 347)	150	up to 24"	Class condition
		above 24"	Line condition ($)
	300	upto 14"	Class condition
		above 14"	Line condition ($)
	600	upto 6"	Class condition
		above 6"	Line condition ($)
	900,1500	upto 4"	Class condition
		above 4"	Line condition
	2500	upto 2"	Class condition
		above 2"	Line condition
Higher Alloys	150	upto 6"	Class condition
		above 6"	Line condition
	300-2500	all sizes	Line condition

Only If the thickness / schedule as per class condition exceeds XS.

$ Only If the thickness / schedule as per class condition exceeds 40S.

For Cat-D classes, for aboveground applications, 'D/t' ratio shall be taken as 120(max.). For other than Cat-D services, 'D/t' ratio shall be generally restricted to 100. 'D' is nominal dia. and 't' is nominal thickness.

2.8.1.2 Pipe Size

Pipe sizes shall normally be 0.5", 0.75", 1.0", 1.5", 2.0", 3", 4", 6", 8", 10", 12", 14", 16", 18", 20", 24", 26", 30", 36", 40", 44", 48", 52", 56", 60", 64", 72", 78", 80"

2.8.1.3 Pipe Type

Material	Size	Type
CS, LTCS, AS (except for Cat 'D' fluids)	Upto 14"	Seamless
	16" and Above	E.Fs.W.
SS (Process lines)	Upto 8"	Seamless
	10" and Above	E.Fs.W.
SS (Non process lines)	Upto 1.50"	Seamless
	2" & Above	Welded
CS (Cat 'D' fluids & Fire water service)	Upto 12" 14"and above	Seamless Welded

2.8.2 Fittings

- Type of fittings shall be equivalent to pipe type.
- Thickness of fittings at ends to match pipe thickness for BW fittings.
- SW fittings shall be 3000#, 6000#or 9000# depending on the pipe thicknesses S80, S160 and above S160 respectively.
- Upto 600# all branch connections shall be as follows, unless specifically mentioned otherwise in PMS:

Up to 1-1/2" NB	Half couplings/ Tee
2" and above	Tees/ Pipe to pipe with or without reinforcement pad

- For branch connections above 600# rating, equal tee/unequal tee shall be used for all sizes. In case of non availability of unequal tees, o-lets may be used. Usage of sweepo-let shall be avoided due to poor availability globally.

- Mitres shall be used in Category 'D' service above 6"NB. Elbows(seamless/welded) are acceptable in place of mitres, however, thickness of elbows shall be same as mitres. Seamless elbows are acceptable in place of welded elbows.

- For other than Category 'D' fluid in 150# and 300# Class mitres can be permitted for sizes above 48". Mitres to be designed as per ASME B31.3. However, use of mitres shall be minimum.

- Union shall not to be used in lines other than Cat-D water lines.

2.8.3 Flanges

- Flanges shall be as follows:

Rating	Size	Type	Remarks
150	Up to 1.50"	WN RF	For spiral wound gasket
	2" & above	WN RF	For CS , AS & SS (Cryo)
	2" & above	LJ FF+Stub ends	For SS (Other than Cryo)
300,600	Up to 1.50"	SW RF	
	2" & above	WN RF	
≥ 900	All	WN RTJ	

- All flange joints on piping system including flanges on the equipment, manholes, etc shall be tightened using Hydraulic bolt tensioner as per the requirement given in the following table & the stud bolt length shall be longer by one diameter to facilitate bolt tensioning and shall have extra nut to protect the longer length of threads :

Nominal Bolt Diameter	Condition	Remarks
All	When specified by Process licensor/ Vendor/Project Specifications	
50 mm & over	All Joints	Except under Cat-D service, as defined in ASME B31.3

38 mm & above & below 50mm	a) Class 600 & above b) Hydrogen service (Note-1) c) Cat-M service as per ASME B31.3 d) Joints with leakage potential (Note-2) e) Critical joints with equipments (Note-3)	
25 mm & above & below 38mm	a) Joints with leakage potential (Note-2) b) Critical joints with equipments (Note-3)	

Notes:

1) Hydrogen service is defined as service in contact with hydrogen or gaseous mixtures containing hydrogen in which the partial pressure of hydrogen is 5 bar(abs) (58 psig) or more.
2) Joints with leakage potential shall include
   a) Joints involving tapped holes
   b) Items not subjected to hydrotest eg. Joints for equipment manholes, equipment mounted temp, pressure & level instruments, line mounted temp connections, online instrument joints like control valves and safety valves, compressor volume bottles.
   c) Items involving two sets of gaskets with one set of bolt eg orifice flange joint, joints with spectacle blind, spacer, flangeless wafer check valve, wafer type butterfly valves.
   d) Tie-in joints with other Contractors & package vendors
   e) High temperature (above 370deg C) joints in hydrocarbon service.
3) Critical joints with equipments shall include inlet & outlet flanges of pumps, compressors & turbines

   For flange assemblies not covered under the requirements of hydraulic bolt tensioning, but falling in the following categories Bolt Torquing using prespecified torque value shall be employed:

Service	Classes (as per ASME B16.5)
Hydrogen Service	All
Category-M services as per ASME B31.3	All
Other Services	600# & above

2.8.4 Gaskets

No flat ring non metallic gaskets shall be used in plant. Gaskets shall be as per ASME B 16.20. Only Non-asbestos materials shall be used as fill materials

Gaskets shall be as follows:

Rating	Material /service	Temperature (^{0}C)	Type	Gasket or Strip material + Filler material/RTJ Gasket Material
150	CS & SS (utilities & LP Steam)	up to 371 ^{0}C	Spiral wound	SS316+Grafoil
150	CS & LTCS (other than utilities)	up to 371 ^{0}C	Spiral wound	SS316+Grafoil
150	AS (all services)	up to 371 ^{0}C	Spiral wound	SS316+Grafoil
300 & 600	CS	up to 427 ^{0}C	Spiral wound	SS316+Grafoil
300 & 600	AS	All	Spiral wound	SS316+Grafoil
Rating	Material /service	Temperature (^{0}C)	Type	Gasket or Strip material + Filler material/RTJ Gasket Material
150, 300, 600	SS (other than utilities	All	Spiral wound	SS316+Grafoil (where trim material is SS304/316) SS316L+Grafoil (where trim material is SS304L/316L
300(*), 600(*),900, 1500,2500	CS	All	Octagonal RTJ	Soft Iron
300(*), 600(*), 900, 1500,2500	AS <=5% Cr.	All	Octagonal RTJ	5Cr-Alloy steel
	AS 9% Cr.			9Cr-Alloy steel
300(*), 600(*), 900, 1500,2500	SS	All	Octagonal RTJ	SS

(*) Only if RTJ is specially mentioned in PMS.

2.8.5 Valves

SW valves - Upto 1½ inch, for 150#, 300#, 600# (except ball & plug valves). Ball & Plug valves shall be flanged for all sizes.

Flanged valve- Above 1½ inch for 150#, 300#, 600#.

BW valves - 900# and above

2.8.6 Others

Over and above the requirements specified in clause 2.8.1 through 2.8.5, other technical requirement prescribed in Annexure "D" shall also be adhered to.

2.8.7 NDE Requirements (If not specified in PMS)

Depending upon the severity of application, extent of NDE shall be decided. As a rule, all hydrogen, oxygen, NACE and any other lethal service shall have 100% radiography on weld joints in all class ratings.

For high pressure applications, i.e., 900# and upward 100% radiography on butt weld joints shall be employed. In 100% radiography classes any fillet welds employed shall have 100% DP/MP test in CS/AS classes and 100% DP test in SS classes.

Cat. 'D' service as per ASME B31.3 does not require radiography.

Butt welds for Class in 150# for normal hydrocarbon service shall be subjected to 10% radiography and fillet welds to10%DP/ MP test for CS&AS and 10%DP test for SS.

Butt welds for Classes 300# & 600# for normal hydrocarbon service shall be subjected to 20% radiography and fillet welds to 20% DP/MP test for CS&AS and 20%DP test for SS.

For firewater service, IBR etc., radiography shall be as per statutory requirement.

2.9 THERMAL INSULATION OF PIPING, EQUIPMENT & VESSELS

2.9.1 Hot Insulation

Insulation thickness, materials, application etc. on piping shall be as per 'Process design basis'.

2.9.2 Cold Insulation

Insulation thickness, insulation materials & application etc. on piping shall be as per 'Process design basis'.

2.10 PAINTING

Painting materials, application etc. shall be as per MRPL's Project Painting specifications.

2.11 WELDING

2.11.1 APPLICABLE CODES & STANDARDS

All welding work, equipment 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: B31.3

b) The Indian Boiler Regulations - I.B.R.

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.

Welding and Brazing Qualifications ASME BPV Sec. IX.

Non-destructive examination ASME BPV Sec. V.

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.

2.11.2 WELDING PROCESSES

2.11.2.1 Welding of various materials shall be carried out using one or more of the following processes with the approval of the Engineer-in-charge. - Shielded Metal Arc Welding process (SMAW)

- Gas Tungsten Arc Welding process (GTAW).

2.11.2.2 Automatic and semi-automatic welding processes shall be employed only with the express approval of the Engineer-in-charge. The welding procedure adopted and consumables used shall be specifically approved.

2.11.2.3 A combination of different welding processes could be employed for a particular joint only after duly qualifying the welding procedure to be adopted and obtaining the approval of engineer-in-Charge.

2.11.2.4 All small bore piping and steam tracer lines, size ¾" and below shall be welded by TIG process for all type of joints, e.g. Butt Weld, Socket Weld, tee etc. Root Pass for all piping shall be welded by GTAW process

2.11.2.5 Preheating/Post heating is mandatory for all type of Alloy steel piping welding joints.

2.11.2.6 All low hydrogen electrodes shall be baked at 350 deg.C in suitable furnace at site by the contractor.

2.11.2.7 Welding of Alloy steel butt joints should not be left incomplete for long hours, at least one third of the weld joint shall be completed in continuity.

2.12 MISCELLANEOUS

Positive material identification (PMI) test at construction site shall be done for all Alloy Steel & Stainless steel piping

2.12.1 Potable water shall be used for testing of Carbon steel & Alloy steel piping. For testing of Stainless Steel piping maximum chlorine content in water shall be 15-20 ppm.

2.12.2 Item codes for surplus & spare materials shall be as per Owner codes at the time of handing over of the Project.

3.0 REFERENCED PUBLICATIONS

The following codes and standards shall be followed unless otherwise specified:

ASME SEC. I	Rules for Construction of Power Boilers.
ASME SEC. II, Part-C	Material Specifications :Welding Rods, Electrodes and filler metals
ASME SEC. VIII	Rules for Construction of Pressure Vessels.
ASME SEC. IX	Welding and Brazing qualifications
ASME B31.1	Power Piping
ASME B31.3	Process Piping
API RP 520	Sizing, Selection & Installation of Pressure Relieving Devices in Refineries
API Std. 610	Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Service
ANSI/NEMA SM 23	Steam Turbines for Mechanical Drive Service

API Std. 617	Centrifugal Compressors for Petroleum, Chemical and Gas Industry Service
API Std. 618	Reciprocating compressors for Petroleum, Chemical & Gas Industry service.
API Std.661	Air Cooled Heat Exchanger
API Std.560	Fired Heater
EJMA	Expansion Joints Manufacturer's Association
TEMA	Tubular Exchangers Manufacturers Association
OISD-118	Layouts for Oil and Gas Installations
IBR	Indian Boiler Regulations
NACE MR0103	Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments Resistant Metallic Materials for Oilfield Equipment
NACE MR0175/ISO15156	Materials for use in H2S containing Environments in Oil & Gas Production
NACE MR-0284	Evaluation of Pipeline and Pressure Vessel Steel for Resistance to Hydrogen Induced Cracking
NACE TM-0177	Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking in H_2S Environments

Annexure-A : TABLE OF BASIC SPAN

Pipe Size NB (inch)	SCH/ THK (in)	PIPE-VAPOR-INSULATION			PIPE-LIQUID-INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe Size NB (inch)
		BASIC SPAN (L) M			BASIC SPAN (L) M							
		Upto 175 ^{0}C	176 ^{0}C To 315 ^{0}C	316 ^{0}C To 400 ^{0}C	Upto 175 ^{0}C	176 ^{0}C To 315 ^{0}C	316 ^{0}C To 400 ^{0}C	SPAN (L) M	Weight KG/M	SPAN (L) M	Weight KG/M	
3/4"	SCH 40	3.5	3.5	2.5	3.5	3.0	2.0	4.5	1.68	4.0	2.04	3/4"
1"	SCH 40	4.5	4.0	3.0	4.5	3.5	3.0	5.0	2.52	4.5	3.07	1"
1-1/2"	SCH 40	5.0	5.0	4.5	5.0	4.5	3.5	6.0	4.08	5.0	5.4	1 -1/2"
2"	SCH 40	5.5	5.0	4.5	5.0	4.5	3.5	6.5	5.47	5.5	7.65	2"
2-1/2"	SCH 40	6.5	6.0	5.0	6.0	5.5	4.5	7.5	8.7	6.5	11.79	2 -1/2"
3"	SCH 40	7.5	6.5	5.5	6.5	6.0	5.0	8.0	11.35	6.5	16.15	3"
4"	SCH 40	8.0	7.5	6.5	7.5	7.0	6.0	9.0	16.2	7.5	24.45	4"
6"	SCH 40	10.0	9.5	8.5	9.0	8.0	7.5	10.5	28.3	9.0	46.7	6"
8"	SCH 40	12.0	11.0	10.0	10.0	10.0	9.0	12.0	42.84	10.0	75.22	8"
10"	SCH 40	13.5	13.0	12.0	11.5	10.5	10.5	14.0	60.74	11.5	111.9	10"
12"	3/8" w	14.5	13.5	13.0	12.0	11.5	11.0	15.0	74.40	12.0	147.5	12"
14"	3/8" w	15.0	14.5	13.5	12.0	12.0	11.5	16.0	82.5	12.5	172.05	14"
16"	3/8" w	16.0	15.5	14.5	13.0	12.5	12.0	17.0	94.5	13.0	213.15	16"
18"	3/8" w	17.0	16.5	15.0	13.5	13.0	12.0	18.0	106.5	13.5	258.3	18"
20"	3/8" w	18.0	17.5	16.0	14.0	13.5	12.5	19.0	118.5	14.0	307.5	20"
24"	3/8" w	20.0	19.0	17.5	14.5	14.5	13.0	21.0	142.5	15.0	418.2	24"
3/4"	SCH 80	3.5	3.5	2.5	3.5	3.0	2.0	4.5	2.20	4.0	2.49	3/4"
1"	SCH 80	4.5	4.0	3.0	4.5	3.5	3.0	5.0	3.25	4.5	3.72	1"
1-1/2"	SCH 80	5.0	5.0	4.5	5.0	4.5	4.0	6.0	5.45	5.0	6.60	1 -1/2"
2"	SCH 80	6.0	5.0	4.5	5.5	5.0	4.0	6.5	7.53	6.0	9.45	2"
2-1/2"	SCH 80	6.5	6.0	5.5	6.0	6.0	5.0	7.5	11.49	6.5	14.25	2 -1/2"
3"	SCH 80	7.5	6.5	6.0	6.5	6.5	6.0	8.0	15.37	7.0	19.66	3"
4"	SCH 80	8.0	8.0	7.0	7.5	7.5	6.5	9.0	22.47	8.0	29.94	4"
6"	SCH 80	10.5	10.0	9.0	9.5	9.0	8.5	10.5	42.90	9.5	59.85	6"
8"	1/2" w	12.0	11.5	10.5	10.5	10.0	10.0	12.0	65.10	11.0	94.8	8"
10"	1/2" w	13.5	13.0	12.0	11.5	11.5	10.5	14.0	82.20	12.0	130.69	10"
12"	1/2" w	14.5	13.5	13.0	12.5	12.0	11.5	15.0	98.13	13.0	168.64	12"
14"	1/2" w	15.0	14.5	13.5	13.0	12.5	12.0	16.0	108.15	13.5	194.4	14"
16"	1/2" w	16.0	15.5	15.0	13.5	13.0	13.0	17.0	124.2	14.0	240.0	16"
18"	1/2" w	17.5	17.0	16.0	14.5	14.0	13.5	18.0	140.25	14.5	286.64	18"

20"	1/2" w	18.0	17.5	17.0	15.0	14.5	14.0	19.0	157.5	15.0	341.8	20"
24"	1/2" w	20.0	19.0	18.5	16.0	15.0	15.0	21.0	188.25	16.0	458.44	24"
1"	10 S	4.0	3.5	3.0	4.0	3.0	2.5	4.5	2.08	4.0	2.7	1"
1-1/2"	10 S	5.0	4.5	3.5	4.5	4.0	3.0	5.5	3.12	5.0	4.57	1 -1/2"
2"	10 S	5.0	4.5	3.5	4.5	4.0	3.0	6.0	3.94	5.5	6.33	2"
2-1/2"	10 S	6.5	5.5	4.5	5.5	5.0	4.5	7.0	5.26	6.0	8.85	2 -1/2"
3"	10 S	7.0	6.0	5.0	6.0	5.5	5.0	7.5	6.45	6.0	11.91	3"
4"	10 S	7.5	7.0	6.0	6.5	6.0	6.0	8.0	8.34	7.0	17.67	4"
6"	10 S	9.5	9.0	8.0	8.0	7.5	7.5	10.0	13.82	8.5	34.54	6"
8"	10 S	11.0	10.5	10.0	9.5	9.5	8.5	11.5	19.94	10.0	55.5	8"
10"	10 S	12.5	12.0	11.0	10.5	10.0	9.5	13.0	27.83	11.0	83.4	10"
12"	10 S	14.0	13.0	12.0	11.0	11.0	10.0	14.5	36.00	11.5	114.6	12"
14"	10 S	14.5	14.0	13.0	11.5	11.0	11.0	15.5	41.18	11.5	132.6	14"
16"	10 S	16.5	14.5	14.0	12.0	11.5	11.5	16.5	47.33	12.5	172.2	16"
18"	10 S	16.5	15.5	14.5	12.5	12.5	11.5	17.5	53.18	13.0	212.1	18"
20"	10 S	17.5	16.5	15.5	13.0	13.0	12.0	18.5	68.50	13.0	264.5	20"
24"	10 S	19.0	18.0	17.0	14.0	13.5	12.5	20.5	94.37	14.0	376.8	24"

Annexure-B : Accessibility for Valves & Instruments

VALVES, INSTRUMENTS, EQUIPMENT TO BE OPERATED	CENTRELINE 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	CENTRELINE 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
EXCHANGER HEADS	Nil	Nil
OPER. VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
OPER. VALVES 3" & ABOVE	PLATFORM	PLATFORM
MOTOR OPERATED VALVES	PLATFORM	PLATFORM
CONTROL VALVES	PLATFORM	PLATFORM
RELIEF VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
RELIEF VALVES 3" & ABOVE	PLATFORM	PLATFORM
BLOCK VALVES 2" & SMALLER	PORTABLE LADDER	PORTABLE LADDER
BLOCK VALVES 3" & ABOVE	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)
BATTERY LIMIT VALVES	PLATFORM	PLATFORM
PRESSURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2 m HEIGHT	FIXED LADDER IF ABOVE 2.2 m HEIGHT
TEMPERATURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2 m HEIGHT	FIXED LADDER IF ABOVE 2.2 m HEIGHT
SAMPLE POINTS	PLATFORM	PLATFORM
GAUGE GLASSES	FIXED LADDER	FIXED LADDER
LEVEL CONTROLLERS	PLATFORM	PLATFORM
PROCESS BLINDS AND SPACERS 2" & SMALLER	PORTABLE LADDER / PLATFORM	PORTABLE LADDER / PLATFORM
PROCESS BLINDS AND SPACERS 3" & ABOVE	PLATFORM	PLATFORM
MANWAYS/ MANHOLES	PLATFORM	PLATFORM
HANDHOLES/ INSPECTION HOLES	PLATFORM	PLATFORM
NOZZLES	NO ACCESS REQD. (NOTE-2)	NO ACCESS REQD. (NOTE-2)
VESSEL VENTS	PORTABLE LADDER	PORTABLE LADDER
LINE DRAINS & VENTS	PORTABLE LADDER	PORTABLE LADDER
ORIFICE FLANGES	PORTABLE LADDER	PORTABLE LADDER

Note-1: Block valves with centrelines located above 2.0 m from the operating floor, which are required for normal operation shall be provided with portable platform or chain for operation of valves.

Note-2: Temporary arrangement for access should be feasible.

Annexure-C : Vertical and Horizontal Guides Spacing

NOM PIPE SIZE IN INCHES	VERTICAL SPACING METRES	HORIZONTAL SPACING METRES NOTE-1
1	6.0	6.0
1 ½	6.0	6.0
2	6.0	6.0
3	8.0	12.0
4	8.0	12.0
6	8.0	12.0
8	8.0	12.0
10	12.0	18.0
12	12.0	18.0
14	12.0	18.0
16	12.0	18.0
18	12.0	18.0
20	16.0	18.0
24	16.0	18.0
26 and above	16.0	18.0

Note-1: These spacing may be varied to suit column spacing of rack. The above spacing is for straight runs of pipe & does not include guides which are used for control of thermal movements, as decided by stress group.

Note-2: The guide spacing given in the above table are indicative only

Annexure-D : Technical Requirements for Piping Material

1.0 General

1.1 Ends

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

SW/SCRD: ASME B16.11
BW : ASME B16.25
FLANGED: ASME B16.5 and ASME B16.47 SERIES 'B'
THREADING: ASME/ANSI B1.20.1 (NPT, Taper threads)

1.2 Face Finish

This shall be to MSS-SP-6/ASME B46.1/ASME B16.5/ B16.47 . The interpretation shall be as follows:

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

1.3 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.).

OR

ASTM A262 Practice 'E' with acceptance criteria of 'No cracks as observed from 20Xmagnification' & microscopic structure to be observed from 250 X magnification".

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.

For all items of stabilised SS grades (SS321, SS347), stabilizing heat treatment shall also be done. It shall be carried out subsequent to normal solution annealing. Soaking temperature and holding time shall be 900ºC and 4hrs respectively.

1.4 Threads

Threads for threaded Pipes, Fittings, Flanges, Valves etc shall be in accordance with B1.20.1 taper threads, unless otherwise specified. All threaded joints, irrespective of pressure and

temperature, for critical services including toxic fluid, hydrogen etc shall be seal welded with a full strength fillet weld.

2.0 ITEM SPECIFIC NOTES:

2.1 Pipes

Unless specifically exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding.

Unless mentioned otherwise in the material code, double seam 180 deg. apart is allowed for sizes 36" and larger only.

Galvanised Pipes shall be only Hot Dip galv. to ASTM A153.

2.2 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 and made employing automatic welding only.

All welded fittings shall be normalised for CS, normalised & tempered for AS; and 100% radiographed 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.

2.3 Flanges

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

Flange Material	Min. Hardness of Groove (BHN)
Carbon Steel	140
1% Cr to 5% Cr, 1/2 Mo	150
Type 304,316,347,321	160
Type 304L. 316L	140

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.

2.4 Valves

2.4.1 General

Valves of Class 900 & above shall be pressure-seal type. Threaded and seal welded or welded bonnet may be employed upto sizes $1^1/_2$".

All flanged valves (except forged) shall have flanges integral with the valve body. Weld-on flanges shall be made by full penetration joints and 100% radiographed.

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 under cryogenic service (temp. below -45°C) shall meet the requirements of BS-6364 and shall be procured from prequalified vendor.

2.4.2 Dimensions

Face-to-Face/End-to-End dimension shall be as per ANSI B16.10. In case the same is not covered under B16.10, the dimension shall be as per BS 2080/Manufacturer's Std.

2.4.3 Operation

Generally the valves are handwheel or lever operated. However, suitable gear operator in enclosed gear box shall be provided for valves as follows:

Valve Type	Class	For Sizes (= & >)
Gate/Globe	150	12"
	300	12"
	600	12"
Gate/Globe/Y-Globe/ Stop-Check	900	6"
	1500	3"
	2500	3"
Ball/Plug (other than Pressure balanced Plug)	150	6"
	300	6"
	600	4"
	900	3"
	1500	3"
Butterfly	150	6"
	300	6"

Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500 mm on each side. Effort to operate shall not exceed 35 kgf at handwheel periphery. However, failing to meet the above requirement, vendor shall offer gear operation. Quarter-turn valves shall have "open" position indicators with limit stops.

2.4.4 By Pass

A globe type valve (size as per ASME/ANSI B16.34) shall be provided as by-pass for the following sizes of gate valves:

Class	Size
150	26" & above
300	16" & above
600	6" & above
900	4" & above
1500	4" & above
2500	3" & above

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.

2.4.5 Radiography of Cast Valves

All casting shall be of radiographic quality. This requirement to be ensured by sample radiography before proceeding with the actual production.

Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME/ANSI B16.34.

a) Radiography requirement for casting of sizes for special/ critical piping classes shall be as follows:

i) For hydrogen / hydrogen bearing hydrocarbons, oxygen, NACE services & stress relieved Piping classes:

Class	Size	qty
150	upto 24"	50%
300	upto 16"	50%

ii) For LT/CRYO services:

Class	Size	qty
150	upto 24"	20%
300	upto 16"	20%

b) Radiography requirement for castings for categories not mentioned in a) above shall be as follows:

Class	Size	Qty
150	upto 24"	5% For Carbon Steel material (Except Cat 'D' & Fire water services for which it is NIL)
150	upto 24"	10% For Alloy steels & Stainless Steels
150	26" & above	100% For all materials (Nil for Cat. 'D'& Fire water service)
300	upto 16"	10% For all materials
300	18" & above	100% For all materials
600 & above	All	100% For all materials

Note-1 No radiography is required for castings for Demineralised Water service (Cat-D)'

Note-2 For stabilized grades of SS 100% radiography is required for castings irrespective of the category or rating these belong to.

2.4.6 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:

Class	Floating Ball	Trunion Mounted
150	8" & below	10" & above
300	4" & below	6" & above
600 & above	11/2" & below	2" & above

Use of soft seated ball/plug/butterfly valves shall be suitably selected based on temperatures handled.

Butterfly valves shall be suitable for throttling application.

Use of Fire safe valves shall be as per Process requirement.

For Process (Hydrocarbon) services butterfly valve shall be triple offset, high performance type.

2.5 Strainer

Allowable pressure drop when specified shall be certified along with the offer. If asked specifically, pressure drop calculations shall be furnished.

All 2" & higher sized Y type strainers shall be provided with 3/4" threaded tap and solid threaded plug as drain connection on the blind flange. For less than 2", this shall be 1/2" size.

Bottom flange of Y-type strainer shall not have tapped hole. Full length standard size studs shall be used for joining blind flange.

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.

2.6 Traps

All Thermodynamic traps shall be provided with external strainers if internal strainers are not provided.

For LP & MP Steam Thermodynamic traps shall be suitable for 42 Bar max. op. pressure.
For HP Steam Thermodynamic traps shall be suitable for 62 Bar max. op. pressure. For SHP Steam Thermodynamic traps shall be suitable for 120 Bar max. op. pressure.

Balanced Pressure Thermostatic steam Traps shall be suitable for 21 bar max. operating pressure (20 degrees sub cooling) with 40 mesh internal strainer.

Vendor shall 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 as in vertical installation.

All traps shall be hydrostatically tested to twice the design pressure.

2.7 Hoses

Suitability of hoses shall be guaranteed for the service and working conditions specified in the requisition, even if the material is not specified in the Material Requisition for any particular service.

All hoses shall be clearly marked with service and working pressure at both ends.
Hoses shall be resistant to ageing, abrasion and suitable for outdoor installations.

Complete Hose assembly shall be tested at two times the design pressure.

Steam hoses shall be subject to steam resistance test.

2.8 Expansion Joints

The applicable codes are ASME B31.3 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.
- Moments & forces due to stiffness & pressure thrust due to expansion joint

2.9 Supports & Spring Assemblies

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

Testing of springs shall be as per BS1726.

2.10 Gaskets

Asbestos / Grafoil material shall be used for gaskets / fillers as per table listed in Cl.2.8.4.

Spiral wound gaskets as per ASME B16.20 shall match flanges to ASME/ANSI B16.5 upto 24", and ASME B16.47 series 'B' for sizes > 24" unless otherwise specified.

Inner and outer rings requirement for spiral wound gaskets shall be as per PMS General notes.
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 SS321, SS347 and H-grade SS classes.
e) For classes where temperature is higher than 427°C.
f) For 900# rating and above classes. (If PMS specifies spiral wound gasket)

In case of RTJ gaskets, only octagonal section ring gaskets shall be used & 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.

2.11 Stud, Bolts, Nuts and Jack Screws

All bolting shall be as per ASME/ANSI B18.2.1 for Studs, M/C Bolts and Jack screws, and ASME/ANSI B18.2.2 for nuts.

Threads shall be unified (UNC for < or = 1" dia and 8UN for > 1" dia) as per ANSI B1.1 with class 2A fit for Studs, M/C Bolts and jack screws, and class 2B fit for nuts.

Stud bolts shall be threaded full length with two heavy hex nuts. Length tolerance shall be in accordance with the requirement of table F2 of Annexure F of ASME B16.5

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.
Heads of jack screws and M/C bolts shall be heavy hexagonal type. Jack screw 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 nut.

3.0 Special Service Requirements:

3.1 NACE & Sour Service

For items under this category, NACE-MR-0175 shall be followed.

3.2 CRYO & Fire-Safe

For items to be used under cryogenic conditions, temp below - 45 ^{0}C and those required to be fire-safe, special designs and tests would be applicable. Prequalification criteria need to be specified before execution of job.

3.3 Impact Tests

Welded Pipes and Fittings used below ASME Temp. –29 °C shall be impact tested as per requirement of ASME B31.3.

3.4 Hydrogen & other demanding services

Vendor quality plan shall include the special quality checks and inspection requirements for these services.

For items to be used in Hydrogen service, requirements as mentioned in Annexure-F shall be applicable, except wherever specified otherwise as per Licensor's requirement.

4.0 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/data sheets.

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.

Positive material identification test at vendor's works shall be done as per 'Standard specification for positive material identification PMI at vendor's works, 6-81-0001'.

Inspection & testing shall be per approved QAP.

5.0 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 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.

6.0 Despatch

All items shall be dry, clean and free from moisture, dirt and loose foreign material 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.

Annexure-E : CLEARANCES

OVERHEAD CLEARANCES

Equipment, structure, platforms, piping & its supports shall be arranged to provide the following clearances overhead:

Over rail roads, top of rail to bottom of any obstruction.	7 m
Over plant roads for major mobile equipment.	7 m
Over secondary roads (bottom of pipe) and access ways for mobile equipment.	5 m
Over grade & bottom of pipe (inside battery limit) at pump row access way.	3.5 m
Over walk-ways, pass-ways & platforms to nearest obstruction and inside building.	2.2 m
Over exchangers at grade, shell cover channel end.	1.5 m

HORIZONTAL CLEARANCES :

Between exchangers (aisles between piping).	0.9 m
Around pumps (aisles between piping).	0.9 m
Fired heaters to pumps handling flammable stock.	15 m
Fired heaters to other flammable containing equipment not closely associated with heaters.	15 m
At driver end of pumps, where truck access reqd	3 m
At driver end of pumps, where truck access not reqd	1.8 m
At shell cover end of exchangers at grade, for access way.	1.3 m
Between shells of adjacent horizontal vessels.	1.2 m

PIPE BERTHING:

Under ground	300 mm minimum clear gap between pipes
Above ground	Normal -Flange to bare pipe (or insulation) plus 25 mm

EQUIPMENT SPACING:

Small pumps (3.7 kw & less)	Mounted on common foundations with suitable centre to centre distance.

Medium pumps (22.5 kw & less)	900 mm clear aisle
Larger pumps (above 22.5 kw)	900 mm clear aisle
Exchangers & other equipment on structures	900 mm minimum clear aisle

PLATFORMS :

Towers, vertical & horizontal vessels :

Distance of platform below centerline of manhole flange - side platform	900-1050 mm
Width of manhole platform from manhole cover to outside edge of platform	900 mm
Platform extension beyond centerline of manhole - side platform	900 mm
Distance of platform below underside of flange - head platform	175 mm
Width of platform from three sides of manhole - head platform	750 mm

HORIZONTAL EXCHANGER :

Clearance in front of channel or bonnet flange	1200 mm
Heat exchanger tube bundle removal space	Bundle length + 1m
Min. clearance from edge of flanges	300 mm

VERTICAL EXCHANGER :

Distance of platform below top flange of channel or bonnet	1500 mm

FURNACES :

Width of the platform at side of horizontal and vertical tube furnace	750 mm min.
Width of platform at ends of horizontal tube furnace	1000 mm min.

Annexure-F : SPECIAL REQUIREMENTS FOR HYDROGEN SERVICE

1. GENERAL

These requirements are applicable in addition to the requirements specified in the Piping Material Specifications.

2. PIPES, FLANGES AND FITTINGS

Method of Manufacture

All carbon steel pipes, fittings and flanges having wall thickness 9.53 mm and above shall be normalised. Cold drawn pipes and fittings shall be normalised after the final cold draw

pass for all thicknesses. In addition, fittings made from forgings shall have Carbon - 0.35% max. and Silicon - 0.35% max. The normalising heat treatment shall be a separate heating operation and not a part of the hot forming operation.

All alloy steel (Cr-Mo) pipes, forgings and fittings shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psi.

Post Weld Heat Treatment (PWHT)

All carbon steel pipes and fittings having wall thickness 19 mm and above shall be post weld heat treated.

All alloy steel (Cr-Mo) pipes and fittings shall be post weld heat treated irrespective of type or thickness of weld.

100% radiography of welded joints shall be done both before and after PWHT.

All austenitic stainless steel grades shall be solution annealed after welding.

Ferrite No. Test

For all austenitic stainless steels, the weld deposit shall be checked for ferrite content. A Ferrite No. (FN) not less than 3% and not more than 10% is required to avoid sigma phase embrittlement during heat treatment. FN shall be determined by Ferrite scope prior to post weld heat treatment.

Impact Test

For all carbon steels and alloy steels pipes, flanges and fittings with thickness over 19 mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and in accordance with ASTM A370. Impact energies at 0 C shall average greater than 27J (20 ft-lb) per set of 3 specimens, with a minimum of 19J (15 ft-lb).

If welding is used in manufacture, impact test of Heat Affected Zone (HAZ) and weld metal shall also be carried out.

Hardness

For carbon steel pipes and fittings, hardness of weld and HAZ shall be limited to 200 BHN (max.).

For alloy steel pipes and fittings, hardness of weld and HAZ shall be limited to 225 BHN (max.).

Radiography

All girth welded joints (longitudinal and circumferential) shall be 100% radiographed in accordance with UW-51 of ASME Section VIII, Div-1 and ASME Section V.

3. VALVES

- All valve castings shall be of radiographic quality.
- All cast valve flanges & bodies with flange rating of Class 900 or greater shall be examined in accordance with paragraphs 7.2 through 7.5 of Appendix-7 of ASME SEC-VIII, DIV.1, regardless of casting quality factor.

- Only Normalized and Tempered material shall be used in the following specifications:
  Castings: A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12
  Forgings: A182 Gr.F11 Cl.2, A182 Gr.F22 CL.3, A182Gr.F5, A182Gr.9
- Body / bonnet / cover joints & stuffing box of valves shall have low emission. One valve per size / per valve sheet number shall be helium leak tested as per ASME Sec.V, Subsection A, Article 10 (Detector Probe Technique), Appendix IV at a minimum of 25% of the allowable (rated) cold working pressure. Selection of valves for helium leak test shall be at random. Test duration shall be as follows:

Test Duration in Minutes					
Nominal Size	Pressure Class				
	Up to 300	600	800 & 900	1500	2500
Up to 2"	3	6	9	12	12
3" to 6"	6	9	12	15	18
8" to 16"	9	9	12	15	18
18" to 24"	9	12	15	18	21

The valve shall show no leakage. No leakage is defined as a total leakage rate of less than 0.0001 ml/s of helium.

CS & AS Valves:

Bend test and Magnetic Particle inspection of the entire surface of body and bonnet casting shall be in accordance with ASTM A217. Supplementary requirement S3 & S4 evaluation of magnetic particle, inspection shall be in accordance with MSS-SP-53 except that no linear discontinuities shall be allowed.

The Brinell hardness of heat treated casting shall not exceed 200 BHN for carbon steel & 225 for alloy steel.

Repair of defective casting shall be outlined in writing to the purchaser before repair starts. Repair method to be approved prior to welding.

Casting shall be preheated to a minimum of 400ºF prior to welding and all Chromium Molybdenum alloys shall be post weld heat treated after welding is complete. Stress relieving is essential for welds.

Carbon steel shall be normalised and alloy steels shall be normalised & tempered.

Dye Penetrant test of welds shall be in accordance with ASTM B165 Procedure B-2. Interpretation as per Appendix-8 of ASME-VIII Div.1.

The tensile stress for AS shall be less than 100,000 psi.

Charpy V-notch impact testing is to be done for valve material (average 20 ft-lb for set of 3 [minimum value 15 ft-lb] at 30 F).

For radiography and acceptance criteria for valve castings, refer para 2 of clause3.6.

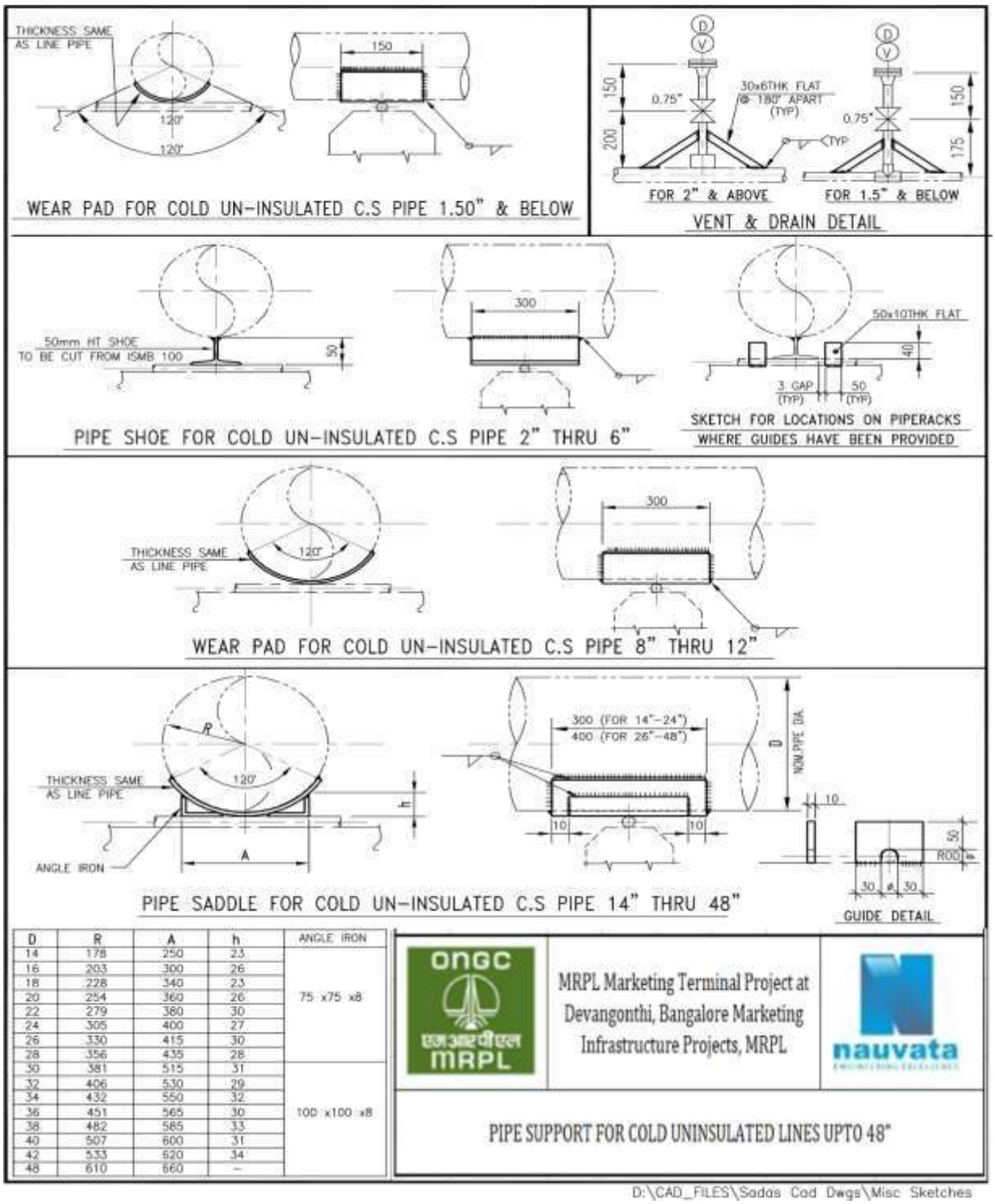
SS Valves:

Casting and test bar shall be heat treated together. Valve casting shall be in solution heat treated and pickled condition.

Critical body and bonnet casing section typically defined by ASME B16.34 shall be radiographed and shall meet ASTM E446 (up to 2" thick) Category A,B & CA Level 2, Category CB, OC & CD Level 3, Category D,B & F Level 0. For wall thickness 2" to 4.5" comparable plates of ASTM E186 shall be used. ASTM E94 and ASTM E142 shall be used for recommended practice & controlling quality of radiography as guide. The entire surface of all castings shall be dye-penetrant inspected after pickling.

Repair welds shall be 100% radiographed and evaluated in accordance with paragraph 344.5 of ASME B31.3 with a minimum casting quality factor of 0.95. Dye Penetration test shall be as per ASTM E165 Procedure B-2, Interpretation as per Appendix-8 of ASME-VIII Div.1.

Annexure-G : PIPE SUPPORT FOR COLD UNINSULATED LINES



D	R	A	h	ANGLE IRON
14	178	250	23	75 x75 x8
16	203	300	26	
18	228	340	23	
20	254	360	26	
22	279	380	30	
24	305	400	27	
26	330	415	30	
28	356	435	28	
30	381	515	31	100 x100 x8
32	406	530	29	
34	432	550	32	
36	451	565	30	
38	482	585	33	
40	507	600	31	
42	533	620	34	
48	610	660	–	

MRPL Marketing Terminal Project at Devangonthi, Bangalore Marketing Infrastructure Projects, MRPL

PIPE SUPPORT FOR COLD UNINSULATED LINES UPTO 48"

D:\CAD_FILES\Sadas Cad Dwgs\Misc Sketches

Annexure-H: ADDITIONAL REQUIREMENT TO DESING BASIS

ENGINEERING DESIGN BASIS
PIPING

Table of Contents

1.0 SCOPE

The Design Basis briefly covers the basic requirements for the design of Piping systems for Refineries, Petrochemicals, Onshore Piping & Gas Processing facilities covered by ASME B31.3. These shall be adhered to by Engineering / EPCC Contractor(s) or his subcontractor(s) during the course of engineering, procurement & construction

2.0 ABBREVIATIONS, CODES & STANDARDS / PUBLICATIONS

2.1 ABBREVIATIONS

Code	Description
EDB	Engineering Design Basis
EPCC	Engineering, Procurement, Construction & Commissioning
ISBL	Inside Battery Limit
LSTK	Lumpsum Turnkey
OISD	Oil Industry Safety Directorate
OSBL	Outside Battery Limit
HAZ	Heat Affected Zone
BHN	Brinell Hardness Number

2.2 CODES & STANDARDS / PUBLICATIONS

The following codes & standards in their latest edition including latest addenda as on the date of first issue of this design basis shall be followed.

S.No.	Description	Standards / Codes	Edition	Remarks
1	International Codes/Standards		Latest	
1.1	Process Piping	ASME B31.3	Latest	
1.2	Pipe Flanges and Flanged Fittings	ASME B16.5	Latest	
1.3	Welding and Brazing Qual.	ASME BPV Sec. IX	Latest	
1.4	Non Destructive Examination	ASME BPV Sec.V	Latest	
1.5	Welding rods, electrodes & filler materials	ASME BPV Sec.II Pt.C	Latest	
1.6	Indian Boiler Regulations	IBR	Latest	
1.7	Expansion Joints Manufacturers' Association	EJMA Standards	Latest	
1.8	Layouts for Oil and Gas Installations	OISD-118	Latest	
1.9	Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments Resistant Metallic Materials for Oilfield Equipment	NACE MR 0103	Latest	

S.No.	Description	Standards / Codes	Edition	Remarks
1.10	Materials for use in H2S containing Environments in Oil & Gas Production	NACE MR0175/ISO15156	Latest	
1.11	Sizing, Selection & Installation of Pressure Relieving Devices in Refineries	API RP 520	Latest	
1.12	Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Service	API Std. 610	Latest	
1.13	Steam Turbines for Mechanical Drive Service	ANSI/NEMA SM 23	Latest	
1.14	Centrifugal Compressors for Petroleum, Chemical and Gas Industry Service	API STD. 617	Latest	
1.15	Air Cooled Heat Exchanger	API Std. 661	Latest	
1.16	Fired Heater	API STD. 560	Latest	
1.17	Evaluation of Pipeline and Pressure Vessel Steel for Resistance to Hydrogen Induced Cracking	NACE MR-0284	Latest	
1.18	Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking in H2S Environments	NACE TM-0177	Latest	
2	EIL Standards		Latest	
2.1	Standard Spec for Hot Insulation	6-44-0002	Latest	
2.2	Standard Spec for Cold Insulation	6-44-0003	Latest	
2.3	Standard Spec. For Steam Tracing	6-44-0007	Latest	
2.4	Standard Spec. For Steam Jacketing	6-44-0078	Latest	
2.5	Standard specification for application of torque and hydraulic bolt tension for flange joints	6-76-0002	Latest	
2.6	Welding Specification for fabrication of Piping	6-77-0001	Latest	
2.7	Standard specification for surface preparation and protective coating (new construction)	6-79-0020	Latest	
2.8	Standard specification for positive material identification (PMI) at construction sites	6-82-0002	Latest	
2.9	Clearances	7-44-0501	Latest	

S.No.	Description	Standards / Codes	Edition	Remarks
2.10	Accessibility for valves and Instruments	7-44-0502	Latest	
2.11	Table of Basic Span	7-44-0506	Latest	
2.12	Maximum Spacing of Guides for Vertical and Horizontal Pipes	7-44-0507	Latest	

3.0 GENERAL / DESIGN CONSIDERATIONS

3.1 EQUIPMENT LAYOUT

3.1.1 BASIS OF EQUIPMENT LAYOUT

Equipment Layout shall be developed based on the following data.

S.No.	Project Philosophy
1	P&IDs
2	Overall Plot Plan
3	Wind direction
4	Equipment Data Sheets
5	Indicative Equipment Layout from Process Licensor/EIL Process
6	Process Package
7	OISD Std. 118

3.1.2 DEVELOPMENT OF EQUIPMENT LAYOUT

The following aspects shall be considered during development of equipment layout.

S.No.	Project Philosophy
1	Process Requirement i.e. proper interconnection between equipment as per P&IDs to achieve the intended process parameters.
2	Economy of Piping material Minimize the quantity of costly piping.
3	Erection & Construction requirement-Erection scheme and schedule of all equipment must be considered during equipment layout to have smooth erection mainly in case of tall columns, heavy equipment like thick walled reactors, space for laying tall column, approach road for cranes / derrick for lifting the column or reactors and requirement of special foundation / pile etc.
4	Safety Requirements - As a minimum, 'OISD Std. 118' shall be followed. Safety shower location shall be marked in equipment layout.
5	Operation and Maintenance Requirement like Overhead and side clearances for exchangers and pumps, Provision of exchangers tube bundle pulling area, Horizontal & overhead clearances for easy movement of working personnel, Crane approaches for air coolers/fired heaters/exchangers. Provision of catalyst loading/unloading facilities, Provision of monorail/mobile crane for maintenance of pumps, Provision of hydro extractor/monorail for maintenance of exchangers and Provision of EOT/HOT crane for compressors, Provision of Analyzer shelter.
6	Similar equipment grouping - All columns, exchangers, pumps etc. should be grouped together for convenience of maintenance and safety wherever feasible.
7	The technological structures should be inter-connected for easy movement of operational personnel.
8	U/G piping corridors for main headers and U/G trenches (as applicable) should be marked in equipment layout.

S.No.	Project Philosophy
9	All areas requiring crane access for erection or specific maintenance purpose e.g. catalyst loading etc., hard stand for construction, tube bundle pulling area and drop-out/laydown areas shall be marked on the equipment layout.
10	Clearance, maintenance and safety requirements as specified are applicable to new units; for revamped units existing norms shall be followed to the extent possible.

3.1.3 PIPE RACK

S.No.	Type	Description
1	Pipe Rack Configurations	Preferably Straight. However, L/T/U/H/Z can be used based on area available
2	Preferred Pipe rack width depending on project requirements	Single Bay : 6M/8M/10M/12M Double bay : 14M/16M/18M/20M/24
3	Maximum Tiers	4
4	Portal Spacing	8M(standard). All other spacing as per job requirements. Intermediate structural member shall be provided in pipe rack for supporting pipes as per requirement
5	Clearance beneath Pipe Rack - Units	4.75M Vertical X 3M Horizontal; First Tier at 6M
6	Road Clearance	7M : Main Road 5M : Secondary Road
7	Pipe Rack Clearance - Offsites	2.2M
8	Space for Future Expansion - Units	As per Clause 5.0 S.No. 3.
9	Space for Future Expansion - Offsites	As per Clause 5.0 S.No. 3.
10	Water lines on Pipe Rack	As per Clause 5.0 S.No. 4.
11	Minimum Sleeper Height	As per Clause 5.0 S.No. 5.
12	Interconnecting platforms	Interconnecting platforms shall be provided between pipe rack & technological structures.

3.1.4 TOWERS AND VERTICAL VESSELS

S.No.	Type	Description
1	Location	Towers and vertical vessels in a row with a common centerline with OD minimum 4M away from Pipe Rack. Chemical Dosing vessels near dosing point to the extent possible, especially for ammonia and corrosion inhibitors and grouped together with escape routes
2	Minimum Clearance	Minimum 3M. Minimum 100mm horizontal gap between platforms of adjacent tower. Minimum 900mm clear aisle between plinths. Clearance shall allow full opening of Manhole.
3	Interconnecting platforms	To be provided at suitable levels where possible allowing for differential expansion.

S.No.	Type	Description
4	Davit provision for heavy items (relief valves, blinds, etc)	On side of vessel away from pipe rack with clear drop out area at grade Clear access shall be provided at grade on the access side for lowering external & internal fittings, PSVs, Control valves etc from elevated equipment(columns, towers etc) by providing pipe davits.

3.1.5 REBOILER

S.No.	Type	Description
1	Location	Reboilers shall be located next to the tower they serve except fired heater type. Clearance for rodding to be provided for vertical reboilers. Vertical thermo siphon types to be supported by tower (except large vertical types which may require independent structure) and located away from pipe rack. Pressure drop calculations to be done before finalizing.
2	Elevation	As per P&ID.

3.1.6 HORIZONTAL VESSELS

S.No.	Type	Description
1	Location	Perpendicular to Pipe Rack and Min. 4M away from it.
2	Minimum Clearance	Minimum 2M Minimum 900mm clear aisle.

3.1.7 PUMPS

S.No.	Type	Description
1	Location	As per Clause 5.0 S.No. 7. Wherever possible, centerline of discharge shall be kept on common straight line.
2	Minimum Clearance	Minimum 900mm clear aisle between pumps Gap between each pump foundation and foundation of technical structure should be sufficient after piping, for access.
3	Maintenance	
3.1		As per Clause 5.0 S.No. 8.
3.2		Sufficient space to be available for maintenance below pipe rack. Clear access of 4.0M vertically and 3M horizontally shall be provided centrally under main pipe ways for small mobile equipment to service pumps/motors, wherever these are installed under pipe ways with prior specific approval. Pumps outside rack shall be approachable by mobile equipments etc. from under the pipe rack.

3.1.8 EXCHANGERS

S.No.	Type	Description
1	Location	Floating head 4M from pipe rack

S.No.	Type	Description
2	Minimum Clearance	Minimum 2M. Minimum 900mm clear aisle. Heat Exchanger train should be suitably spaced such that shell/ tube inlet/ outlet piping do not foul with floating Head Covers.
3	Maintenance	
3.1	Maintenance of shell and tube type exchangers	Shell and tube type exchangers may have a removable shell cover with flanged head. Tube pulling or rod cleaning area must be allowed at the channel end.
3.2	Maintenance with Hydroextractor	Tube bundle pulling area shall be minimum the tube bundle length + 4M from the channel head for hydroextractor frame (1.5M on platform and rest clear in front of tech. structure subject to a minimum of 10M for crane movement)
3.3	Maintenance with monorail and chain pulley block	Tube bundle pulling area shall be minimum the tube bundle length + 1.5M from the channel head on the platform and 4M clear in front of Tech structure for vehicular movement.
3.4	Maintenance of vertical exchangers	In case of vertical exchanger suitable platform shall be provided below the top flange of channel or bonnet. For vertical exchanger, davit shall be provided for cover removal (as part of exchanger),if required, for maintenance.
3.5	Maintenance of high pressure exchangers	For high pressure exchangers, shell pulling on rails shall be provided, as required.
3.6	Means of tube bundle removal	As per Clause 5.0 S.No. 9.

3.1.9 AIR COOLERS

S.No.	Type	Description
1	Location	As per Clause 5.0 S.No. 6.
2	Flooring	For air coolers located on technological structure/rack, blind floor shall be provided if any part of pumps /equipment handling hydrocarbons are placed below them. In other cases, flooring with grating shall be provided.
3	Supporting Structure	The width of the structure from where Air cooler assembly is supported shall be about 2.0m more than the Air cooler tube bundle length so that proper supporting of inlet/outlet piping manifolds can be done from the main members of pipe rack/technological structure to transfer piping load to main structural members
4	Maintenance	Davit shall be provided for lowering the motor, gear boxes etc. along with mobile trolley with retractable jacking arrangement of suitable load carrying capacity. Crane access shall be provided.

3.1.10 FIRED HEATERS

S.No.	Type	Description
1	Location	

S.No.	Type	Description
1.1		Fired heaters are located upwind or sidewind of process units to blow any combustible leaks away from the open flame. They are located minimum 90M away from hydrocarbon tanks and 30M away from control room. Distances for equipments handling hydrocarbon from the fired heaters shall be as per OISD norms. Vessels / reactors directly connected to fired heaters are exception.
1.2		Fired heaters shall be arranged with centerline of the stacks on a common line in case of circular fired heaters and wherever a common stack is furnished to cater more than one fired heater the stacks shall be located at the end or side, which is away from the unit. In case of individual box fired heater, the edge of the fired heater on the rack side shall be matched. F.D. fans shall be located at one corner of fired heater area away from equipments handling hydrocarbons.
1.3		It shall be ensured that there are no working platforms within an elevation of 6M below the tip of stack and within a 25M radius of stack. However, the stack height is governed by the clearances from statutory authorities like Director General of Civil Aviation and Pollution Control Board.
1.4		Air Pre Heaters should be located in such a way that the modules can be removed by crane.
2	Maintenance	
2.1		Vertical tube fired heaters must have access to permit a crane to remove and replace tubing.
2.2		Horizontal tube fired heaters must have horizontal free space equal to tube length plus crane parking space for tube pulling / maintenance / cleaning.
2.3		In case of bottom floor fired heaters, there shall be adequate headroom clearance underneath the fired heater for removal of burners.
2.4		In case of wall fired heaters min. 2M wide platform with escape route at each end is necessary.
3	Drainage	
3.1		Pits and trenches are not permitted under fired heater or any fired equipment. All the OWS/CRWS/SS drain points within 15M of Fired heater area shall be taken through closed pipe sewers.

3.1.11 COMPRESSORS AND THEIR PRIME MOVERS

S.No.	Type	Description
1	Location	
1.1		Compressors shall be located to keep suction lines as short as possible.
1.2		The gas compressors shall be located downwind side of fired heater so that leaks are not blown towards fired heater.

S.No.	Type	Description
1.3		In general compressors are to be located under shed if required as per Clause 5.0 Point 18.1. When compressors are located under shed, sides to be kept fully open for the low shed or partially closed from top for high shed to avoid accumulation of heavier gases in the shed, however, in case of hydrogen compressors located under the sheds provision for top venting from compressor sheds shall be provided.
1.4		In case of a turbine driven compressor, if exhaust steam is condensed, turbine and compressor need to be located at an elevated level and condenser to be located below turbine.
1.5		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.
1.6		Intercoolers & Knockout pots may be kept within/outside the Compressor house shed, but, shall be kept near compressor house.
1.7		Compressor manufacturer may be consulted for recommended layout. Licensor's requirement, if any, shall also be taken into consideration.
2	Maintenance	
2.1		For compressors E.O.T/H.O.T as per clause 5.0 S.No. 18.2 to handle heaviest removable piece shall be provided for each compressor house.
2.2		Maintenance bay for compressors shall be provided. Maintenance bay shall be accessible from road to facilitate unloading & loading on to truck etc.
2.3		For removal of bundles of exchangers located within building monorail arrangement shall be provided.
2.4		Compressor manufacturer may be consulted additional requirement for maintenance. Licensor's requirement, if any, shall also be taken into consideration.

3.1.12 ACCESSIBILITY

S.No.	Type	Description
1	Crane access	
1.1		Equipment, Structures shall be arrange to permit crane access to service air coolers, compressors & exchangers
1.2		A clear space for tube bundle removal shall be provided. Dropout bay may be considered for exchangers at elevated structures.
1.3		For High Pressure Exchanger, Shell pulling on rail shall be provided as required.
2	Pumps Maintenance	As per Clause 3.1.7
3	Access to lowering piping components	Clear access shall be provided at grade on the access side for lowering external & internal fittings, PSVs, Control valves etc. from elevated equipment (Column, Tower etc.) by providing pipe Davits.

3.1.13 LAYOUT AND ACCESS REQUIREMENTS FOR PLATFORM

S.No.	Type	Description
1	Platform requirement	
1.1		Air coolers shall have platforms with interconnected walk ways provided to service valves, fan motors and instruments.
1.2		Fired heaters located adjacent to one another shall have inter connecting platforms at various elevations.
1.3		Inter connecting platforms between adjacent towers shall be provided wherever feasible, taking into consideration expansion of towers.
1.4		Platforms shall be provided for columns/vertical vessels as per Clause 5.0 S.No. 35.
2	Access to Platforms - ladders and stairs	
2.1		Two means of access (i.e. two ladders or one ladder and one stair case) shall be provided for any elevated platform, which serves three or more vessels and for battery limit valves operating platform.
2.2		Compressor House and Turbine decks shall have access staircase on either side of the bay. Staircase shall face open area.
2.3		Platforms, ladders & stairways shall be consistent with access & safety requirements.
2.4		Stairway for tanks to be provided on upstream of predominant wind direction.
2.5		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. Maximum distance to escape ladder/staircase shall not be more than 22.65M from any point on the platform. Additional ladders to ensure this shall be provided as required.
2.6		Air coolers platforms shall have Dual access (i.e. one staircase and one ladder).
2.7		Platforms shall be provided with stair access in the case of platforms provided for normal monitoring (once a day or more) or where samples are taken, where vessels or equipment items have operator attention such as compressors, heaters, boilers etc and main pipe rack at battery limits.
2.8		Ladder access shall be provided in the case of platforms for items that require occasional operating access including valves, spectacle blind and motor operated valves, heater stack sampling points and Man-ways above grade on equipment.
3	Ladder Design	
3.1		Wherever practicable, ladder shall be so arranged that users face equipment or platform rather than facing open space.
3.2		Landings shall be staggered. No ladder shall be more than 6M in one flight.
3.3		Ladder shall preferably have side entry to platform.

3.1.14 CLEARANCES

S.No.	Project Philosophy
1	Clearance requirements shall be as per 7-44-0501

3.1.15 ELEVATOR

S.No.	Project Philosophy
1	Requirements shall as per Clause 5.0 Point 17

3.2 UNIT PIPING

3.2.1 BASIS OF UNIT PIPING

S.No.	Project Philosophy
1	Piping & Instrument Diagrams
2	Equipment layout
3	Equipment Data sheet & Setting plan
4	Line list
5	Instrument Data sheet
6	Structural 3D model & building drawings
7	Topography of the plant
8	Piping material specification
9	Overall Plot Plan
10	Proper access to all operating points including valves and for all orifice -tapping points, instruments in particular (refer 7-44-0502).
11	Proper access to interrelated operating points for specific purpose and for maintenance

3.2.2 PIPE WAYS/RACK PIPING

S.No.	Project Philosophy
1	Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.
2	Predominantly process lines are to be kept at lower tier and utility & hot process lines on upper tier. Generally, hot lines and cold lines shall be kept apart in different groups on a tier.
3	Generally the top tier is to be kept for Electrical cable trays (if not provided in underground trench) and Instrument cable ducts/trays. Cable tray laying to take care of necessary clearances for the fire proofing of structure.
4	Generally the bigger size lines shall be kept nearer to the rack column.
5	Minimum 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. Even if flange is not appearing the min. spacing shall be based on above basis only.
6	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.
7	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.

S.No.	Project Philosophy
8	Anchors shall be provided within unit on all hot lines leaving the unit.
9	Process lines crossing units (within units or from unit to main pipeway) 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 be provided.
10	Branches from main headers shall be preferably from top.
11	For pipes at grade level, sufficient ground clearance shall be provided (minimum 300mm) for the flange nearest to the ground from grade, after the insulation cladding, on drain/trap connections for Operational/maintenance access.

3.2.3 COLUMN / VESSEL PIPING & CONTROL VALVES

S.No.	Project Philosophy
1	Piping from column shall drop or rise immediately upon leaving the nozzle and run parallel and close as practicable to vessel. Reboiler outlet piping shall be as short as possible with minimum bends.
2	Piping shall be grouped as far as possible for the ease of supports and shall run on the rack side of the column.
3	Manholes shall be kept on the road side and shall be approachable from the platform.
4	Piping shall be supported from cleats welded on the Vessel. Small bore lines may also be supported from operating platform where taking support from cleat is not feasible.
5	Proper guides at recommended intervals shall be provided for long vertical lines.
6	Access platforms/ladders shall to be provided along the column for valves and instruments as per Clause 5.0 S.No.35. Minimum clear width of platform shall be 750mm.
7	For ease of operation and maintenance, column and vessels which are grouped together, should preferably have their platforms at the same elevation and should be interconnected by walkways where feasible. However each column / vessel shall have an independent access also.
8	Column / vessel platforms should be designed in such a way so that all the nozzles should be approachable from platforms.
9	Piping at columns/vessel nozzles shall be arranged so that blanks can be easily installed for hydrotesting.
10	Unless specifically indicated in P&IDs control valves shall preferably be kept at grade or on technological platforms.
11	Piping intended for vacuum services shall be routed as short as possible with minimum bends and flanged joints.
12	Piping support cleats for safety valves shall be independent and meant for safety valves only. These cleats shall be designed considering impact loading during popping off.
13	Utility Connection nozzles shall be from side/top.

3.2.4 EXCHANGER PIPING

S.No.	Project Philosophy
1	Exchanger piping shall not run in the way of built in or mobile handling facilities.
2	Wrench clearance shall be provided at exchanger flanges.
3	Piping shall be arranged so that they do not hinder removal of shell end and channel cover and withdrawal of tube bundle. Wherever required, to facilitate the removal of tube bundles / head cover, break-up flanges shall be provided in the piping.

3.2.5 FIRED HEATER PIPING

S.No.	Project Philosophy
1	Arrange piping to permit burner removal by providing break-up flanges in the piping. All piping to burner including the utility headers shall have clear head room. The grade shall be kept clear for maintenance and access to the heaters all around.
2	Burner valves shall be located close to the peepholes/sight doors for operation so that adjustment can be made while observing the flame from working level as per Clause 5.0 S.No. 46.
3	Piping to burners shall be arranged so that there are no pockets & shall distribute equal and sufficient quantity of oil/gas to all burners.
4	Block valves for emergency, snuffing steam valve shall be located at the recommended distance from the heater, preferably on the upwind side of the heater.
5	Piping from various passes of heater outlet nozzles should preferably be symmetrical. Transfer line from heater to column shall be as short as possible, without pockets, free draining and with minimum bends.
6	No piping shall be routed in the tube withdrawal area. If unavoidable, break up flanges shall be provided in the piping for removal.
7	Only flexible metallic SS (SS316/SS304) hoses shall be used for burner piping, if required.

3.2.6 PUMP PIPING

S.No.	Project Philosophy
1	Pump drives shall have clear access.
2	Pump suction piping shall be as short as possible and shall be arranged to avoid vapour pockets.
3	Reducers immediately connected to the pump suction shall be eccentric type with flat side up to avoid the accumulation of gas pocket.
4	For pump suction, elbows shall not be directly connected to the suction flange. A straight piece minimum 3 times the line size shall be provided at the suction nozzle.
5	Pump discharge check valve if installed in vertical lines shall be fitted with a drain connection as close as possible downstream of the valve.
6	All small bore piping connected to pump (drain to OWS & CBD, seat and gland leak drain) shall have break up flanges for removal of pumps.
7	Piping shall be so arranged that the forces and moments imposed on the pump nozzle do not exceed the manufacturer recommended values / Double the allowable values of API 610.
8	Pump discharge piping should be routed away from the motor side.
9	Pump cooling water connection shall be taken from the top of circulating cooling water header.

3.2.7 COMPRESSOR PIPING

S.No.	Project Philosophy
1	Suction lines shall be as short as possible
2	Suction piping shall have adequate flanged joints for ease of erection and maintenance.
3	Where the line between knockout drum and the compressor cannot be routed without pocket, low point drain shall be provided to remove accumulation of liquid. The system should be approved by Process.

S.No.	Project Philosophy
4	A minimum straight length of suction pipe shall be provided as per manufacturer's recommendation.
5	Lube oil cooler space shall be provided in a way so as to facilitate tube bundle removal.
6	All operating valves on main suction and discharge piping shall be lined on one side as far as possible.
7	Piping shall be designed so that forces and moments imposed on the compressor do not exceed the manufacturer's recommendation.
8	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.
9	In case of reciprocating compressor, piping shall be suitably supported to avoid vibrations due to pulsating flow. Unless requirements of no pockets are specified by the licensor, all the piping shall run at 500mm above grade level so that proper supports can be provided 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.
10	Reciprocating compressor piping shall be provided independent supports (preferably RCC) from grade and shall not be supported from compressor shed / platform structure.
11	The small bore branches shall be checked for requirement of braced supports
12	Seal gas skid shall be placed below the compressor platform level so as to avoid entry of entrapped liquid in to dry gas seal unless otherwise recommended by Vendor.
13	All the inlet & outlet piping of the compressor and drive shall be routed from one side, to the extent possible so as to enable free space for maintenance.
14	For reciprocating compressor, normal operating valves, strainers, and check valve piping loops shall be in a separate tier to the extent possible to avoid congestion in the compressor platform.
15	Strainers shall be installed at ground / platform level.

3.2.8 RELIEF SYSTEM /BLOW DOWN SYSTEM PIPING

S.No.	Project Philosophy
1	Wherever the inlet line size is higher than the safety valve inlet size, reducer shall be installed adjacent to inlet of safety valve.
2	Relief valve discharging steam, air or other non flammable vapour or gas directly to atmosphere shall be equipped with weep-hole / drain to prevent accumulation of liquid at valve outlet.
3	Liquid-phase blowdown piping connected to a gravity flow closed system shall be self draining to the blowdown system.
4	Liquid-vapour 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.
5	Pockets in the flare header and blowdown system shall be prohibited.
6	Relief valve discharge piping shall be taken to safe location as per following: 3M above top platform of column or structure, within 6M radius for steam and 8M for hydrocarbon/ toxic discharge 25M Horizontally away from fired heater for hydrocarbon. 50M Horizontally away from fired heater, if more than one hydrocarbon relief system of different set pressures is discharging into one common riser of vent stack.
7	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.

S.No.	Project Philosophy
8	Reaction forces including both momentum & static pressure effects due to safety valve popping shall be ascertained in the connected piping according to API RP520 for systems discharging to atmosphere. 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. platform members etc. are capable of withstanding them.

3.2.9 BOILER REGULATION REQUIREMENTS

S.No.	Project Philosophy
1	All statutory requirements as per Indian Boiler Regulations (IBR) shall be met for IBR piping.
2	All materials used on lines falling under IBR must be accompanied with IBR Inspection Certificate in original. Alternatively, photocopy of the original certificate duly countersigned and attested by local boiler inspector is acceptable. Leading inspection authority viz. Lloyds, EIL, CEIL etc are authorised inspection authorities for IBR outside India, whereas, for Indian supply only IBR is the inspection authority.
3	IBR documents for lines falling under IBR must be approved by IBR authority of State in which the system is being installed.
4	All welders used for fabrication of IBR system must possess IBR welding qualification certificate.
5	IBR system shall be designed to comply with IBR regulations as well as ASME B31.3. Design calculations for the same must be approved by IBR authority.
6	IBR approval is obtained with requisite fees payable to Indian Boiler Board of the State concerned.
7	The discretion of IBR authority of state is final and binding for the above cases.

3.2.10 STEAM HEADER AND SUPPLY LINES

S.No.	Project Philosophy
1	Steam header shall be located generally on the upper tier and at one end of the rack adjacent to columns.
2	Branch lines from horizontal steam header, except condensate collection points, shall be connected to the top of the pipe header.
3	Isolation valves (if provided) on the branch line shall preferably be provided on the horizontal run and outside the pipe rack.
4	All branch lines should be drainable. For steam lines, sufficient no of additional drain provisions may be considered during fabrication and unused tappings may be kept blinded.
5	Drip legs & compact steam trap assemblies with integral glandless piston valve and in-built strainer shall be provided at all low points and dead ends of steam header. Steam trap assemblies may be used for 900# and above. Drip legs at low points shall be closer to downstream riser.
6	All turbines on automatic control for startup shall be provided with a steam trap in the steam inlet line.
7	All traps shall be provided with strainers if integral strainers are not provided.
8	Expansion loops are to be provided to take care of the expansions within units.
9	Wherever condensate is to be drained, proper condensate draining facility shall be provided.

3.2.11 STEAM TRACING

S.No.	Project Philosophy
1	Shall be as per 6-44-0007. Material of tracer shall be as per Clause 5.0 S.No. 28.
2	Steam Manifolds shall be located preferably at upper levels in pipe-rack, accessible from a platform whereas Condensate Manifolds shall be located on grade. Manifolds shall be installed in vertical position.

3.2.12 STEAM JACKETING

S.No.	Project Philosophy
1	Shall be as per 6-44-0078. For jacketed lines using high pressure steam, actual calculations for core jacket and feeder pipe shall be performed before finalization.

3.2.13 UTILITY STATIONS

S.No.	Project Philosophy
1	Requisite number of utility stations shall be provided throughout the unit to cater to the utility requirement. Number of utility stations shall be such that all equipments shall be approachable from at least one utility station. The approach of utility station shall be considered 15M all around the station location.
2	Utility stations shall have three connections [one for LP steam (SL), one for Plant Air (AP) and one for Service Water (WS)] each of 1"NB unless otherwise specified in P&ID. Air and water lines shall have quick type hose connection and steam line shall have flanged type hose connection and shall be directed downward. All connections shall have globe valve for isolation purpose. Inert gas hose, when required, shall have built in non return valve and quick connection coupling at piping end.
3	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. Operating platforms having manholes must be accessible from utility station.

3.2.14 ADDITIONAL REQUIREMENTS

S.No.	Type	Description
1	Safety Shower / Eye Wash	As per Clause 5.0 S.No. 16
2	Fire Fighting	Refer General Civil Design Basis

3.3 OFFSITE & YARD PIPING

S.No.	Type	Description
1	General philosophy	In general, offsites piping (except tankages area), electrical cable and instrumentation cable shall be laid as per Clause 5.0 Point 10. Wherever piping is laid on pipe sleepers & hard surfacing/gravel is provided below it, hard surfacing/gravel should be completed before start of pipe laying. Width of hard surfacing/gravel shall be about 1 meter more than the piping corridor on either side. This extra hard surfacing/gravel shall be for movement of operating personnel along the piping corridor. This movement area shall be approachable from the road at a distance of every 500 meters.

S.No.	Type	Description
2	Road Crossings	Pipes at road crossing shall be as per Clause 5.0 Point 12. Culverts / overhead pipe bridges shall be adequately designed to take care of future requirements
3	Layout	
3.1		Clearances between lines shall be minimum 'C' as given below. C=(Do+Df)/2 + 25 mm + Insulation thickness(es) Where, Do - outside diameter of smaller pipe (mm) Df - outside diameter of flange(min 300#) of bigger pipe (mm) However this 'C' spacing between the offsite piping on the rack/sleeper can be suitably increased so that the lines should not touch each other after insulation/lateral expansion.
3.2		Adequate clearance shall be provided for every long & high temperature lines to avoid clashing at the bends. 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.
3.3		Expansion loops for all lines shall generally be kept at the same location.
3.4		Vents shall be provided on all high points & drains shall be provided at all low points. Drain valves at sleeper piping shall be kept outside the sleeperway if the same is not accessible and valves shall be put in horizontal only. At all such places where piping is extended to make drain valves accessible - 2 nos. of stiffeners, irrespective of pipe rating, shall be provided at 90° 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.
3.5		Spacing of guides on each line on a pipe bay shall not exceed the value given in 7-44-0507.

3.4 TANK FARM PIPING

S.No.	Type	Description
1	Layout	
1.1		The number of pipelines in the tank dyke shall be kept minimum and shall be routed in the shortest practicable way to main pipe track outside the tank dyke, with adequate allowance for expansion. Within one tank dyke the piping connected to that tank shall only be routed.
1.2		Manifolds shall be located outside the tank dyke & by the side of the roads, easily accessible by the walkway.
1.3		Special consideration shall be given as regards to spacing of nozzles while installing special item like hammer blind, MOV etc.

S.No.	Type	Description
1.4		Pipe crossing the dyke wall shall pass through a sleeve suitably sealed. Coating & wrapping for pipe sleeves & pipes crossing dyke walls, shall be as requirements of 6-79-0020
1.5		Valves shall be operable from walk ways / platforms. Platforms shall be provided if valves are not operable from walkways.
1.6		Plug valves whenever specified shall be of pressure balance type.
2	Settlement	If exceptionally high settlement is expected, it shall be taken care during stress analysis as per Clause 5.0 Point 27.

3.5 FLARE PIPING

S.No.	Type	Description
1	Layout	Flare header shall be sloped towards flare knock-out drum. Expansion loop shall be provided in horizontal plane 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 400mm.
2	Stress Analysis and supporting	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 knock out drum and water seal drum shall be designed for pressure fluctuations and adequately supported to avoid vibrations.

3.6 UNDERGROUND PIPING SYSTEM

S.No.	Type	Description
1	Design and Layout	As per General Civil Design Basis

3.7 FLEXIBILITY ANALYSIS AND SUPPORTING

3.7.1 PIPE SUPPORTING CRITERIA & GENERAL GUIDELINES

Piping system shall be properly supported taking into account the following:

S.No.	Project Philosophy

S.No.	Project Philosophy
1	Sustained Loads including weight of Piping (Bare pipe, service fluid, valves, flanges etc), Weight of Insulation (if any), - Weight of snow (if any), Weight of online equipments (if any), Weight of instruments (if any). Thermal loads due to operating/design/steam out/decoking or any other possible abnormal condition. Occasional Loads such as Wind/Seismic loads(as and when required). Pressure relief loads due to safety valve operation, Dynamic loads due to pulsating flow/two phase with slug flow, Pressure-Thrust loads in case of expansion joints, Differential settlement for tanks.
2	The design of piping systems shall take into account the different conditions expected during operation, start-up, shut-down, cold branch in case of standby pump, tracing, etc. Hydrocarbon lines shall be designed for steam-out conditions, if so specified in Process document. System where combination of different operating conditions are envisaged, such system shall be analysed for all possible combinations e.g. ejector system etc.
3	All Load cases shall also be checked and qualified in corroded condition for Design code stress checks.

3.7.2 BASIC SPANS, GUIDES SPACING

S.No.	Project Philosophy
1	Pipe supporting shall preferably follow the basic span as given in 7-44-0506 except for flare line in offsite on trestles in which case the basic span shall be restricted to max. 18.0 metres. For sizes not covered in 7-44-0506, 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.
2	Guides shall be provided on straight run of pipes at intervals as specified in 7-44-0507, unless specifically becomes non-viable due to flexibility problems.

3.7.3 SUPPORTING

S.No.	Project Philosophy
1	Guides, anchors, special supports like spring supports and sway braces shall be provided based upon detailed analysis of piping system to restrict the forces on nozzles of critical equipments like pumps, compressors, turbines, exchangers, Air coolers etc.
2	A permanent support, either resting or spring support shall be provided for lines which do not need any supporting otherwise but require supporting during maintenance.
3	In the heaters where steam air decoking provision is there, the main lines and decoking lines should be supported in such a way that either of the lines should not be in the hanging position when not in operation.
4	Piping passing through the technology structure or passing near the concrete column etc. should have adequate space to avoid restriction of line movement during thermal expansion. The gap should take care the thermal expansion along with insulation thickness.

S.No.	Project Philosophy
5	Pipe support design shall be such that deflection in piping systems due to sustained loads shall not exceed 15mm, between two adjacent supports.
6	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.
7	All pipes supports shall be so designed that there is no undue tension on equipment flanges. 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 the same is exceeded, categorical written confirmation of acceptance of the higher loads shall be obtained from the equipment supplier.

3.7.4 CORROSION PAD REQUIREMENT

S.No.	Project Philosophy
1	As per Clause 5.0 S.No. 49.

3.7.5 TRUNNION SUPPORTS

S.No.	Project Philosophy
1	As far as possible long trunnion types of supports (more than 0.5 mtr.) are to be avoided. In case long trunnion support is unavoidable in straight length of pipe, trunnion height to be preferably restricted to 0.5m and balance height to be made up by providing extended structure.

3.7.6 SUPPORTING FOR SMALL BORE LINES

S.No.	Project Philosophy
1	Adequate care shall be taken for small bore (1.5" and below) branch from piping. As a rule, for all lines in 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, e.g. vents, drain, orifice taps, pressure tappings, temperature tapings, sample connections, PSV inlet, TSV inlet etc. shall be provided with 2 number stiffeners at 90° to each other from the main pipe to impart adequate stiffness to the branch connection. The stiffeners shall be made of 6mm thick, 40mm wide 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.

3.7.7 SUPPORTING OF COLD INSULATED LINES

S.No.	Project Philosophy
1	High density PUF blocks shall be considered for cold piping supports. Wooden blocks may be used for load taking supports on vertical lines or as anchor supports.

3.7.8 ANALYSIS TEMPERATURE

S.No.	Project Philosophy

S.No.	Project Philosophy
1	All lines shall be analysed at analysis temperature. In the absence of analysis temperature, lines shall be analysed at operating temperature if difference between operating & design temperatures is less than or equal to 30 deg.C, otherwise it shall be analysed at design temperature. However, analysis of flare line & calculation of thermal growth of tall equipments shall be done as per Process input. All hydrocarbon lines shall be analysed at Steam out temperature. Steam out temperature shall be taken as per the line list. In case of non-availability of line-list, it shall be taken as 30 deg.C less than the saturation temperature of type of steam.

3.7.9 LINES REQUIRING MANDATORY FORMAL ANALYSIS

S.No.	Project Philosophy
1	All process lines to and from fired heaters and steam generators
2	All process lines to and from centrifugal compressor and blower
3	All lines to and from turbines
4	All pump lines (6" & above and analysis temp > 120°C & less than -60°C) & air cooler lines.
5	Reboiler piping, Flare header/sub headers, Jacketed lines, Non metallic Piping
6	All other lines as below: 6" to 8" with analysis temp above 300°C & less than -100°C 10" to 14" with analysis temp above 150°C & less than -80°C 16"& above with analysis temp above 100°C & less than -80°C
7	Lines requiring composite stress analysis (Piping along with Structure and Equipments), Dynamic/Wind/Seismic analysis
8	Lines requiring Flange leakage check, i.e. 26" & above except air & water lines (upto 600 rating) 4" & above for hydrogen lines (900 rating and above) 8" & above, other lines (900 rating and above)
9	All other critical lines (connecting to sensitive equipments). Such as Platefin exchangers, Cold boxes (sizes 6" and above and analysis temp. > 120°C & less than -60°C)
10	For lines involving pulsating flow such as those connected to reciprocating pumps & compressors, in addition to thermal analysis, analog study for acoustic & mechanical vibration shall be done along with equipments, by approved vendor / Agency.
11	Dynamic analysis shall be performed as per Clause 5.0 S.No. 43. The fundamental frequency of the piping system shall be well above the imposed frequencies, if any, to avoid resonance. The minimum acceptable frequency for transfer lines shall be 7 Hz and for remaining lines with slug flow, it shall be 6 Hz.
12	Seismic Analysis shall be performed as per Engineering Technology Development Department Seismic analysis Design Basis.
13	Wind Analysis shall be performed as per Engineering Technology Development Department Wind analysis Design Basis.

3.7.10 ADDITIONAL REQUIREMENTS

S.No.	Type	Description
1	Software	As per Clause 5.0 S.No. 34.

3.8 MATERIALS

S.No.	Type	Description
1	Basic Material of Construction	Basic material selection of particular line depending on its service, temperature and corrosivity shall be as spelt out in process package. Detailed material specification shall follow the requirements stated herewith, except wherever specified as per Licensor's requirement.

3.8.1 PIPE

3.8.1.1 THICKNESS

S.No.	Project Philosophy
1	Calculation of pipe thickness and branch reinforcement shall be based on requirements of ASME B31.3 / IBR as applicable. Proper corrosion allowance and mill tolerance shall be considered while selecting nominal thickness.
2	For carbon steel and low alloy steel pipes minimum pipe thickness shall be as follows: 'S160' up to 0.75"NB(except steam tracing), 'XS' up to 0.75"NB(for steam tracing), 'XS' for 1" to 2"NB, 'STD' for above 2NB.
3	For stainless pipes minimum pipe thickness shall be as follows: '80S' up to 0.75"NB, '40S' for 1"NB to 2"NB, '10S' for above 2"NB
4	The philosophy of minimum thickness / schedule is applicable for both seamless and welded pipes but is not applicable to category -D classes (for services in A3A, A3Yspecs etc), firewater service(A33A) and A10A specification where IS pipes or welded API 5L pipes are being used.
5	All pipes (seamless & welded) shall have uniform negative wall thickness tolerance of 12.5% for wall thickness calculations purpose.
6	For thicknesses exceeding minimum thickness/schedule criteria, schedule XS shall be selected for CS & AS classes (for 2" & above). Intermediate schedules between STD & XS shall be ignored. Similarly for SS classes (2" & above) S10, S20, S30 & 40S may be selected beyond minimum thickness/schedule criteria.
7	Maximum 10% of corrosion allowance may be reduced in special cases, to optimize the pipe schedules.
8	For Cat-D classes, for aboveground applications, 'D/t' ratio shall be taken as 120(max.). For other than Cat-D services, 'D/t' ratio shall be generally restricted to 100 (except for Flare, Cooling water, Vacuum, O/H Vapour and Transfer lines. For these lines minimum thickness specified in clause 3.8.1(2) shall be followed). 'D' is nominal dia. and 't' is nominal thickness.
9	Pipe wall thickness shall be calculated at Class condition except as defined in Clause 3.8.1.2

3.8.1.2 BASIS FOR WALL THICKNESS CALCULATION

In general, the pressure-temperature combination to calculate wall thickness shall be as given. Deviation to this clause can be permitted with specific permission from HOD-Piping and Client.

Material For Groups

Group A
(1) C.S. (A106 GR.B, API-5L GR.B, A672)
(2) LTCS (A333 GR.6)
(3) Low Alloys
(4) 1.25% Cr-0.5% Mo
(5) 2.25% Cr-1.0% Mo
(6) 5%Cr-0.5% Mo
(7) 9%Cr-1.0% Mo
(8) 9%Cr-1.0% Mo-V

Group B
(1) SS (A312 TP304, 304L, 316L, 321,347)
(2) SS (A358 TP304, 304L, 316, 316L, 321, 347)

Group C
(1) Higher Alloys

S.No.	GROUP	CLASS	SIZE	DESIGN CONDITION
1	A	150	upto 24"	Class condition
2	A	150	above 24"	Line condition (Note-1)
3	A	300	upto 14"	Class condition
4	A	300	above 14"	Line condition (Note-1)
5	A	600	upto 8"	Class condition
6	A	600	above 8"	Line condition (Note-1)
7	A	900	upto 8"	Class condition
8	A	900	above 8"	Line condition
9	A	1500, 2500	upto 4"	Class condition
10	A	1500, 2500	above 4"	Line condition
11	B	150	up to 24"	Class condition
12	B	150	above 24"	Line condition (Note-2)
13	B	300	upto 14"	Class condition
14	B	300	above 14"	Line condition (Note-2)
15	B	600	upto 6"	Class condition
16	B	600	above 6"	Line condition (Note-2)
17	B	900, 1500	upto 4"	Class condition
18	B	900, 1500	above 4"	Line condition
19	B	2500	upto 2"	Class condition
20	B	2500	above 2"	Line condition
21	C	150	upto 6"	Class condition
22	C	150	above 6"	Line condition
23	C	300 to 2500	all sizes	Line condition

NOTES:
1. Only If the thickness / schedule as per class condition exceeds XS the thickness shall be calculated based on actual design service conditions subject to a minimum of 80% class rating upto 20mm thickness. Above 20 mm thickness, it should be based on actual/design service conditions subject to minimum 20mm.

2. Only If the thickness / schedule as per class condition exceeds 40S The thickness shall be calculated based on actual design service conditions subject to a minimum of 80% class rating upto 20mm thickness. Above 20 mm thickness, it should be based on actual/design service conditions subject to minimum 20mm.

3.8.1.3 PIPE SIZE

S.No.	Project Philosophy
1	Pipe sizes shall normally be 0.5", 0.75", 1.0", 1.5", 2.0", 3", 4", 6", 8", 10", 12", 14", 16", 18", 20", 24", 26", 30", 36", 40", 44", 48", 52", 54", 56", 60", 64", 72", 78", 80"

3.8.1.4 TYPE

S.No.	MATERIAL	SIZE	TYPE
1	CS, LTCS, AS (except for Cat 'D' fluids)	Upto 14"	Seamless
2	CS, LTCS, AS (except for Cat 'D' fluids)	16" and Above	E.F.S.W.
3	SS (Process lines)	Upto 8"	Seamless
4	SS (Process lines)	10" and Above	E.F.S.W.
5	SS (Non process lines)	Upto 8"	Seamless
6	SS (Non process lines)	10" and Above	E.F.S.W
7	CS (Cat 'D' fluids & Fire water SERVICE)	ALL	Welded
8	CS (LP hydrocarbons offsites)	Upto 6"	Seamless
9	CS (LP hydrocarbons offsites)	8" & Above	Welded

3.8.2 FITTINGS

S.No.	Type	Description
1	Material	
2	Type	Type of Fittings shall be equivalent to pipe type
3	Thickness / Rating	Thickness of fittings at ends to match pipe thickness for BW fittings SW fittings shall be 3000#, 6000#or 9000# depending on the pipe thicknesses S80, S160 and above S160 respectively.
4	Branch Connections	
4.1	Upto 600#	1.5" NB and below : Half Couplings/Tees 2" and above : Tees/Pipe to Pipe with or without reinforcement
4.2	900# and above	Equal tee/unequal tee shall be used for all sizes. In case of non availability of unequal tees, o-lets may be used. Usage of sweepo-let shall be avoided due to poor availability globally.
5	Mitres	Mitres shall be used in Category 'D' service above 6"NB. Elbows(seamless/welded) are acceptable in place of mitres, however, thickness of elbows shall be same as mitres. Seamless elbows are acceptable in place of welded elbows. For other than Category 'D' fluid in 150# and 300# Class mitres can be permitted for sizes above 48". Mitres to be designed as per ASME B31.3. However, use of mitres shall be minimum.

S.No.	Type	Description
6	Unions	Union shall not to be used in lines other than Cat-D water lines.

3.8.3 FLANGES

S.No.	Type	Description
1	Type	
1.1	For 150 class rating	Upto 1.5" : WN RF (with metallic/Spiral Wound gasket) 2" and above : WN RF for CS (other than Cat.D), AS & SS (Cryo) ; LJ FF+Stub Ends for SS other than Cryo SO RF for Cat.D service up to 24" and SO FF for Cat.D service 26" and above
1.2	For 300,600 class rating	Upto 1.5" : SW RF 2" and above : WN RF
1.3	For 900 class rating and above	All sizes : WN RTJ
2	Hydraulic Bolt Tensioning	Shall be performed to the extent and as defined in 6-76-0002

3.8.4 GASKETS

S.No.	RATING	MATERIAL/SERVICE	TEMPERATURE	TYPE	GASKET OR STRIP MATL+FILLER MATL/RTJ GASKET MATL
1	150	CS & SS(utilities & except steam)	up to 371 Deg.C	Spiral wnd/ PLAIN	SS316+Grafoil For AWWA Flanges of size > 24"- BS 7531 Gr. X
2	150	CS & LTCS (Process and steam)	up to 371 Deg.C	Spiral wnd	SS316+Grafoil
3	150	AS (all services)	up to 371 Deg.C	Spiral wnd	SS316+Grafoil
4	300 & 600	CS	up to 427 Deg.C	Spiral wnd	SS316+Grafoil
5	300 & 600	AS	All	Spiral wnd	SS316+Grafoil
6	150, 300, 600	SS (other than utilities)	All	Spiral wnd	SS316+Grafoil (where trim material is SS304/316) SS316L+Grafoil (where trim material is SS304L/316L

S.No.	RATING	MATERIAL/SERVICE	TEMPERATURE	TYPE	GASKET OR STRIP MATL+FILLER MATL/RTJ GASKET MATL
7	300(*), 600(*), 900, 1500 2500	CS	All	Octagonal RTJ	Soft Iron
8	300(*), 600(*), 900, 1500 2500	AS	All	Octagonal RTJ	5Cr-Alloy steel
9	300(*), 600(*), 900, 1500 2500	SS	All	Octagonal RTJ	SS

(*) Only if RTJ is specially mentioned in PMS.

3.8.5 VALVES

S.No.	Type	Description
1	SW Valves	Upto 1.5 inch, for 150#, 300#, 600# (except ball & plug valves).
2	Flanged Valves	Above 1.5 inch for 150#, 300#, 600#. Ball & Plug valves shall be flanged for all sizes.
3	BW Valves	900# and above

3.8.6 STRAINERS

S.No.	Type	Description
1	Y-Strainers	As per Clause 5.0 S.No. 42.1.
2	T-Strainers	As per Clause 5.0 S.No. 42.2.

3.8.7 TRAPS

S.No.	Type	Description
1	Main line drains up to 600# Rating / Steam Supply Manifold	Pre-fabricated Compact Steam Trapping assemblies with thermodynamic Steam traps
2	Main line drain for 900# and above	Thermodynamic/Bimetallic Steam traps with conventional fabricated Steam Trap Assembly.
3	Traps in Steam Tracing Lines	As per Clause 5.0 Point 28
4	Process Traps	As per Process Data Sheets

3.8.8 NDE REQUIREMENTS (IF NOT SPECIFIED IN PMS)

S.No.	Type	Description

S.No.	Type	Description
1	General	Extent of NDE in all cases shall depend on severity of application. In case of any conflict in NDE specifications, more stringent NDE shall apply.
2	No radiography	Category 'D' service as per B31.3
3	10% Radiography of Butt welds and DP/MP testing of Fillet welds	150# Normal Hydrocarbon service, CS, SS & LTCS 150#, 300#, 600# in IBR, Firewater
4	20% Radiography of Butt welds and DP/MP testing of Fillet welds	300#, 600# Normal Hydrocarbon service, CS, SS & LTCS 150#, 300#, 600# up to 3% Cr AS - General Services.
5	100% Radiography of Butt welds and DP/MP testing of Fillet welds	All ratings for Cryo, 5%Cr and above AS, High temp. applications (>500 deg.C), severe cyclic Piping. 900# and above for all services . 150#, 300#, 600# and above for NACE, Caustic - CS& SS. 150#, 300# & 600# and above for hydrogen& oxygen in CS. NACE, Oxygen, Hydrogen, Caustic for all ratings for up to 3% Cr AS.

In case of any conflict amongst the radiography requirements above or any other specifications, the more stringent requirement shall be followed.

3.9 THERMAL INSULATION OF PIPING, EQUIPMENT & VESSELS

S.No.	Type	Description
1	Hot Insulation	As per 6-44-0002
2	Cold Insulation	As per 6-44-0003

3.10 PAINTING

S.No.	Type	Description
1	Shop and Field Painting	As per Clause 5.0 S.No. 23.
2	Colour Coding requirements	As per Clause 5.0 S.No. 24.
3	Environment	As per Clause 5.0 S.No. 21.

3.11 WELDING

S.No.	Type	Description
1	Applicable Codes & Stds.	Process Piping - B31.3 (all requirements) Indian Boiler Regulations (all requirements) ASME BPV Sec. IX(Welding and Brazing Qual.) ASME BPV Sec.V (Non Destructive Examination) ASME BPV Sec.II Pt.C (Welding rods, electrodes & filler materials)
2	Welding Specification	As per 6-77-0001

3.12 MISCELLANEOUS

S.No.	Type	Description
1	Positive Material Identification	Positive material identification (PMI) test at construction site shall be done as per 'Standard Specification for positive material identification PMI at construction site, 6-82-0002'.

4.0 SPECIFIC DESIGN REQUIREMENTS

4.1 HYDROGEN SERVICE REQUIREMENTS

4.1.1 PIPES, FITTINGS AND FLANGES

S.No.	Project Philosophy
1	All carbon steel pipes, fittings and flanges having wall thickness 9.53 mm and above shall be normalised. Cold drawn pipes and fittings shall be normalised after the final cold draw pass for all thicknesses. In addition, fittings made from forgings shall have Carbon - 0.35% max. and Silicon - 0.35% max. The normalising heat treatment shall be a separate heating operation and not a part of the hot forming operation.
2	All alloy steel (Cr-Mo) pipes, forgings and fittings shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psi.
3	For carbon steel pipes, fittings and flanges, hardness of weld and HAZ shall be 200 BHN (max.). For alloy steel, hardness of weld and HAZ shall be 225 BHN (max.).
4	For all Carbon steel and Alloy steel pipes, fittings and flanges with wall thickness over 20mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°Celsius shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 19J (15 ft-lb). If welding is used in manufacture, impact testing of Heat Affected Zone(HAZ) & weld metal shall also be carried out.

4.1.2 VALVES

4.1.2.1 GENERAL

S.No.	Project Philosophy

S.No.	Project Philosophy
1	All valve castings shall be of radiographic quality. All cast valve flanges & bodies with flange rating of class 900 or greater shall be examined in accordance with paragraphs 7.2 through 7.5 of Appendix-7 of ASME SEC-VIII, DIV.1, regardless of casting quality factor. Only Normalized and Tempered material shall be used in the following specifications: Castings : A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12 Forgings : A182 Gr.F11 Cl.2

4.1.2.2 HELIUM LEAK TEST

Body / bonnet / cover joints & stuffing box of all valves shall have low emission. One valve per metallurgy, per rating, per size shall be helium leak tested as per ASME Sec.V, Subsection A, Article 10 (Detector Probe Technique), Appendix IV at a minimum of 25% of the allowable (rated) cold working pressure. Selection of valves for helium leak test shall be at random. Test duration shall be as follows :

S.No.	PRESSURE CLASS	NOMINAL SIZE	TEST DURATION(In Minutes)
1	Upto 300	Upto 2"	3
2	Upto 300	3" to 6"	6
3	Upto 300	8" to 16"	9
4	Upto 300	18" to 24"	9
5	600	Upto 2"	6
6	600	3" to 6"	9
7	600	8" to 16"	9
8	600	18" to 24"	12
9	800 & 900	Upto 2"	9
10	800 & 900	3" to 6"	12
11	800 & 900	8" to 16"	12
12	800 & 900	18" to 24"	15
13	1500	Upto 2"	12
14	1500	3" to 6"	15
15	1500	8" to 16"	15
16	1500	18" to 24"	18
17	2500	Upto 2"	12
18	2500	3" to 6"	18
19	2500	8" to 16"	18
20	2500	18" to 24"	21

The valve shall show no leakage. No leakage is defined as a total leakage rate of less than 0.0001 ml/s of helium.

4.1.2.3 CS & AS VALVES

S.No.	Project Philosophy

S.No.	Project Philosophy
1	Bend test and Magnetic Particle inspection of the entire surface of body and bonnet casting shall be in accordance with ASTM A217. Supplementary requirement S3 & S4 evaluation of magnetic particle, inspection shall be in accordance with MSS-SP-53 except that no linear discontinuities shall be allowed. The Brinell hardness of heat treated casting shall not exceed 200 BHN for carbon steel & 225 for alloy steel. Repair of defective casting shall be outlined in writing to the purchaser before repair starts. Repair method to be approved prior to welding. Casting shall be preheated to a minimum of 400°F prior to welding and all Chromium-Molybdenum alloys shall be postweld heat treated after welding is complete. Stress relieving is essential for welds. Carbon steel shall be normalized and alloy steels shall be normalized & tempered. Dye Penetrant test of welds shall be in accordance with ASTM B165 Procedure B-2. Interpretation as per Appendix-8 of ASME-VIII Div.1. The tensile stress for AS shall be less than 100,000 psi. Charpy V-notch impact testing is to be done for valve material (average 20 ft-lb for set of 3 [minimum value 15 ft-lb] at 30 F). For radiography and acceptance criteria of Valve castings, refer Paragraph 2 of Clause 4.1.2.4(1)

4.1.2.4 SS VALVES

S.No.	Project Philosophy
1	Casting and test bar shall be heat treated together. Valve casting shall be in solution heat treated and pickled condition. Critical body and bonnet casing section typically defined by ASME B16.34 shall be radiographed and shall meet ASTM E446 (upto 2" thick) Category A,B & CA Level 2, Category CB, OC & CD Level 3, Category D,B & F Level 0. For wall thickness 2" to 4.5" comparable plates of ASTM E186 shall be used. ASTM E94 and ASTM E142 shall be used for recommended practice & controlling quality of radiography as guide. The entire surface of all castings shall be dye-penetrant inspected after pickling. Repair welds shall be 100% radiographed and evaluated in accordance with paragraph 344.5 of ASME B31.3 with a minimum casting quality factor of 0.95. Dye Penetration test shall be as per ASTM E165 Procedure B-2, Interpretation as per Appendix-8 of ASME-VIII Div.1.

4.2 TECHNICAL REQUIREMENTS FOR PIPING MATERIAL

This is applicable over and above the requirements specified in Clause 3.8.

4.2.1 GENERAL

S.No.	Type	Description
1	Ends : Unless otherwise specified, the ends shall be to the given standard	SW/SCRD : ASME B16.11 BW : ASME B16.25 FLANGED : ASME B16.5 and ASME B16.47 SERIES 'B' and MSS SP-44 for 22" THREADING : ASME/ANSI B1.20.1 (NPT, Taper threads) up to 1.5" and IS-554 for 2" to 6"
2	Face Finish shall be to MSS-SP-6/ASME B46.1 / ASME B16.5 / B16.47.The interpretation shall be as given	Stock Finish : 250-1000 µ in AARH Serrated Finish /Smooth Finish/125 AARH : 125-250 µ in AARH Extra Smooth Finish/63 AARH : 32-63 µ in AARH
3	Austenitic Stainless Steel requirements	
3.1		All items/parts shall be supplied in solution annealed condition
3.2		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. OR ASTM A262 Practice 'E' with acceptance criteria of 'No cracks as observed from 20Xmagnification' & 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.
3.3		For all items of stabilised SS grades (SS321, SS347), stabilizing heat treatment shall also be done.It shall be carried out subsequent to normal solution annealing. Soaking temperature and holding time shall be 900°C and 4hrs respectively
4	Threaded joints	Upto 204 deg.C, threaded joints shall be made with 1" width PTFE joining tape. Above 204 deg.C, threaded joints shall be seal welded with a full strength fillet weld. All threaded joints, irrespective of pressure and temperature, for critical services including toxic fluid, hydrogen etc shall be seal welded with a full strength fillet weld.
5	Piping used in fire fighting system	Piping used in fire fighting shall be marked as such.

4.2.2 PIPES

Unless specifically exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding.

S.No.	Project Philosophy
1	Spiral Weld pipes shall be acceptable only for Category D and Fire Water services.

S.No.	Project Philosophy
2	Unless mentioned otherwise in the material code, double seam 180 deg. apart is allowed for sizes 36" and larger only.
3	Galvanised Pipes shall be only Hot Dip galv. to ASTM A53.

4.2.3 FITTINGS

S.No.	Project Philosophy
1	All fittings shall be seamless in construction unless otherwise specified.
2	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.
3	All welded fittings shall have maximum negative tolerance equivalent to pipe selected.
4	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.
5	For fittings made out of welded pipe, the pipe itself shall be of double welded type, manufactured with the addition of filler material and made employing automatic welding only.
6	All welded fittings shall be normalized for CS, normalized & tempered for AS; and 100% radiographed by X-ray for all welds made by fitting manufacturer as well as for welds on the parent material.
7	Bevel ends of all BW fittings shall undergo 100% MP/DP test.
8	Those used in fire fighting facilities shall be marked.

4.2.4 FLANGES

S.No.	Project Philosophy
1	Bore of weld neck flange shall correspond to the inside diameter of pipe for specified schedule/thickness. Ends shall be beveled to suit the specified schedule / thickness.
2	For RTJ flanges, only octagonal section ring joint flanges shall be used.
3	Minimum Hardness of groove of RTJ flanges of given materials, blinds and spacers shall be as given : Carbon Steel : 140BHN 1% Cr to 5%, 9% Cr : 150BHN Type 304, 316, 321, 347 : 160BHN Type 304L, 316L : 140BHN
4	For RTJ flanges, blinds & spacers, the hardness of the groove shall be specified on the test report.

4.2.5 VALVES

4.2.5.1 GENERAL

S.No.	Type	Description
1		Valves of Class 900 & above shall be pressure-seal type. Threaded and seal welded or welded bonnet may be employed upto sizes 1.5".
2		All flanged valves (except forged) shall have flanges integral with the valve body. Weld-on flanges shall be made by full penetration joints and 100% radiographed.
3		Yoke material shall be at least equal to body material.

—

S.No.	Type	Description
4		Forgings are acceptable in place of Castings but not vice-versa.
5		No cast iron valves to be used in firewater or any other service except in drinking water service. Valves used in drinking water service shall be of ductile cast iron.
6		Valve under LTCS (Low temperature Carbon Steel temperature below -29°C to -45°C) and cryogenic service (below -45°C) shall meet the requirements of BS-6364 and shall be procured from pre-qualified vendor. Pre-qualification test as per BS-6364 is mandatory regardless of intended service.
7		Face-to-Face/End-to-End dimension shall be as per ANSI B16.10. In case the same is not covered under B16.10, the dimension shall be as per BS 2080/Manufacturer' s Std.
8	By pass arrangement	
8.1	A globe type valve shall be provided as bypass for the given sizes of gate valves. Size of bypass valve shall be 0.5" for main valve up to 4", 0.75" for main valve of 6" and 8" size and 1" for main valves 10" and above.	Class Rating Size of valve requiring bypass 150 26" and above 300 16" and above 600 6" and above 900 4" and above 1500 4" and above 2500 3" and above
8.2		Bypass piping, fittings and valves shall be of compatible material and design. By-pass attachment to the main valve body shall not be screwed. All fillet welds for by-pass installation shall be 100% examined by DP/MP test and Butt-weld joints shall be 100% examined by radiography. NDT of bypass valve shall be in line with main valve.
9	Radiography of castings	All casting shall be of radiographic quality. This requirement to be ensured by sample radiography before proceeding with the actual production. Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME B16.34. Percentage of radiography shall be as given below.
9.1	Hydrogen/Hydrogen bearing hydrocarbons, oxygen, NACE service, stress relieved classes	Class 150 : 50% up to 24" and 100% for 26" & above Class 300 : 50% up to 16" and 100% for 18" and above
9.2	LT/Cryo services	Class 150 : 20% up to 24" and 100% for 26" & above Class 300 : 20% up to 16" and 100% for 18" and above
9.3	Stabilized grades of SS	100% radiography irrespective of size or rating

S.No.	Type	Description
9.4	All services other than those mentioned at 5.8.1, 5.8.2, 5.8.3, Category-D services, Fire water	Class 150 CS : 5% up to 24" and 100% for 26" and above Class 150 AS & SS : 10% up to 24" and 100% for 26" & above Class 300 : 10% up to 16" and 100% for 18" and above
9.5	All services	Class 600 & above : 100% radiography for all sizes
9.6	Category `D" , Fire water	NIL
10	Ball/Plug /Butterfly valve requirements	
10.1		Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves
10.2		Soft-seated ball, plug & butterfly valves shall be supplied with antistatic devices.
10.3		The ball of ball valve shall not protrude outside the end flanges of valve.
10.4	Ball valves shall be of floating ball / trunnion mounted type as given:	150# : Up to 8"-Floating ball;10" & above-Trunnion mounted 300# : Up to 4"- Floating ball; 6" & above-Trunnion mounted 600# and above : Up to 1.5"- Floating ball; 2" & above- Trunnion mounted
10.5		Use of soft seated ball/plug/butterfly valves shall be suitably selected based on temperatures handled.
10.6		Butterfly valves shall be suitable for throttling application.
10.7		For Process (Hydrocarbon) services butterfly valve shall be triple offset, high performance type.
10.8		Quarter-turn valves shall have "open" position indicators with limit stops.
10.9		Fire safe valves shall be used for all Hydrocarbon services.

4.2.5.2 VALVE OPERATION REQUIREMENT

Manual mode of operation shall also be provided for all MOVs. Requirement of Gear operator for manual mode of operation shall be defined below.

Gear operation shall be provided as given. For sizes lower than these ranges, hand wheel / lever / wrench shall be provided. For pressure balance plug valves manufacturer's recommendation shall be acceptable. Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on either side. Effort to operate shall not exceed 35 Kg at hand wheel periphery. However, failing to meet the above requirements, vendor shall offer gear operation.

Group	Valve Type
A	Gate Valve, Globe Valve & Diaphragm Valve
B	Ball Valve / Plug Valve (Other than pressure balance plug valves)
C	Butterfly Valve

S.No.	VALVE GROUP	CLASS	SIZE REQUIRING GEAR-OPERATOR
1	A	150 Class	12" and larger
2	A	300 Class	12" and larger
3	A	600 Class	10" and larger
4	A	900 Class	6" and larger
5	A	1500 Class	3" and larger
6	A	2500 Class	3" and larger
7	B	150 Class	6" and larger
8	B	300 Class	6" and larger
9	B	600 Class	4" and larger
10	B	900 Class	3" and larger
11	B	1500 Class	3" and larger
12	C	150, 300 Class	6" and larger

4.2.6 STRAINERS

S.No.	Project Philosophy
1	Allowable pressure drop when specified shall be certified by vendor along with the offer. If asked specifically, vendor shall furnish pressure drop calculations.
2	All 2" & higher sized Y type strainers shall be provided with 0.75" threaded tap and solid threaded plug as drain connection on the blind flange. For less than 2", this shall be 0.5" size.
3	Bottom flange of Y-type strainer shall not have tapped hole. Full length standard size studs shall be used for joining blind flange.
4	For fabricated strainers, all BW joints shall be fully radiographed and fillet welds shall be 100% DP/MP.
5	All the strainers shall be hydrostatically tested at the lower of twice the design pressure and 1.5 times the class rating as per ASME B16.5 at ambient temperature.

4.2.7 TRAPS

S.No.	Project Philosophy
1	Vendor shall furnish the performance curve indicating the capacity in mass/hour at various differential pressures across the trap.
2	Parts subject to wear and tear shall be suitably hardened.
3	Traps shall function in horizontal as well as in vertical installation.
4	Traps shall have integral strainers.
5	All traps shall be hydrostatically tested to twice the design pressure. Air traps shall be tested at 1.5 times the design pressure.

4.2.8 HOSES

S.No.	Project Philosophy
1	Manufacturer shall guarantee suitability of hoses for the service and working conditions specified in the requisition, even if the material is not specified in the Material Requisition for any particular service.
2	All hoses shall be clearly marked with service and working pressure at both ends.
3	Hoses shall be resistant to ageing, abrasion and suitable for outdoor installations.
4	Complete Hose assembly shall be tested at two times the design pressure.
5	Rubber Steam hoses shall be subject to steam resistance test.

4.2.9 EXPANSION JOINTS

S.No.	Project Philosophy
1	The applicable codes are ASME B31.3 and EJMA (Expansion Joint Manufacturer's Association).
2	Bellows shall be formed from solution annealed sheet conforming to the latest ASTM Spec.
3	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.
4	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.
5	No repairs of any kind are allowed on the bellows after forming. Deep scratches and dents are not acceptable.
6	The out of roundness shall be limited to ± 3mm. This is the max. deviation between the max. & min. diameter.
7	The actual circumference of the welding end shall be maintained to ± 3mm of the theoretical circumference.
8	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 and Moments & forces due to stiffness & pressure thrust due to expansion joint.

4.2.10 SUPPORTS AND SPRING ASSEMBLIES

S.No.	Project Philosophy
1	The Material, Design, Manufacture and Fabrication shall be generally as per MSS-SP-58/ MSS-SP-89 and/or BS 3974.
2	Testing of springs shall be as per BS1726

4.2.11 GASKETS

S.No.	Project Philosophy
1	Asbestos shall not be used for gaskets and fillers.
2	Full face gaskets shall have bolt holes punched out
3	Non-metallic ring gaskets as per ASME B16.21 shall match flanges to AWWA for sizes > 24" unless otherwise specified.
4	Spiral wound gaskets as per ASME B16.20 shall match flanges to ASME B16.5 upto 24", and ASME B16.47 series """"B""""" for sizes > 24" unless otherwise specified.
5	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 SS321, SS347 and H-grade SS classes. e) For classes where temperature is higher than 427°C. f) For 900# rating and above classes.(If PMS specifies spiral wound gasket)
6	In case of RTJ gaskets, only octagonal section ring gaskets shall be used & 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.

4.2.12 STUDS, BOLTS, NUTS

S.No.	Project Philosophy
1	All bolting shall be as per ASME B18.2.1 for Studs, M/C Bolts and Jack screws, and ASME B18.2.2 for nuts.
2	Threads shall be unified (UNC for ≤ 1" dia and 8UN for > 1" dia) as per ANSI B1.1 with class 2A fit for Studs, M/C Bolts and class 2B fit for nuts.
3	Stud bolts shall be threaded full length with two heavy hex nuts. Length tolerance shall be in accordance with the requirement of ASME B16.5
4	The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process.
5	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.
6	Heads of jack screws and M/C bolts shall be heavy hexagonal type. Jack screw end shall be rounded.
7	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 nut.

4.2.13 SPECIAL SERVICE REQUIREMENTS

S.No.	Type	Description
1	IBR	IBR stands for Indian Boiler Regulation. For steam services, it is statutory obligation to meet IBR requirements. For items under IBR material composition restrictions, test reports, painting, etc. shall be as per IBR's stipulations.
2	NACE & Sour Service	For items under this category EIL Standard Specification 'Material requirements for Carbon steel components used in sour service in Petroleum Refinery Environments, 6-79-0013' shall be followed.
3	CRYO & Fire-Safe	For items to be used under LTCS (low temperature Carbon Steel -29°C to -45°C) and cryogenic conditions, temp below -45 0C 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.
4	Impact Tests	Welded Pipes and Fittings used below ASME Temp. -29 °C shall be impact tested as per requirement of ASME B31.3.

4.2.14 INSPECTION AND TESTING

S.No.	Project Philosophy
1	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/data sheets.
2	The examining personnel shall have the requisite qualification and experience.
3	Client and its authorized representative reserve the right to vet and suggest changes in vendor's procedures.
4	Vendor's works and facilities shall be accessible to the Client/Representative at all reasonable times.
5	Test reports for all mandatory as well as supplementary tests wherever specified shall be furnished.

S.No.	Project Philosophy
6	Positive material identification test at vendor's works shall be done as per 'Standard specification for positive material identification PMI at vendor's works, 6-81-0001'.

4.2.15 MARKING

S.No.	Project Philosophy
1	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.
2	For ease of identification, the colour of painted strip (wherever required) shall be as per the applicable standard.
3	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.

4.2.16 DISPATCH

S.No.	Project Philosophy
1	All items shall be dry, clean and free from moisture, dirt and loose foreign material of all kinds.
2	All items shall be protected from rust, corrosion, and mechanical damage during transportation, shipment and storage.
3	Rust preventive on machined surfaces to be welded shall not be harmful to welding and shall be easily removable with a petroleum solvent.
4	Ends shall be suitably protected, and the protectors shall be securely and tightly attached.
5	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.
6	Carbon steel, LTCS and low alloy steel valves shall be painted with one coat of inorganic zinc silicate primer.

5.0 OWNER / CLIENT SPECIFIC REQUIREMENTS

S.No.	Description	Selected Option
1	Equipment spacing (ISBL)	Generally OISD norms / Licensor requirements
2	Minimum pipe rack width (Main Pipe Rack)	As per equipment layout
3	Spare capacity on Rack / Sleeper	10% for Units and 25% for Offsites.
4	Cooling water lines	On rack upto 30" Underground above 30"
4.1	FW lines (in Units)	As per General Civil Design Basis
5	Minimum height of sleeper	300mm (with pavement/ gravel below pipe-way) or 500mm without pavement
6	Air cooler location	On Pipe rack / Tech structure top
7	Location of pumps:	
7.1	In Units	Pump discharge 1m outside rack with motor towards rack
7.2	In Offsites	Open area (no shed)

S.No.	Description	Selected Option
8	Requirements of monorail on pumps:	
8.1	Under pipe rack / shed	In Motor rating 75KW and above for all pumps
8.2	Open area	None
9	Means for Exchanger bundle removal:	
9.1	In Open area at grade and on Tech Structures top floor open to sky	None
9.2	On Tech Structures except top floor open to sky	Hydroextractor
10	Offsites Piping (On sleepers / Pipe Rack)	Generally Pipe Rack, however, sleepers may be considered in localized areas
11	Battery limit valves' operation:	
11.1	OSBL Piping on sleepers	Operable from ground / platform at grade level
11.2	OSBL/ISBL Piping on Piperack	
11.2.1	Valves at grade level	Operable from ground / platform at grade level
11.2.2	Valves at Piperack level	Operable from platform
12	Pipe way road crossing	Culvert / Overhead pipe bridges, as applicable
13	Electrical cable routing underground / above ground	As per Electrical Design Basis
14	Instrument cable routing underground / above ground	As per Instrumentation Design Basis
15	Any requirement of statutory approval.	IBR regulations for projects in India
16	Safety shower / eye wash	As per P & ID, Equipment Layout
17	Requirement of elevators	As per Specific requirement of Client/Licensor
18	Compressor house for ISBL & OSBL:	
18.1	Location	Under shed
18.2	Maintenance requirement	E.O.T(ISBL) H.O.T/ E.O.T (OSBL)
19	Instrument Air Drier Shed	None
20	Insulation material: Hot Cold Safety Electrical heat tracing	Material selection and thickness as per agreed Process Design Basis
21	Type of environment for selection of painting system	Environment as per Job Spec B038-000-79-41-PLS-01
22	Method of surface preparation: Mechanical tools Power tool cleaning Blast cleaning	Blast cleaning (Grit blasting) No sand blasting is permitted
23	Corrosion protection below insulation:	
23.1	CS Pipe (upto 125 DEG C operating temperature)	As per Job Spec B038-000-79-41-PLS-01

S.No.	Description	Selected Option
23.2	SS Pipe: Cold Insulated Hot insulated	As per Job Spec B038-000-79-41-PLS-01
24	Specific colour coding requirements	As per Job Spec B038-000-79-41-PLS-01
25	Usage of IS grade material	Limited to Cat-D services as per ASME B31.3 & Fire water service
26	Usage of asbestos sheet gasket	Not permitted
27	Provision for high settlement in tank farm: Usage of dresser coupling in tank farms Flexibility of piping	Flexibility of piping
28	Steam tracing	Tracer Material as per Process Design Basis Bought out Standard modules of Steam distribution & Condensate Recovery with 'integral glandless piston valves' for Steam Station and 'integral glandless piston valves and trap valve station' for Condensate recovery. Condensate Return station shall have Balanced pressure thermostatic steam traps.
29	Bulk Material Supplier	EIL approved vendor list
30	Engineering Drawing mode	Electronic - ISBL/OSBL
31	Specific software package for engineering drawings:	PDS/PDMS for Units and Offsites. AutoCAD for revamp jobs.
32	Material Control System	EIL in-house software package (for Jobs for which detail engineering is done by EIL) & LSTK Vendor's software for Packages
33	Item Coding system	EIL practice(for Jobs for which detail engineering is done by EIL) & LSTK Vendor's coding for Packages
34	Stress analysis package	CAESAR-II
35	Access to nozzles of columns	Platform for 'manholes, nozzles with valves, spectacle blinds.
36	Staircase / Ladders for tall columns	Ladder
37	Provision of breakup flanges for removal of tube bundles of heat exchangers	Nil / To be established during 3D model review.
38	Height of pipe support pedestals	150 mm
39	Mandatory Bulk Material Escalation	EIL Standard (for Jobs for which detail engineering is done by EIL) & LSTK Vendor's standard for Packages
40	Cathodic Protection of Tankage and U/G Piping	As per SED (Static Eqpt. Dept.) Design Basis
41	Cast iron valves	None, except in drinking water service for sizes 2" NB and above
42	Strainers:	
42.1	Y Type	Upto 1.5" irrespective of service 2" & above in steam service
42.2	T type	2" & above in services other than steam

S.No.	Description	Selected Option
43	Dynamic stress analysis	Required for: Two phase flow lines with slug/plug flow Transfer lines
44	Piping isolation valve for instruments/ Stand Pipes	As per P&ID/ Process Design Basis/Instrumentation Design Basis
45	Disposal of nonrecoverable condensate in units & offsites: Through U/G header to storm water sewer Soak Pit	As per Process Design Basis
46	Sequence of burner piping near peep-doors	Valves to be operable while viewing from peepholes
47	Sea Water Piping	CS with Corrosion Allowance 3.0mm upto 2" size and Cement Lined CS for 3" & above
48	Spiral Weld pipes	IS pipes for Category D services & Fire Water service and API5LGrB, PSL1 pipes for 'Offsites' and 'U/G OWS pipes'.
49	Corrosion Pad on bare pipe	Corrosion pad to be provided for all lines (except lines with shoe support) including small bore lines.
50	Special requirements for Hydrogen service	As per Clause 4.1
51	Accessibility for Instruments (New Units)	As per Engineering Design Basis for Instrumentation B038-999-16-51-EDB-0005

C-2	ENGINEERING DESIGN BASIS
C-2.6	ELECTRICAL

MRPL Marketing Terminal Project at Devangonthi, Bangalore

PROJECT : Marketing Infrastructure Projects, MRPL

OWNER : MANGALORE REFINERY AND PETROCHEMICALS LTD

PMC : NAUVATA ENGINEERING PVT. LTD.

JOB NO. : JBG20005

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04-02-2020	ISSUED FOR BID	ABN	MKV	MKV
C1	09-01-2020	ISSUED FOR REVIEW/COMMENTS	ABN	MKV	MKV

TABLE OF CONTENTS

1. SCOPE

This specification along with the applicable project design data sheet shall form the basis for the design, engineering supply of equipment and materials, erection, testing and commissioning of electrical and other related works i.e. Electrical power system, lighting, earthing, cabling etc. All the equipment's shall comply with this design basis, design data, respective standard specifications, installation standards and other statutory requirements such as OISD/PESO/TAC/CEA, etc.

2. CODES & STANDARDS

The main codes and standards, considered as minimum requirements, as applicable, are as follows. Latest version of these shall be followed:-

(IEC/CENELEC/any other standard may be followed as applicable for the country of origin)

IS-1646	Code of practice for the fire safety of buildings - Electrical Installations.
IS-2189	Code of practice for selection: installation and maintenance of automatic fire detection and alarm system.
IS-2309	Code of practice for the protection of buildings and allied structures against lightning.
IS-3034	Code of practice for fire safety of industrial buildings - Electrical generating and distributing stations.
IS-3043	Code of practice for Earthing.
IS-3646	Code of practice for Interior Illumination.
IS-3716	Application guide for Insulation Coordination.
IS-4051	Code of practice for installation and maintenance of electrical equipment in mines
IS-5216	Guide for safety procedures and practices in electrical work
IS-5571	Guide for selection of electrical equipment for hazardous areas.
IS-5572	Classification of hazardous areas (other than mines) having flammable gases and vapors for electrical installations.
IS-6665	Code of practice for Industrial Lighting.
IS-7689	Guide for Control of undesirable static electricity.
IS-7752	Guide for improvement of power factor - consumer's installations.
IS-8478	Application guide for on load tap changers.
IS-9676	Reference ambient temperature for electrical equipment
IS-10028	Code of practice for selection, installation and maintenance of transformer.
IS-10118	Code of practice for selection, installation and maintenance for switchgear and control gear.
IS-10561	Application guide for Power Transformer.
IS-12360	Voltage bands for electrical installations including preferred voltages and frequencies.
IS-13234	Guide for short circuit calculations in three phase AC systems.
IS-13408	Code of practice for the selection, installation and maintenance of

	electrical apparatus for use in potentially explosive atmospheres.
IS- 15142	Guide to the use of electrical apparatus for potentially explosive atmospheres in the presence of combustible dusts
SP-30	National Electrical Code (NEC) - BIS Publication.
OISD-STD-110	Recommended practices on static electricity
OISD STD-113	Classification of Area for electrical installation at Hydrocarbon and handling facilities
OISD-STD-147	Inspection and safe practices during Electrical Installations
OISD STD-149	Design aspects for safety in electrical systems
OISD STD-173	Fire Protection System for Electrical Installations
OISD STD-180	Earthing and Lightning Protection
IS/IEC 60079-0	Electrical apparatus for hazardous area - General requirements.
IS/IEC 60079-1	Equipment protection flameproof enclosures "d"
IS 5780/IEC 60079-1	Electrical apparatus for explosive gas atmospheres Intrinsic safety '1'
IS-6381/IEC 60079-7	apparatus for explosive gas atmospheres -Increased safety type "e"
IS 7693/IEC 60079-6	Electrical apparatus for explosive gas atmospheres- Oil immersion "o"
IS 7724/IEC 60079-5	Electrical Apparatus for explosive gas atmospheres - Powder filling 'q'
IS 9570/IEC 60079-12	Classification of flammable gases or vapors with air according to their maximum experimental safe gaps and minimum igniting currents
IS/IEC 6007-15	Electrical apparatus for explosive gas atmosphere -Pan-15 Construction, test and marking of type of protection "n" electrical apparatus
IS 3961	Recommended Current ratings for cables
IS 4201	Application guide for CT
IS 3842	Application guide for electrical relays for AC systems
IS 4146	Application guide for VT
IS 1255	Code of practice for installation & maintenance of power cables up to and including 33kV rating
IS 732	Code of practice for electrical wiring installations
IS 1944	Code of practice for lighting of public thoroughfares
IS 13346	General requirements for electrical apparatus for explosive gas atmosphere
OISD-RP-146	Recommended Practices- Preservation of idle electrical equipment's
IS 2026	Oil Filled Transformers
IEC Pub 34	Electrical Motors
IEC pub 79- 10	Classification of Hazardous Areas

IEC Pub 79-2	Pressurized safety equipment
IEC Pub 79-14	Electrical Installations in gaseous explosive atmosphere
IEC Pub 72-1&2	Electrical Motor
IEC Pub 76	Power Transformer
IEC Pub 86	Evaluation and classification of electrical insulation
IEC Pub 529	Enclosure protections classification (IP)
IEC 947-4-1	Low Voltage switchgear and control gear
IS 12459	Code of practices for Fire protection of Cable runs
IS 325	Specification for Three Phase Induction Motors

3. DEFINITIONS & ABBREVIATIONS

The following includes the definition of terminologies and expanded forms of abbreviations.

3.1 DEFINITIONS

The CLIENT / COMPANY / OWNER where used in this document shall mean the ultimate user / owner of the plant and facilities.

The CONTRACTOR / PURCHASER where used in this document shall mean the party, who undertake LSTK / EPC contract for the above project.

The VENDOR / SUPPLIER where used in this document shall mean the party, who manufactures or supplies the equipment and services specified.

The INSPECTOR / TPIA / TPI where used in this document shall mean the PURCHASER / COMPANY or their authorized Third Party Agency for carrying out the inspection.

The PMC where used in this specification shall mean the party, who perform Project Management for COMPANY.

3.2 ABBREVIATION

A	:	Ampere
AC	:	Alternating Current
ACB	:	Air Circuit Breaker
ACDB	:	AC Distribution Board
ASB	:	Auxiliary Service Board
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CCOE	:	Chief Controller of Explosives
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mining and Fuel Research
CPRI	:	Central Power Research Institute

CT	:	Cathodic Protection
DC	:	Direct Current
DCDB	:	DC Distribution Board
DG	:	Diesel Generator
DGMS	:	Director General Mine's safety
DOL	:	Direct On Line
ERTL	:	Electronic Regional Test Laboratories
ELCB	:	Earth leakage Circuit Breaker
ELR	:	Earth Leakage Relay
FM	:	Factory Mutual
FRP	:	Fiber Reinforced Polymer
GI	:	Galvanized Iron
HRC	:	High Rupture Capacity
HV	:	High Voltage
Hz	:	Hertz
IAC	:	Internal Arc Classification
IEC	:	International Electro technical Commission
IEEE	:	The Institute of Electrical and Electronics Engineers
IP	:	Ingress protection
IS	:	Indian Standard
kA	:	Kilo Ampere
kW	:	Kilo Watt
kWH	:	Kilo Watt Hour
LAN	:	Local Area Network
LCIE	:	Laboratories Central des Industries Electriques
LDB	:	Lighting Distribution Board
LED	:	Light Emitting Diode
LOTO	:	Lock-out Tag-out
LSC	:	Loss of service Continuity
LV	:	Low Voltage

MCB	:	Miniature Circuit Breaker
MCC	:	Motor Control Centre
MCCB	:	Moulded Case Circuit Breaker
MOV	:	Motor Operated Valve
MV	:	Medium Voltage
NEC	:	National Electric Code
NFPA	:	National Fire Protection Association
OISD	:	Oil Industries Safety Directorate
ONAF	:	Oil Natural Air Forced
ONAN	:	Oil Natural Air Natural
PCC	:	Power Control Centre
PEM	:	Project Engineering Management
PMCC	:	Power cum Motor Control Centre
PO	:	Purchase Order
PTB	:	Physikalisch-Technische Bundesanstalt
PVC	:	Poly Vinyl Chloride
PT	:	Potential Transformer
PU	:	Polyurethane
RAL	:	Reichs-Ausschuss fur Lieferbedingungen
SF	:	Sulphur hexafluoride
SWG	:	Standard Wire Gauge
UL	:	Underwriter's Laboratory
UPS	:	Uninterrupted Power Supply
V	:	Volt
VCB	:	Vacuum Circuit Breaker
VDE	:	Vendor Data Evaluation
VFD	:	Variable Frequency Drive
VT	:	Voltage Transformer
XLPE	:	Cross Linked Poly Ethylene

4. STATUTORY REQUIREMENTS

The latest version of the following statutory regulations shall be followed for design of electrical system:

a) Indian Electricity Act.
b) Indian Electricity Rules.
c) The Factory Act.
d) The Petroleum Rules.
e) The Mines Act
f) The TAC Rules
g) The NFPA

Requirements of other statutory bodies as applicable, e.g. CEA/ State Electrical Inspectorate, CCOE, DGMS

5. SYSTEM DESIGN PHILOSOPHY

5.1 GENERAL

The electrical system shall be designed to provide:

a) Safety to personnel and equipment both during operation and maintenance.
b) Reliability of Service.
c) Minimal fire risk.
d) Ease of maintenance and convenience of operation.
e) Automatic protection of all electrical equipment through selective relaying system.
f) Electrical supply to equipment and machinery within the design operating limits.
g) Adequate provision for future extension and modification.
h) Suitability for applicable environmental factors.
i) Maximum interchangeability of equipment.
j) Fail safe feature.
k) Energy efficient equipment.
l) Protection against electromagnetic induction (EMI) shall be considered during while designing battery charger/UPS/EPABX/PA Comm /Heater/ Exciter/ MV & HV switchgear/VFD/Soft starters, etc. and other electronic equipment's.

5.2 AREA CLASSIFICATION AND EQUIPMENT SELECTION

5.2.1. All the areas within the battery limits shall be classified for the degree and the extent of hazard from flammable materials as applicable. Classification of hazardous areas shall be done in accordance with Petroleum Rules, DGMS regulations (where applicable), IS-5572, IS-15142, OISD standards and Process Licensors recommendations.

5.2.2. Following factors shall be considered for proper selection of electrical equipment for use in hazardous area:

a) Area classification i.e. Zone-0,1 or 2

b) Gas classification i.e. Group - The characteristic of the gas or vapor involved in relation to the ignition current or minimum ignition energy and safe gap data.

c) Dust classification i.e. Group - The characteristic of the dust involved.

d) Temperature classification - The ignition temperature of the gas, vapor or dust involved or the lowest value of the ignition temperature if more than one combustible material is present.

e) Environmental conditions in which apparatus is to be installed - The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies, water ingress, thermal and mechanical stresses as determined by the environmental conditions.

5.2.3. All electrical equipment installed in hazardous areas shall be selected as per IS-5571 and IS-15142 and shall meet the requirements of relevant IS and Statutory regulations. Ordinary industrial electrical equipment (even though permitted for use in Div.2 area as per NFPA-70) shall not be used in Zone-2 areas. Type of explosion protection to be used for individual equipment shall be as specified in the project design data sheet.

5.2.4. Electrical equipment's for hazardous areas shall be certified by CIMFR/ CPRI/ ERTL/CMRI or equivalent recognized independent test house such as BASEEFA / LCIE I PTB / UL / FM etc. All equipment (indigenous and imported) shall also have valid statutory approvals i.e. CCOE/DGMS/ equivalent as applicable for the country of origin as applicable for use in the specified hazardous area. All indigenous flameproof equipment's shall have valid BIS license and marking as required by statutory authorities.

5.2.5. Selection of Electric equipment in Hazardous area.

a) When certified equipment is not available to meet the specific requirements of the dictated area, equipment certified for more onerous conditions should be employed. For example, in Zone 2 area where equipment certified for use in Zone 2 is not available, then equipment certified for use in a Zone 1 area should be employed.

b) The electrical equipment installed in a hazardous area shall be designed to operate with a maximum surface temperature not greater than the maximum temperature given in the table below.

i) For flameproof apparatus, the surface to be considered is the external surface.

ii) For other type of protection internal surface shall also be considered, if the explosive gas atmosphere has access to them. (E.g. Ex 'e')

iii) According to IS-5572 the apparatus shall be marked with the symbol indicating the class, as shown in table below.

MARK OF CLASS "T" ON THE EQUIPMENT	LIMIT To OPERATION (°C)	CLASS TO OF EXPLOSIVE GAS ATMOSPHERE IN WHICH THE EQUIPMENT CAN OPERATE
T1	450°C	T1
T2	300°C	TI -T2
T3	200°C	TI -T2-T3

T4	135°C	TI to T4
TS	100°C	TI to TS
T6	85°C	TI to T6

5.3 POWER SYSTEM DESIGN

The distribution system shall be designed in accordance with project specification taking into account all possible factors affecting the choice of the system to be adopted such as required continuity of supply, flexibility of operation, operational costs, and reliability of supply from available power sources, total load and the concentration of individual loads.

Special attention is drawn to chapter X of IE rules, which includes requirements for design of electrical system as applicable to Mines and oil fields installation.

5.4 CAPACITY OF ELECTRICAL SYSTEM

All the components of the electrical system shall be sized to suit the maximum load, under the most severe operating conditions. The amount of electrical power consumed by each process unit shall be calculated for its operation at the design capacity. 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. System design shall permit direct on line starting of all motors unless specified otherwise.

5.5 SYSTEM VOLTAGES

System voltages shall be as defined in project design data sheet.

5.6 VOLTAGE DROPS

5.6.1. The maximum voltage drops in various sections of the electrical system under steady state conditions at full load operating conditions shall be within the limits stated in the following table:

Sl. No.	System Element	Maximum Permissible Voltage Drop
a)	Bus duct / Cable between Generator, transformer secondary and Switchboards	0.5 %
b)	Cable between PCC/PMCC and MCC or auxiliary switchboard i) MCC/Auxiliary Switchboard near PCC/PMCC ii) MCC/ Auxiliary Switchboard situated remote from PCC/PMCC	 0.5% (Note-3) 2 % (Note-3)
c)	Cables between HV Switchboard and HV Motor	3%
d)	Cable between PCC/PMCC and MV motor	5%
e)	Cable between MCC (situated near PCC / PMCC) and motors	5%
f)	Cable between MCC (situated remote from PCC / PMCC)	3%

	and motors	
g)	Cable between Auxiliary Switchboard / LDB and Lighting Panel	1.5%(Note-2)
h)	Circuit between lighting panels and lighting points	3% (Note- 2)
i)	DC Supply Circuit (Electrical Controls)	5%
j)	DCDB to Control Room	2% (Note -1)
k)	UPS outgoing circuit	2% (Note -1)

Notes:-

1. Minimum voltage available across any instrument in the field shall be as per instrumentation design basis. Distribution system for instrumentation supplies shall be designed accordingly. In case of any conflict between electrical design basis and instrumentation design basis, the latter shall govern regarding instrumentation power supplies.
2. In case of difficulty in achieving specified voltage drops in cables up to lighting panel, 5% drop from Auxiliary switchboard up to lighting points may be permitted.
3. Higher voltage drop may be permitted between PCC / PMCC and remote mounted MCC/ASB, if overall voltage drop up to motor (from PCC / PMCC) is limited within 5%. For large substations 1% drop may be permitted.

5.6.2. The maximum voltage drop at various buses during start-up of large motor and/or motor Reacceleration conditions shall be within the limits stated below:

Sl. No.	System Element	Operating Condition	Max. Permissible Voltage Drop
a)	At the bus bars of the worst affected Switchboard	Start -up of the large HV motor with other loads on the bus or reacceleration of a group of HV motors (Simultaneous start-up or group reacceleration of HV motors is not envisaged)	15 %
b)	At the bus bars of the worst affected MV Switchboard (PCC/PMCC/MCC)	Startup of large MV motor with other loads on the bus, or reacceleration of a group of MV Motors.	5%
c)	Cables between HV Switchboard and motor	Motor start-up or reacceleration	5% (Note-a)
d)	Cables between MV Switchboard (PCC/PMCC/MCC) and motor	Motor start-up or reacceleration	15% (Note-a)

Notes:-

a) Higher voltage drop in motor cables may be permitted, in case the conditions given in Note b), c) and d) are complied.

b) The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or reacceleration of the motor (even with the motor fully loaded, if required), without causing any damage to the motor.

c) For medium voltage motors, the voltage available at the motor terminals must not be less than 85% of the rated value during start-up or reacceleration.

d) For high voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or reacceleration.

5.7 SYSTEM EARTHING

System earthing for incoming supply and primary/secondary HV distribution system shall be as per Design data. The 415V system neutral shall be solidly earthed.

33 KV system	:	Solidly Earthed
6.6kV system	:	Resistance Earthed
415 V system	:	Solidly earthed
110V DC System	:	Unearthed
110V AC UPS system	:	Earthed

5.8 SHORT CIRCUIT CAPACITIES

Each short circuit interrupting device shall be designed to have rated service short circuit breaking capacity (Ics) equal to or higher than the maximum value of short circuit current calculated, at its location. The related switchgear and bus-ducts shall withstand the above maximum available fault current for a minimum period of one second. The minimum size of high voltage cables shall also be based on the short circuit withstand capacity for a minimum time period as dictated by the protection system as defined in project design data sheet in addition to the maximum anticipated load current. For cables connected in parallel, each cable of the circuit shall be designed to withstand the short circuit current for the given duration.

5.9 INSULATION SYSTEM

The insulation of electrical facilities shall be designed considering the system voltage, the system neutral earthing and the over voltages resulting due to system fault, switching or lightning surges. Lightning arresters and surge absorbers shall be provided where necessary. The insulation coordination between the electrical equipment and the protective devices shall be done in line with IS: 3716.

5.10 PROTECTION SCHEMES

5.10.1. The protective system shall be selected and coordinated to ensure the following:

a) Protection of equipment against damage, which can occur due to internal or external short circuits or atmospheric discharges.

b) Uninterrupted operation of those parts of the system, which are not affected by the fault.

c) Personnel and plant safety.

d) Contact of the downstream 33/6.6/.415kV isolator breaker Numerical relay shall be wired to trip the upstream breaker when the isolator breaker fails to trip during a fault even after getting a trip command from its Numerical protection relay (local breaker failure protection).

5.10.2. Protection relays shall be provided as specified in project design data sheet. Any other protective relay & auxiliary relays shall be provided as per complete system functional requirements

5.10.3. Auto Change Over Scheme:-

Switchgears (HV, MV) to be supplied shall have 2 incomers and 1 no. Bus coupler. Normal operation shall be with 2 incomers 'CLOSE' and the bus coupler 'OPEN'. Upon opening of any of the incomers due to loss of power supply, bus coupler shall be closed through automatic bus transfer, thereby restoring power supply to affected section. Once the power supply is resumed / fault is cleared on affected incomer, closing of the incomer and opening of the desired breaker (any of the incomers or bus coupler) shall be done manually, with momentary paralleling of the two incomers through synchro check relay.

The bus coupler change over scheme shall have two separate relays for monitoring the bus healthy and unhealthy conditions. Preferably healthy bus relay shall be set at 80% setting and un-healthy bus relay shall be set at 40% or less.

For switchboards having Auto transfer facility , opening of incomers on under voltage shall be inhibited if the voltage dip is transient and is experienced on both the incomers simultaneously.

All MCCs shall be provided with two incomers and one bus coupler of 800Amps ACB. Each ACB shall be provided with Numerical protection relay. Paralleling of the MCC incomers shall be possible by manually closing of bus coupler. Auto transfer facility shall be provided at MCC level after tripping the No Volt MCC incomer (1 or 2) after checking the voltage healthiness of the incomer (2/1) and after checking that lock out relay 86 of the MCC incomer that has to be tripped is not operated.

Downstream bus coupler change over scheme shall not be blocked on operation of pilot wire / cable / transformer differential and restricted earth fault protection.

Auto change over scheme shall be PLC logic frame in the Numerical relay to eliminate/minimize unreliable contact multiplier/relays. Auto/independent/ Manual and Trip Selection Switches shall be provided.

All plant feeders which are connected to captive power plant generation bus shall be provided with differential protection. The CT arrangement /Locations for differential protection shall be such that overlapping zones are formed for differential protection provided for HV feeders, Bus couplers tie feeders etc.

Auto transfer shall be inhibited, if the operation of under voltage relay is due to opening of PT fuse/MCB.

The bus coupler closing in the bus transfer scheme shall be blocked after a time delay of about 5 seconds from safety point of view

Protective relays shall be of numerical type with latest version with nonvolatile memory and

shall be suitable for communication with data acquisition system. Relay shall support functions like remote relay parameterization, disturbance recorder, time stamping etc. It shall be possible to set or operate the relay from the front fact a. Lock out relay shall be provided separately and it shall be conventional type with hand rest facility. Numerical Protection Relay shall have RS 485/FO Port with coating on PCBs conformal for G3 environmental protection

Special protections for any feeder such as differential, restricted earth fault directional, distance, power relay etc., shall also be through separate relay having communication facility with data acquisition system

Special protections for any feeder such as differential, restricted earth fault, directional, distance, power relay etc., shall also be through separate relay having communication facility with data acquisition system.

Failure of control supply to the Numerical relay should not trip the breaker/power to the equipment, except generator breaker, elsewhere Alarm shall be generated in annunciation panel located at control room

Process trip & Electrical trip shall be through different master trip relay (86). Process trip relay shall have manual reset flag & self-reset coil. Electrical Master relay flag & coil shall be manual reset type. Both the Master trip relay actuation shall be recorded in Sequence of Events through Numerical relay. In case the necessary indications/Measurements are not possible by means of Relay/Load Managers then necessary I/O modules, transducers shall be provided.

Metering shall be provided to keep a record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc. as specified in project design data sheet.

The minimum metering requirements for the various switchboards shall be as per Electrical design data. The metering requirements of UPS, DC systems, rectifiers, shall be as per the respective equipment specs

Any other metering equipment, if felt necessary to meet system requirement shall be provided by the Contractor. All meters shall be digital communicable type.

The Load managers shall be suitable for communicating to data acquisition system through separate Metering LAN

5.11 DC POWER SUPPLY

Independent DC power supply systems shall be provided for the following (unless otherwise specified):

- Plant shutdown system including DC instrumentation.
- Electrical switchgear controls including critical lighting.

5.12 EMERGENCY POWER SUPPLY

The emergency power supply system, wherever envisaged, shall feed the following:

- Electrical loads essential for the safe shutdown of the plant.
- Emergency lighting.

- Communication system.
- Fire detection and alarm systems.
- D.C. Supply systems.
- UPS Systems.
- Firefighting equipment excluding main firewater pump.
- Lube oil pump motors & fin fan cooler motors or any other motor load as per process requirement
- Loads critical for process, plant and personnel safety.

Emergency power supply could be from a different power source or Emergency Generator as per Project design data sheet. Where Emergency Generator is envisaged, emergency power supply shall be made available within a time period of 30 seconds from the instant of failure of normal supply.

The emergency generator shall, be required to run continuously in parallel with the normal power supply system. Paralleling facility shall be provided for transferring load to normal power supply or other operational needs as required. Accordingly synchronization facility for parallel operation shall be provided.

5.13 UNINTERRUPTED POWER SUPPLY (UPS)

Uninterrupted power supply system shall be provided, (as required) for meeting critical loads that cannot withstand a momentary interruption in voltage (e.g. critical instrumentation, control, Human machine interface (HMI) for numerical relays, fire alarm, LAN system etc.).

UPS system shall have two sets of Inverter and rectifier along with two equal capacity battery banks for critical loads as mentioned above. The backup time of the batteries for UPS shall be according to Electrical Design Data

5.14 POWER FACTOR IMPROVEMENT

Capacitor banks shall be provided, as specified in Project design data sheet, to improve the power factor to meet the minimum stipulated power factor by the power supply authorities.

5.15 PLANT COMMUNICATION SYSTEM

5.15.1. It shall consist of the following:

- Central exchange(s) along with power supply system(s).
- Master control station along with loudspeaker, microphone etc.
- Desk type call stations along with microphone and external loudspeaker for installation in buildings.
- Wall/column mounting type call stations for hazardous/safe areas with external loudspeaker as per Operational requirements.

5.15.2. Paging Speakers shall be suitable for installation in areas having high ambient noise levels without compromising the audibility performance

5.15.3. The construction of the exchange shall be designed and manufactured with both hardware and software to have at least 20% spare capacity for future additions without any major site

modifications. The exchange shall be fully wired for connecting the future field call stations in the speech diagram the plant communication system comprising of central exchange master control station, field call stations, paging loud speakers etc. shall be provided conforming to respective standard specifications and as per block diagram during engineering.

5.15.4. The central exchange & master control station shall be provided in the main control room.

5.15.5. Required no. of field call stations and loud speakers shall be provided to cover all the present operating areas of the OMPL Complex including all process and non-process buildings, but excluding non-plant buildings.

5.15.6. Exchanges located at different locations need to be connected together to function as single exchange during normal operation. It should be possible to establish communication between any two instruments falling in different exchanges. In case of failure of an exchange the other exchanges shall function independently.

5.15.7. Process units & CPP shall have separate exchange located in Master control room & CPP control room respectively. Offsite & Utilities and non-plant buildings shall have separate exchange located in one of the substation for Offsite and Utilities. / non plant building

5.15.8. Communication shall be maintained between these three exchanges (process units, CPP, off site & Utilities/ non-plant buildings).

5.15.9. Redundancy shall be maintained for power supply (In-built supply + Normal/emergency supply), Power supply modules. A dedicated UPS supply shall be provided for plant communication and same shall be supplied by Vendor of PA system

5.15.10. All the spare line modules shall be wired to receive cards in future.

5.16 FIRE DETECTION AND ALARM SYSTEM

5.16.1. The Fire Detection and Alarm System shall be an independent system comprising of individual break glass type manual call points, automatic sensors e.g. smoke/heat detectors, main panel, zonal panel, hooter, battery, battery charger and other hardware. The system shall be designed to provide audio-visual indication at the main panel to be located in fire station and zonal panels, in control rooms. Repeater panels shall be provided as specified in project design data sheet.

5.16.2. Electrical sirens shall be provided to cover entire plant area.

5.16.3. Each panel and each loop / Zone shall have at least 10ko spare capacity. Panel design and component selection shall be done for future extension up to 10%of specified zones or one zone, whichever is maximum in each panel. The design of common facility and hardware shall be provided for required future extension of zones.

5.16.4. Paging speakers shall be suitable for installations in areas having high ambient noise levels without compromising the audibility performance

5.16.5. Electronic Hooters and LED type EXIT lights shall be provided at all required locations in the buildings

5.16.6. The fire detection system shall be interfaced with fire suppression system, HVAC system and plant communication system, clean agent system, Gas detection system, wherever specified.

5.16.7. The technical requirements of Fire Alarm system shall conform to block diagram during engineering and respective Standard Specifications for Fire Alarm System

5.16.8. Fire alarm system shall be micro-processor based intelligent, analogue addressable type for the plant area and Administration building, Production and maintenance building and fire station. For all other Non-plant building areas the Fire Alarm System shall be non-addressable type. For FA system Zones shall be formed & each zone shall have a Zone panel with a common address for identification 'the fire alarm system Zonal panels should have local hooters for alarming the fire occurrence inside respective building.

5.16.9. System shall be designed to provide necessary audio visual signals at control room with mimic panel and repeater control panel. The system shall be hooked with main F & G panel located at the main control room. The repeated panel shall be located near Main Control Room.

5.16.10. System shall comprise of individual break glass type manual call points, smoke/ heat detectors, main panel, hooter, siren, battery charger and other hardware.

5.16.11. Battery and charger shall be provided for each panel separately, rated for complete fire alarm system operation for failure of power supply for at least 48 Hours. FRLS armored cables shall be used for the system.

5.16.12. Detectors and Manual call points can be connected in separate loop.

5.16.13. Response indicators shall be provided for detectors located in hidden location.

5.16.14. A fire siren network with a common control panel at Fire control station shall be provided as per the standard sounds and with timer control to communicate abnormal situations / fire incidents in units/ OSBL areas.

6. EQUIPMENT DESIGN PHILOSOPHY

6.1 GENERAL

Equipment's shall be selected and sized as per philosophy given below:

6.1.1. All electrical equipment's shall be brand new and of make & type as per the vendor list. The final make and type of equipment's shall be subject to approval of Owner/ PMC.

6.1.2. The contractor shall use standard specifications & particular specifications for various equipment's. However for equipment's where specifications have not been attached, the contractor shall use their equipment specifications developed based on the project requirements specified in the bid package and good engineering practices prevalent in petroleum Industry and to ensure satisfactory operational and maintenance requirements.

6.1.3. The equipment's shall in general conform to the latest revision of Indian Standards, IEC/Other International Standards applicable for the country of origin of the equipment.

6.1.4. All electrical equipment's for which standard specifications have been given, shall be subjected to type, routine & acceptance tests as specified therein.

6.1.5. All other equipment shall be subjected to routine and acceptance tests as per the applicable specifications and all type test certificates shall be submitted as a minimum. The type test certificates for all electrical equipment's shall not be more than 5 years old at the time of

contract award. In case this criterion is not met, then the type test shall be conducted before delivery of equipment without any additional cost & schedule impact to owner. Contractor shall specify in their purchase specification the requirement of conducting other special tests/type tests, which are envisaged to be conducted for various electrical equipment.

6.1.6. All equipment shall be epoxy painted and colour shade of all electrical equipment shall be as below.

Outdoor located equipment's	632 as per IS: 5
Indoor equipment's	631 as per IS: 5

6.1.7. Special tools/tackles required for operation & maintenance of equipment's shall be supplied.

6.1.8. HV motors/power feeders, PMCC fed motors and power feeders shall be under Load Shedding scheme. Necessary wiring shall be made for tripping the above with a Load Shedding scheme. Suitable load shedding scheme by means of under frequency relays shall be provided at each unit substation

6.2 TRANSFORMERS

6.2.1. All Transformers except lighting transformers shall be three phase, oil immersed, double wound type suitable for outdoor use, unless otherwise specified. The Lighting transformers shall be three phase, double wound, and dry cast resin type suitable for indoor use, unless otherwise specified. The transformers for variable frequency drive system shall be oil immersed or dry type as per project requirement.

6.2.2. 100% standby transformers (for power, distribution and lighting) shall be provided in all unit, offsite and utility substations, unless otherwise specified.

6.2.3. All the transformers shall be with ONAN cooling unless otherwise specified

The Oil cooled transformers shall be conforming to specs no.

The Lighting transformer shall be dry type conforming to specs no.

6.2.4. In general kVA rating and percentage impedance of each transformer shall be selected to limit the rated current and short circuit current to values which are within the current rating and interrupting capacity of switchgear available.

6.2.5. Transformers rated more than 3150KVA shall have provision for fan cooled rating, unless otherwise specified.

6.2.6. The kVA rating for power, distribution and lighting transformers shall be decided on the following basis and should be as far as possible a standard value.

a) In systems having redundancy for transformers, with transformers with natural cooling

b) I.e. ONAN/AN, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 10% margin for future load growth.

c) In systems having redundancy for transformers, with transformers having forced cooling

d) I.e. ONAF, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 10% margin for future load growth (within 110% of its self-cooled (ONAN) rating) and shall be fitted with automatic forced air cooling fans.

e) Where redundancy in number of transformers is not provided, rating shall be equal to or greater than 8 hour maximum demand plus 10% margin for future load growth. Fan

cooled rating, where provided, shall be reserved as spare capacity for further future load growth.

6.2.7. The rating and no. of various transformer shall be decided based on the following criteria and in addition to that rating shall be decided based on largest motor start-up capability and all possible plant operating conditions with respect to process design and plant operation such as running of normal and standby loads together. The transformer feeding a bus section of PMCC/PCC (HV, MV) shall be capable of feeding the entire load connected in both the sections of its switchgears i.e. during normal operation with bus coupler open, it should be loaded to 40 to 45 % of the capacity at its maximum efficiency point. During failure of the other section transformer say section 2, the section-1 transformer shall take the full load with temperature rise within the limits. Voltage drop with the transformer feeding the entire load and starting the biggest motor or reacceleration of group of motors connected to its switchgear shall be suitably considered for designing the transformer.

i) 11/34.5kV transformers (ONAN)

The ONAN rating of each transformer shall be at least equal to the base load rating of one generator at the entire range of ambient temperature with 10% spare capacity margin.

ii) 33/6.9 KV Transformers (ONAN)

The ONAN rating of each transformer shall be equal or higher than 100% Normal Running Load (Name plate Rating) + 50% Intermittent load (Name Plate Rating) + 10% Standby Load. (Name Plate Rating) with 10% spare margin.

iii) 33/ 6.9 kV Unit Transformers (ONAN)

This is a dedicated transformer for motors above 4000kW and shall be designed for starting of particular motor considering permissible voltage drop specified in the design Data doc. A- 6249-098000 + 10% margin .Overload capacity of the transformer shall not be considered while sizing the transformer

iv) 6.6/0.433 KV Transformer (ONAN)

The ONAN rating of each transformer shall be equal or higher than 100% Normal Running Load (Name plate Rating) + 30% Intermittent load (Name Plate Rating) + 10% Standby Load (Name plate Rating) + 20% spare margin.

v) Lighting Transformers

The lighting transformers shall be sized for 125% of maximum simultaneous demand of the corresponding lighting distribution board. Lighting Transformer shall have off circuit tap changing facility to adjust voltage level. The tapings shall be from 370 Volts to 420 Volts in 5 steps of 10Volts

6.2.8. The oil filled transformers shall be provided with minimum following accessories in addition to those listed in IS: 2026.

Accessories	**11/34.5kV**	**33 /6.9 kV**	**6.6/0.433 kV**
Bi-directional On Load Tap Changer (OLTC)	**		
Off circuit Tap changer	X	X	X
Sampling valve	X	X	X

Conservator drain valve	X	X	X
Tap oil filter valve	X	X	X
Drain cum bottom filter valve	X	X	X
Pressure relief valve	X	X	X
WTI with contacts	X	X	X
OTI with contacts (Dial type)	X	X	X
Double float Buchholz relay	X	X	X
Bi-directional flat roller	X	X	X
Marshalling box	X	X	X
Cross channels with towing	X	X	X
Separate neutral bushing	X	X	X
Disconnecting chamber	X	X	X
Inspection cover	X	X	X
Neutral CTs	X	X	X
Oil Level Transmitter	X	X	X
Magnetic Oil level Gauge	X	X	X
Temp Transmitter for Oil and	X	X	X

** - Refer details else where

6.2.9. PRD of equivalent rating of earlier used Aluminum Diaphragms shall be considered for LT transformers instead of Explosion vents with operation indicator. Pressure built up inside the tank shall be considered to confirm proper operation of PRD without any damage to transformer or any unsafe condition

6.2.10. Transformer Bays shall have RCC Roof. Transformer bays shall be provided with MS gates. (Main Gate for removing the transformer and wicket gate for person entry).

6.2.11. In each transformer bay, 63A power receptacle shall be provided for Oil filtration activities.

6.2.12. Transformer conservator tanks shall have Airce11/F1exib1e separator to prevent direct contact of oi1 surface to atmosphere through breather. Flexible separator should not affect Buchholz operation

6.3 SWITCHGEAR

6.3.1. All switchgear and associated equipment fed from generators and transformers shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration. Generator incomer shall be rated w.r.t. maximum power output of the generator set over entire operating temperature range. Transformer incomer shall be rated at least equal to forced cooled rating of transformer or 110% of ONAN rating as applicable.

6.3.2. Bus tie circuit breakers shall have rating higher of the following:

a) Largest incoming circuit breaker.

b) Maximum running load on either side of bus section.

The tie breaker rating shall not be less than the bus-bar current rating, unless otherwise specified.

6.3.3. All other switchgears not directly fed from generator and transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 20%

future load growth. Incomers of these switchgears shall be designed to cater to the complete load including 20% margin for future load growth.

6.3.4. Spare outgoing feeders shall be provided in all switchgear. For HV Switchboards, the number of spares shall be as indicated in SLD. For other switchboards (and where not specifically indicated in SLD), at least one number of each type of outgoing feeder or 20% of each type of outgoing feeder, whichever is more, shall be provided as spare in the switchboard.

6.3.5. Circuit breakers/contactors controlling motor feeders shall have a rating of at least 125% of the maximum continuous rating of the connected motors.

6.3.6. Separate feeders shall be provided in the switchboard for each load/motor. However, as an exception maximum two numbers welding receptacles may be connected to one power feeder.

6.3.7. All circuit breakers shall be of single break type having one pole per phase. Circuit breakers for MV generator incomer shall be with four poles. Alternatively three pole breaker with adequately rated air break contactor for neutral isolation may be provided.

6.3.8. Rated service short circuit breaking capacities (i.e. Ics) for all breakers and MCCBs shall be equal to or higher than the maximum specified value of the short circuit current at the point of installation. MCCB s with backup fuses shall not be acceptable.

6.3.9. For feeders rated up to and including 630A, MCCBs shall be provided, for the feeders rated above 630A, ACBs shall be provided. However in the feeders feeding power to small rated MCCs/ASBs, switch-fuse feeders shall not be used.

6.3.10. Circuit breakers/switch fuse units for capacitors shall, have a current rating of at least 135% of the capacitor rated current. Circuit breakers capability to interrupt applicable capacitive current shall be specifically verified.

6.3.11. The switchboard components viz. circuit breakers, main horizontal and vertical bus-bars, bus bar joints, bus-bar supports etc. shall be designed to withstand the maximum specified short circuit current for a minimum time of 1 second, unless otherwise specified.

6.3.12. Motor modules shall be fitted with ammeters for motors rated 37 kW and above. Consider selector switch type for remote and local operation in the LV panel for motor feeder.

6.3.13. The maximum rating of bus-bars for MCCs/ ASBs/LDBs should preferably be limited to 800 Amps. Heavy duty type load break switches/ ACB/MCCB shall be used for incoming and tie breakers and these shall have suitable interlocks.

6.3.14. All HV and MV switchboards shall be metal clad. All switchgears and associated equipment's fed from generators and transformers shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration.

6.3.15. Bus tie feeder/circuit breakers shall have equal rating as that of incomer.

6.3.16. Spare outgoing feeders shall be provided in all switchboards. At least one number of each rating and type or 20% whichever is more shall be provided as spare on each bus section.

6.3.17. Circuit breakers/contactors controlling motor feeders shall have rating, at least 25% above the maximum continuous rating of the connected motors.

6.3.18. Starters for all motors shall be provided in the switchboards located in substation. However special cases like MOVS, EOT cranes, etc. they shall be located in the field near the motors.

6.3.19. Separate feeders shall be provided in the switchboard for each load/motor. However, as an exception maximum two numbers welding receptacles may be connected to one power feeder.

6.3.20. For all HV motors and for the motors as identified by Process, CTs shall be provided in the switchgear for feeding ammeter on the local push button station.

6.3.21. For MCCs /PDBs /MLDBs, the maximum rating of bus bar shall be limited to 800Amps. For panels having two Incomers, necessary tie Breaker/SFU shall be provided for bus sectionalizing.

6.3.22. Control Supply for HV breakers /PMCC / MCC breakers shall be 110V DC. For contactor controlled MV feeders, 240V AC supply shall be provided. However for critical MV feeders control supply shall be 110V DC.

6.3.23. Numerical Motor Protection relay shall be used for motors rated above 55kW. For motors rated from 37kW and up to and including 55 kW, earth Leakage protection shall be given with CBCT in addition to BMR and fuse.

6.3.24. All motors rated above 55kW shall have separate earth Fault protection. (If the same is not included in Numerical relay)

6.3.25. The HV switchboards shall conform to its respective standard specification.

6.3.26. The draw out type MV switchboards shall conform to its respective standard specification. i.e. Draw-out type for ACB panels and fixed type for all other feeders (MCCB, MCB).

6.3.27. Wherever, auto/manual changeover is provided, the mechanical CLOSE push button provided on the breaker shall be defeated.

6.3.28. All panels shall be vermin proof.

6.3.29. All the three (3) compartment i.e. breaker/bus/cable shall also be provided with metal barrier sheets for proper isolation. All bus bars shall be completely sleeved and openable shrouds shall be provided on joints. No part of the bus bar shall be kept exposed/bare except at the cable connection ends. Non- hygroscopic barriers shall be provided between phase bus bars and between phase and earth bus bars (for MV switchboards). All breakers and cable compartment shall have phase barriers. No incoming section part of breaker bus bar shall be visible in outgoing compartment

6.3.30. All CTs in all incomers and outgoing feeders in HV & MV switchgears shall be easily accessible on opening the rear door for easy CT mounting and maintenance. CTs shall not be mounted close to the breaker incoming & outgoing cradle terminals.

6.3.31. All motor feeders shall be provided with type 2 co-ordination

6.3.32. Ammeter shall be provided for Motor's space heater circuit on respective motor feeder. (For HV & MV motors)

6.3.33. Care shall be taken during design stage for contactor operated motor feeders with long control circuit leads to avoid capacitance effect, Suitable RC circuit shall be provided.

6.3.34. Separate Marshalling cabinet for each bus section of switchgear shall be provided to cater for DCS/DAS interface requirements. Terminals for DCS/DAS input and output contacts shall be segregated and separate terminal blocks shall be provided. Marshalling cabinet shall have provision for terminating incoming and outgoing multicore copper conductor/F.O armoured cables with required cores and numbers.

6.3.35. Power factor improvement capacitor bank shall be provided to meet reactive power demand

6.3.36. All rear panel doors of HV and MV panels shall be provided with handles for ease of maintenance

6.3.37. All insulators used in the switchboards shall be non-hygroscopic

6.3.38. All CTs shall be of window type only (Bar primary CT or wound primary CTs shall not be used)

6.3.39. Dedicated CTs of class 'PS' shall be provided each for differential and restricted earth fault protection and same shall be marked for easy identification

6.3.40. As a mandatory spare, one breaker of the rating of incomer and bus coupler shall be supplied with each panel

6.3.41. All 33kV HV plant feeders shall be provided with Numerical feeder differential protection relays at both ends working on fiber optic cable. Failure of fiber optic cable shall not trip the feeder and provide an alarm.

6.3.42. 33kV feeder differential protection shall overlap the bus bar differential protection system. Additionally, zone crossover of cable differential with bus bar differential protection shall be provided in upstream/downstream switchboards

6.3.43. Auxiliary supply of bus bar differential protection relays shall be tapped from the respective bus PTs and that of cable differential protection relay shall be from respective Line PT. The location of relays shall be on respective feeders.

6.3.44. Each HV distribution bus section shall be provided with bus bar differential protection with overlap across the bus coupler and should cover the entire switchboard including the bus bar.

6.3.45. Two differential protections shall necessarily overlap each other for reliability of the protection system.

6.3.46. The tripping of each (incoming and outgoing) breaker of a particular switchboard section shall be provided on operation of bus bar differential protection.

6.3.47. No auxiliary CTs for magnitude and phase angle correction of current shall be used. The same shall be achieved by providing suitable algorithms in the Numerical relay.

6.3.48. All differential schemes (including Restricted Earth Fault) shall be adequate with respect to stabilizing resistor)

6.3.49. All transformers with HV primary and secondary windings shall be provided with transformer differential protection.

6.3.50. Each breaker shall be provided with provided with Trip circuit supervision through continuous monitoring in all switchboards and provision of alarm at manned location.

6.3.51. Tripping circuit shall not include the service position limit switch contact.

6.3.52. Only ring type lugs shall be used in CT secondary connections at the CT end and the relay end

6.3.53. The star point of a set of CTs shall be earthed at a single point only.

6.3.54. The inter panel wiring of the differential CTs shall be looped from the same side of the CT TBs in a particular feeder and the differential CT wires of the feeder shall be connected at the other side of the TB for ease of isolation.

6.3.55. The CTs in all the incoming and outgoing feeders in HV and MV switchgear shall be easily accessible on opening the rear door for easy CT maintenance, primary injection and CT replacement.

6.3.56. All the CT and PT dimensional drawings shall be provided with the switchboard drawing.

6.3.57. The CTs in HV switchgear shall have insulation class B and shall have a partial discharge value < 20 pico-coulombs tested at Government approved and recognized laboratories with test certificates.

6.3.58. All outgoing transformer and motor feeders shall be provided with a variable stabilizing resistor in the instantaneous earth fault protection circuit. Contractor shall submit setting calculations for the stabilizing resistor.

6.3.59. The three phase MCB shall have provision to switch OFF/TRIP or switch ON all the three phases simultaneously i.e. all the three poles shall be connected through a connector.

6.3.60. The breaker Service and test position limit switches shall be wired up to the TB and then be hooked up in the circuit.

6.3.61. For motor auto start schemes, only breaker auxiliary contact shall be used and not the multiplied contacts.

6.3.62. Under voltage relay contact multiplication shall be provided through self-reset relay.

6.3.63. Where ever required (based on kW rating of motors) Surge suppressors shall be provided in VCB panels for motors.

6.3.64. The test certificates of the circuit breakers mentioning the closing time, opening time, contact resistance, IR values etc. shall be provided for reference.

6.3.65. Horizontal main bus bar and vertical bus bar for HV Switchgear shall be copper only.

6.3.66. One no earthing truck for Bus earthing and one no earthing truck for outgoing feeder cable earthing for each bus section shall be provided.

6.3.67. Switchgear with bus transfer scheme shall be provided with check synchronizing relay which shall be integrated with overall paralleling scheme.

6.3.68. Running indication shall be taken form auxiliary contact of the breaker. Contact Multipliers should be avoided for closing & tripping operations.

6.4 SYNCHRONOUS GENERATOR AND EXCITATION SYSTEM

6.4.1. The generator capacity at rated voltage and frequency shall be based on turbine maximum output with valves wide open (VWO) and power factor of 0.8. The generator shall be 3 phase, 50 Hz furnished complete with all systems, equipment and accessories required for proper operation.

6.4.2. The excitation system of generator shall be brushless type with permanent magnet generator (PMG) and shall be provided with all equipment and devices required for the monitoring, control, indication, operation and protection of the excitation system and its components.

6.4.3. The excitation control equipment shall consist of an Automatic Voltage Regulator (AVR). The AVR shall have dual channels with follow-up circuit (Dual auto channels with manual control devices and appropriate Auto/Manual change over circuits to ensure smooth transition from one mode of operation to the other). The AVR shall be completely microprocessor based digital type. The AVR reference supply shall be reliable i.e. PMG or UPS. Reference voltage set point adjustment range shall be (-) 15% to (+) 10% of nominal voltage for all loads conditions. The AVR shall provide necessary signal exchange to DCS/ ECS for effective monitoring and control.

6.4.4. The accuracy of the AVR shall be within 0.5% of the set value over the whole operating voltage, frequency and load range of the generator.

6.4.5. The rated current and voltage of the excitation system shall be 110% of the machine excitation requirements at rated output. The ceiling voltage shall not be less than 150% of the machine excitation voltage.

The system shall be capable of supplying the field forcing requirement for at least 30 Secs. The nominal exciter response ratio shall not be less than 2.

For Brushless excitation system, bidder shall provide sufficient parallel diodes to allow for 20% failure without derating excimer.

Portable Stroboscope gun for monitoring of generator field rectifier fuses shall be provided.

6.4.6. The generator shall be capable of synchronizing and not running in parallel with other generating units of similar capacity as well as with grid.

6.4.7. Enclosure degree of protection of generator & excitation system shall be minimum IP-54.

6.4.8. Alternator for Gas turbine shall be WYE connected, two (2) pole (3000 rpm), cylindrical rotor and Alternator for steam turbine shall be WYE connected four pole, 1500RPM, three phases & neutral terminals having following parameters:

a) Terminal Voltage : 11 kV
b) Frequency : 50 Hz
c) Short Circuit ratio : Not less than 0.5
d) 3 Ph. S. C. withstand capacity : As per IEC-34
e) Negative Seq. Current carrying capacity : As per IEC-34
f) Overload capability : As per IEC-34
g) Voltage waveform & THF : As per IEC-34.

6.4.9. Generator unit shall be capable of delivering rated output at rated power factor with:

a) Terminal Voltage variation
b) Frequency Variation
c) Combined Voltage & frequency variation

6.4.10. Temperature rise limited to class B considering ambient temperature as stipulated in other sub-section of this specification and winding shall preferably be designed of VPI (Vacuum Pressure Impregnated) type.

6.4.11. Generator shall be provided with Embedded Temperature detector (ETD) in winding, bearing & cooling air duct and Space heater. Monitoring facility of generator space heater shall be provided by means of ammeter on generator control panel.

ETD shall be platinum resistance, 3 - wire type. Separate terminal box shall be provided for ETDs & Space heater.

The generator shall comply with latest applicable ANSI/IEEE/NEMA/ IEC/IS standards.

An independent CO2 fire extinguishing system for each generator with AC

6.4.12. UPS or DC control supply and with PLC control having 2-0-0-3 logic control for 80 deg C and 100 deg. C generator high trip shall be provided.

6.4.13. The CO2 fire extinguishing system shall have weighing type system for CO2 cylinders with alarm facility on reduction of load

6.5 NEUTRAL GROUNDING CUBICLE

6.5.1. The neutral grounding transformer and loading resistor shall be located in separate cubicles adjacent to each other. The cubicles shall have hinged access doors capable of being pad locked.

6.5.2. The transformer cubicle and resistor cubicle shall be of stainless steel construction. All hardware's required for mounting the NGT and LR shall be of stainless steel.

6.5.3. The neutral grounding equipment shall be completely assembled, wired and connected to the neutral bus tap through seal-off bushing.

6.5.4. The neutral grounding transformer shall be dry type, natural air cooled, single phase connected between generator neutral and ground.

6.5.5. The neutral current transformer shall be cast-resin, ring type, suitably mounted to permit easy removal or replacement.

6.5.6. The loading resistor shall be formed of non-aging, corrosion resistant steel, provided with necessary insulations and designed for indoor service.

6.5.7. All alarm, protection and indication leads shall be wired up to terminal blocks that shall be mounted in a dust tight enclosure suitable for flush mounting and having a fully hinged cover with lock.

6.6 GENERATOR PROTECTION

6.6.1. A dedicated relay panel shall be provided for each generator and each panel shall be provided with redundant relay having redundant control supply. Comprehensive Numerical protection relays with IEC 61850 protocol for each Generator shall be provided considering below minimum

6.6.2. Protection viz. Generator differential protection, (with primary spill current display and IEC protocol), rotor earth fault, over fluxing, 100% Stator E/F etc. which shall not cover under comprehensive numerical relays, shall be covered by providing separate numerical. Plug in type relay with individual base or a common base shall not he used.

6.6.3. All lock-out relays shall be high speed hand reset type relay of VAJH type or equivalent. (ABB make lock out relays are not acceptable)

6.6.4. Direct turbine trip command shall be provided from the turbine controller directly to the Generator master trip lockout relay (86)

6.6.5. Emergency tripping of the generator shall be through two emergency push buttons in series.

6.6.6. Check synchronizing relay contact shall be hooked up in the circuit of the auto- synchronizer for safety of synchronizing operation.

6.6.7. Generator field breaker shall not open if any of the Generator circuit breakers is ON in service position.

6.6.8. AVR shall be provided with limiters and limiter settings shall be made as per generator capability.

6.6.9. Power supply failure alarm shall be provided in all AVRs and under voltage auto changeover scheme for DVAR shall be provided with time delay of 2.5 to 3 seconds.

6.6.10. Harmonic suppression filters shall be provided in the PT input circuit of the AVR

6.6.11. Generator shall trip directly on AVR stage-3 faults. Provision of field forcing limiter with its setting for boosting excitation during faults shall be made.

6.6.12. Complete Generator, bus duct, HV cables and Generator breaker shall be covered under the generator differential protection scheme.

6.6.13. Generator differential protection scheme shall have overlapping feature with bus differential protection scheme.

6.7 GENERATOR CONTROL, METERING & SYNCHRONIZATION

6.7.1. A dedicated Generator Control, metering and synchronizing panel shall be provided for Generator and same shall be located in the Generator control room. Each panel shall be provided with redundant control supply. Control & synchronization (auto and manual) of the generator by means of Generator Circuit Breaker (33kV circuit breakers either Bus- I, II or Bus-II) shall be done from the generator control room through Auto synchronizer & synchro-check relay through Auto-manual selector switch.

6.7.2. All the necessary meters (digital type double voltmeter & frequency meters), LED type synchro scope, Voltage & Frequency control switches, Syn. Switches, Selector Switches, lamps, mimic of generator up to 33kV Switchgear, solid state annunciation (both trip & non-trip) with accept/reset/test push buttons will be provided in the Generator control cum synchronizing panel, located in the control room.

6.7.3. All metering of generator & exciter shall be provided within Generator control cum synchronizing panel. All meters (96 mm sq.) shall be Analogue type, apart from load managers. Following meters shall be included as a minimum

- Ammeter for all the phases
- Voltmeter with Selector Switch
- Frequency meter

- KW & KVAR meters
- KWH & KVARH meters
- Power factor meter
- Generator field metering system
- Transducers for current, voltage, frequency, power factor, KW & KVAR All transducers shall be dual output type with 4-20mA.

Profile of Generator control cum synchronizing panel shall match with other panel located in the same row.

6.8 GENERATOR BUS DUCT AND CABLES

6.8.1. Each generator shall be connected to the generator transformer by segregated phase bus duct or cables.

6.8.2. Segregated phase bus duct shall be used up to cable chamber of generator. Voltage Transformers & Surge arrester (VTSA) cubicle shall be tapped from generator main bus duct.

6.8.3. All phase side CTs shall be located within phase side CT chamber located within generator main bus duct. Each generator neutral terminals shall be taken through segregated phase bus duct and shorted to make neutral point and terminated up to neutral grounding transformer (NGT) cubicle through disconnecting link. Neutral side CTs shall be located within neutral side CT chamber.

6.8.4. All CT secondary terminals shall be brought in CT marshalling box located in convenient position for easy access of cable connection. All VTs within VTSA cubicle are drawing out type including primary side fuses. Separate set of VTs shall be provided for metering, protection & AVR. NGT cubicle of generator shall be provided with secondary loading resistor and grounded through dedicated ground risers.

6.8.5. All Generator CTs shall be window type only.

6.9 NUMERICAL PROTECTION, CONTROL & MONITORING SYSTEM

6.9.1. Numerical protection, control & monitoring system shall be provided for all HV equipment's, HV, MV switchboards and Generators.

6.9.2. The relay shall be as per Engineering Specifications for Numerical Relays

6.9.3. Each Numerical relay shall be provided with dedicated control supply, tapped from the upstream of the control supply switch of the respective feeder. All binary inputs to the numerical relays shall be wired with shielded cables. The relays shall be provided with software password only. Hardware lock etc. shall not be provided. The electronic parts of the Numerical Relay shall be provided with coating on PCBs conformal for G3 environmental protection. Ring type terminals are preferred for numerical relays. It shall be possible to isolate single wire/ multiple wires for line check.

6.10 FEEDER LEVEL FUNCTION

6.10.1. Each feeder in HV switchboard shall have stand-alone protection, metering and control. Relays and control shall be programmable type. Alphanumeric display shall be provided on control console on the panel to display metering. However manual closing/tripping of the breaker shall be done by dedicated breaker control switches with pistol grip handle.

6.10.2. All interlocks between electrical switchboards/ panels and DCS/ Instrumentation panels shall be hardwired.

6.10.3. All relays shall be numerical type providing comprehensive protection as required for each feeder. Relays shall be provided with serial communication interface. It should be possible to program the relays from the work station as well as relay face.

6.10.4. All relays shall be provided with self-diagnostic feature.

6.11 DATA ACQUISITION SYSTEM

6.11.1. Data acquisition system shall be provided for each substation. The server for DAS shall be located in the substation. The work station of DAS shall be located in the Master control Room. Following functions shall be carried out by DAS as a minimum. No control functions are envisaged in DAS. Refer block diagram for DAS (Doc No: 6249- C-00-094-001 Rev 7)

a) Measurement of Electrical System parameters

b) Relay monitoring

c) Time stamping & time synchronization

6.11.2. Substation shall be provided Redundant RTU / Data Concentrators separately for HV & MV Switchgear which in turn shall be connected to main DAS located in the substation by means of redundant FO cables.

6.11.3. Redundancy for communication link between RTU/DC and switch board/ panel shall be considered. Failure of any feeder unit /work station shall not affect balance system.

6.11.4. 20% spare capacity shall be provided in the operator station to cater for future expansion requirements.

6.11.5. The whole system shall operate in a real time mode.

6.11.6. The operator station shall be connected with dual redundant data highway.

6.11.7. The communication protocols for DAS shall be as follows

a) Breaker operated relay to Data Concentrator - IEC-61850

b) Meters to Data Concentrator - MODBUS

c) Data Concentrator to DAS Server -MODBUS TCP IP / IEC 104

6.11.8. Server grade computer shall be considered. Configuration to be suitably chosen to avoid hanging of CPU during multitasking/functioning.

6.11.9. All latest software shall be installed in servers & Firewall PCs etc.

6.11.10. Redundancy shall be maintained at every level e.g.

- Field optical cables
- Microprocessors
- Ethernet communication between master & slave PLC
- Server
- Controllers/Processors

- Communication network
- Ethernet switches
- Power supply

6.11.11. DAS System power supply shall be 110V DC. Dual parallel redundant power supplies shall be provided.

6.11.12. Operator station shall have UPS backup for 1 hour. Printer intermittent load shall be considered while designing the UPS.

6.11.13. One no. Laptop computer shall be provided for fast transfer data from/to the numerical relays control/monitoring module. The Laptop shall be supplied by DAS Vendor.

6.11.14. IEC61850 compliant Ethernet switch /star coupler should be installed in the switchboard. All the numerical relays should be connected to the above Ethernet switch / Star coupler in star topology.

6.11.15. IEC61850 Ethernet switch / star coupler should have redundant Fiber optic ports for the onward connection to Data concentrator.

6.11.16. If the quantity of Ethernet switch / star couplers are more than one in a switchboard, then these Ethernet switches/star couplers should be connected to each other in RING topology and the FO link to the Data concentrator should be provided from First and last Ethernet switch / star coupler.

6.11.17. All the required cables, accessories including laying & termination for connecting the Numerical relay to the Ethernet switch / Star coupler shall be in the scope of Switchgear vendor.

6.11.18. All meters should have MODBUS communication port over RS485. All the meters in a switchboard should be looped as per RS485 standard and the end of the same should be made available in one of the Switchboard. No. of meters per RS485 loop should be restricted to maximum 20. If any switchgear having more than 20 meters should have TWO RS485 loops.

6.11.19. The contractor should provide the marshalling cabinet in the respective switchgear with terminal blocks separately for Digital Inputs and Digital outputs at each substation and wire all the IO's as per the IO list from the individual switchboards (HV and MV) to DAS RTU/DC. This will enable the DAS vendor to take the Input data from a single point at each location. All the required control cables supply, laying and termination shall be in the scope of the respective LSTK contractor. DAS vendor shall lay the required cables from DAS RTU/DC further to DAS system server.

6.11.20. For relays with IEC 61850 protocol, ICD/SCD files along with the I/O list shall be supplied by respective LSTK contractor. For relays/meters with Modbus protocol, required address mapping tables along with I/O list shall be provided by respective LSTK contractor.

6.11.21. Switchboard vendor shall provide all necessary engineering support and all the required documents to DAS vendor. However, any modification/ rectification/ addition in the unit substation system shall be done by respective LSTK contractor.

6.11.22. GPS time synchronization resolution should be 1m sec.

6.12 BUS DUCT

6.12.1. The rating of bus ducts connected to breakers shall have same continuous and short circuit rating as that of breakers. Similarly bus ducts connecting to two bus sections shall have same continuous and short circuit rating as that of main bus bars.

6.12.2. The bus duct shall conform to standard specification

a) The bus bar material shall be Aluminum/CU alloy.

b) Bus bar of bus duct shall be of same material as that of switchgear.

6.13 NEUTRAL GROUNDING RESISTOR

6.13.1. The NGRs shall be rated to withstand the fault current for 10 seconds. The neutral grounding resistors shall conform to specs. 6249- N-163

6.13.2. The resistance value of the NGRs shall be chosen to limit the earth fault current to a value, which shall be sufficient for selective & reliable operation of earth fault protection system, while ensuring minimum equipment damage during an earth fault. However the value of the limited earth fault current shall not exceed 50 % of the full load current of corresponding transformer/ generator.

6.14 BATTERIES

Batteries shall be of adequate capacity to meet the back-up requirements as envisaged in the duty cycle. While sizing the battery, temperature correction factor and ageing factor shall be considered in addition to the maintenance factor. Batteries shall be complete with battery racks and accessories.

6.15 DC POWER SUPPLY SYSTEM

6.15.1. Each DC power supply system shall include battery bank, charger-cum- rectifier and DC distribution board.

6.15.2. The battery charger/rectifier shall feed the load and keep the batteries under fully charged condition. Provision shall also be made for necessary boost charging/initial charging of battery.

6.15.3. The DC system shall have at least 20% spare capacity for future load growth.

6.15.4. Each battery charger and DCDB shall be sized to cater the selected battery capacity.

6.15.5. Each DCDB shall have at least 20% spare feeders with one no of each rating for future use.

6.15.6. The battery & chargers used shall conform to its respective standard specification

6.15.7. Fast acting fuses shall be used with proper co-ordination in charger outlet, DCDB incomer, and all outgoing circuits

6.15.8. All cables of the DC system shall be of copper

6.15.9. One number cell booster each shall be provided which shall be capable of charging any type of cell in the substation/UPS room.

6.15.10. Auto start facility shall be provided to avoid manual start of charging during system under voltage condition

6.15.11. Battery Chargers shall be redundant with common battery set as shown in the Overall Single Line Diagram.

6.15.12. Auto start facility for charger shall be provided to avoid manual start of charging during system under voltage condition.

6.15.13. All cables incoming and outgoing to UPS, DCDB, Battery Chargers and ACDB shall be Copper Cables.

6.15.14. Suitable DC ground fault scheme shall be provided in the DC system.

6.16 UNINTERRUPTED POWER SUPPLY SYSTEM

6.16.1. UPS system shall include battery bank, rectifier transformer, rectifier-cum-charger, inverter, set of filter circuit, static switches, bypass transformer, facility for manual transfer between inverter supply and bypass line, facility for bypassing inverter and static switch for maintenance, AC Distribution board and other associated accessories.

6.16.2. Each branch circuit of the UPS distribution system shall have a fused disconnect switch. The fuse shall be fast clearing type and the fuse rating shall be co- coordinated with the rating of the UPS system. Normally the largest branch circuit load shall not exceed 25% of the UPS system rating.

6.16.3. The UPS systems shall conform to its respective standard specification

6.16.4. The UPS shall be provided with fault diagnostic unit

6.16.5. For Instrumentation, redundant battery bank with capacity of supplying 30 Min backup supply shall be provided for full design rating of UPS.

6.16.6. Each battery bank shall be connected independently to UPS.

6.16.7. Auto start facility for charger shall be provided to avoid manual start of charging during system under voltage condition

6.16.8. Fast acting semi conducting fuses shall be used & properly coordinated for UPS outlets, 110V ACDB incomer and all out going feeders to distribution boards.

6.16.9. All cables of the UPS system shall be copper

6.16.10. The UPS shall be provided with isolation transformers at its input and output

6.16.11. The UPS system used for Instrument supply shall be earthed as per Instrumentation Requirement.

6.16.12. All UPS systems shall be provided with a facility for online discharge of the battery bank on load without any risk to the load

6.16.13. Isolation transformer shall be provided at output of UPS for directly fed instruments like analyzer shelters etc.

6.16.14. UPS system shall be sized to have at least 20% spare capacity for future load growth. Each UPS ACDB shall have at least 20% spare feeders for future use by owner.

6.17 MOTORS

6.17.1. In general, three phase squirrel cage induction motors designed for direct on line starting shall be used. Motors shall be totally enclosed, fan cooled type and suitable for continuous use. Synchronous motors and motors with variable frequency operation, soft starter shall be designed for special application.

6.17.2. All motors shall be continuous maximum rated with possible exception of crane and hoist motors, soot blowers, turbine/engine starting motors etc. which may be rated for the envisaged duty cycle.

6.17.3. DOL start high voltage motors shall be suitable for starting under specified load conditions with 80% of the rated voltage at the terminals and DOL start medium voltage motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the terminals. Voltage available at the motor terminals of large size motors which are started through dedicated transformer shall be decided considering the speed torque characteristics of the driven equipment and ensuring the voltage dip at the source bus does not exceed the permissible limits as per design basis.

6.17.4. The HV (Above 1.1 KV) motors shall conform to its respective standard specification

6.17.5. The MV (Up to 1.1kV) motors shall conform to its respective standard specification

6.17.6. All motors shall be suitable for direct on line starting, unless otherwise any other method is required by process. Please refer Electrical Design Data for detailed requirements of starting methods of motors

6.17.7. Only standard output (kW) rating of motors (applicable for country of origin) shall be used.

6.17.8. All motors shall be continuous maximum rated with possible exception of crane and hoist motors and engine starting motors, which may be rated for the envisaged duty cycle.

6.17.9. Energy efficient (Type- EFF-1) motors shall be used.

6.17.10. Space heaters shall be provided for the motors > 30kW. For fin fan coolers motors the space heaters shall be provided for motors >= 15kW.

6.17.11. Ingress of water through motor shaft/bearing housing shall be prevented using superior felts located inside the bearing housing .Motors shall have FRP canopies fully covering motors including bearing housing

6.17.12. All motors with VFD application shall be provided with insulated bearings.

6.17.13. Re-acceleration for critical identified motors shall be provided to cover brief interruption up to 3sec. in normal power supply. Insulation for these motors shall be designed for 140% of rated insulation level to take care of any over voltages that might result during changeover.

6.18 HV CAPACITOR BANKS

6.18.1. The capacitor banks shall be supplied with series reactor and RVT (residual voltage transformer). All the capacitor bank equipment shall be suitable for outdoor location unless otherwise specified.

6.18.2. The capacitor bank in conjunction with series reactor shall provide minimum net kVAR at rated nominal voltage. The insulation system shall be designed to withstand continuous over voltage of 110%.

6.19 EMERGENCY GENERATOR

6.19.1. The emergency generator set shall be designed to start automatically on power failure and feed the selected loads. It shall be capable of taking care of the load variations (e.g. the starting of the largest rated motor with specified base load). However, DG sizing shall not include boost charging loads for UPS and DC system batteries (but shall only include float charging and service loads).

6.19.2. The regulation of generator voltage shall be automatic and necessary instruments for metering viz., Ammeter, Voltmeter, frequency meter, kWH meter, power factor meter, hour run counter etc. shall be included in control panel. Warning of abnormal conditions shall be incorporated prior to automatic trip to prevent unnecessary shutdown.

6.19.3. The unit shall be complete with necessary engine starting equipment, associated control panel and shall be suitable for remote starting. Emergency Generator shall have auto-starting arrangement but only with manual switching off feature. 'Fail to start' annunciation shall be provided, in case the engine fails to start.

6.19.4. The load shall be automatically switched on to the generator only after the requisite voltage build-up.

6.19.5. The Emergency generator set shall have at least 10% spare capacity for meeting future requirements.

6.20 ANNUNCIATION PANEL

6.20.1. Audio-visual annunciation panels shall be provided, where specified in design data, to monitor the switchgear and other electrical equipment's. In case hardwired panel is not provided, audio visual annunciations shall be provided as part of the HMI system.

6.20.2. Detailed annunciation schedule shall be based on but not limited to the following:

a) HV Switchgear

- Breaker-wise fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Trip circuit status for each breaker
- Differential relay operation alarm
- Transformer trouble alarm

- DC supply failure alarm (Bus wise)
- PT secondary MCB trip alarm for all line and bus PTs
- Bus wire supervision alarm

b) MV Switchgear

- Incomer/Bus coupler fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Bus-wise group fault trip alarm for outgoing feeder breakers
- D.C. supply failure alarm (Bus-wise)
- PT secondary MCB trip alarm for all line and bus PTs.

c) Operating status/fault conditions for UPS system.

d) Operating status/fault conditions for DC supply system.

e) Operating status/fault condition for DG sets.

f) Fault alarm for VSD panels.

6.20.3. Annunciation panel shall be complete with acknowledge, test and reset pushbuttons.

6.20.4. 10% spare windows for future use shall be provided in the panel.

6.20.5. Generally, annunciation panel shall be fed from the UPS system/ DC system.

6.21 CABLES AND WIRES

6.21.1. HV cables shall be dry cured XLPE insulated, extruded PVC sheathed, armoured type with stranded aluminum/copper conductors. Conductor & insulation screens, PVC inner sheath Armour & FRLS PVC outer sheath. The screen for the HV cables shall withstand earth fault current for one second. Water swell able type hygroscopic tape shall be provided below inner sheath. The cable shall be Tree Retardant type all cables rated 3.8 kV/6.6 kV and above shall be provided with both conductor screening and insulation screening.

6.21.2. MV power cables shall be XLPE insulated, PVC sheathed, armoured type with stranded aluminum/copper conductors.

6.21.3. The control cables shall be XLPE insulated, extruded PVC sheathed, armoured type with copper conductors. Special cables e.g. twisted pair or shielded control cables etc. shall be used as applicable for numerical relays, VFDs etc. to suit selected equipment as per equipment supplier's recommendations.

6.21.4. The cables shall be sized based on the maximum continuous load current, the voltage drop, system voltage, system earthing and short circuit withstand criteria as applicable. The derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil, etc. shall be taken into account.

6.21.5. Cables connected in parallel shall be of the same type, cross-section and terminations.

6.21.6. As an exception within substation areas, unarmored cables may be used, if specifically agreed upon.

6.21.7. All power and control cables shall be in continuous lengths without any splices or intermediate joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Unless otherwise agreed, cable joints in hazardous areas shall not be permitted.

6.21.8. All incoming cables to switchgear/UPS/DC system/DBs and other equipment shall be sized for maximum anticipated load including 10% future growth. Cable for capacitor banks shall be sized for 135 % of the rated capacitor current.

6.21.9. The incoming cable for heat tracing power distribution panel shall be with four cores, the neutral conductor being of same size as the phase conductors.

6.21.10. All control cables shall have minimum 20% spare cores, except that control cables having up to seven cores may have one core as spare.

6.21.11. The power & control cables shall conform to its respective standard specification

6.21.12. Following cables shall be of Copper conductor.

a) All incoming and outgoing cables from UPS, ACDB DCDB, Battery and Battery charger.

b) Incomer cable to Emergency Switchgear from EMDG

c) Power cables up to 16sq.mm

6.21.13. All control cables shall be with stranded copper conductor, XLPE insulation, armoured, PVC outer sheathed.

6.21.14. The minimum cross sectional areas for cables shall be as per enclosed Electrical design data. AVR output cable size shall be suitably designed depending upon the distance between the AVR and Exciter

6.21.15. Three Core Power cables shall be used for all motors (MV/HV)

6.21.16. The cables shall be sized based on the maximum continuous load current, the voltage drop, system voltage, system Earthing and short circuit withstand criteria. The derating due to ambient air temperature ground temperature, grouping and proximity of cable with each other, thermal resistivity of soil etc. shall be taken into account.

6.21.17. Cables connected in parallel shall be of the same type and cross-section. Further, each length of cable connected in parallel shall be designed to withstand short circuit current for the given duration

6.21.18. All power and control cables shall be in continuous lengths (except for long feeders) without any splices or intermediate joints in no case joints shall be located in hazardous areas. The cable used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals.

6.21.19. All incoming cables to switchgear/UPS/DC system/DBs and other equipment shall be sized for actual rated capacity of the equipment as well as harmonic currents as applicable. Cable for capacitor banks shall be sized for 130% of the rated capacitor current.

6.21.20. Separate control cables shall be used for each of the following CT secondary circuit.

6.21.21. PT secondary circuits. Interlock/inter trip circuits. Pilot wire differential circuits.

6.21.22. DC signals between instrumentation & electrical equipment's. AC signals between instrumentation & electrical equipment's. Switchboards to each local control stations.

6.21.23. However, the above stipulation will not apply to control cable for local control stations with ammeter.

6.21.24. Multicore / multi pair control cables shall have minimum 20% spare cores.

6.21.25. Outer sheath of All HV /MV cables shall have FRLS &anti-rodent properties.

6.21.26. Screened cables shall be used for all VFD drive applications.

6.22 CONTROL STATION

6.22.1. Each motor shall be provided with a control station/control panel in the field, unless otherwise agreed upon. Emergency stop push control station for air cooler motors at grade level and transformer bay shall also be provided.

6.22.2. The control station shall include the following equipment as per individual requirement:

- Start/stop push button
- Ammeter
- Auto/Manual or Local/Remote selector switch (if specified)
- Indication lamps etc. (if specified)

6.22.3. Stop push button shall generally have stay put feature except in the case of critical drives such as lube oil pump etc. Each motor shall be provided with a control station in- the field unless otherwise a specific requirement form the Package vendor.

6.22.4. The control station enclosure shall have suitable protection for site conditions (such as flameproof, weather proof. dust proof, corrosion resistant etc.).

6.22.5. UV protected FRP Canopy shall be provided to protect outdoor control stations against rain.

6.22.6. The control station shall include the following equipment as per individual requirement:

- Start/stop push button or TNC switch (for breaker operation)
- Ammeter for All motors having rating above 55 kW (For process requirement)
- Local /Remote Switch
- Cable glands.

6.22.7. Stop push button shall generally have stay put feature except in the case of critical drives such as lube oil pump etc. All motors having auto start/ remote start provision shall have a nameplate to these effects on the LCS.

6.22.8. All control stations shall be provided IP 65 protection.

6.22.9. The flameproof control stations & industrial type control stations shall conform to standard to its respective standard specification.

6.23 CONVENIENCE RECEPTACLES

6.23.1. These shall have the necessary mechanical interlocks and earthing facilities. The enclosure shall have suitable protection for site conditions specified (flame proof, weather proof, dust proof, corrosion resistant, etc.).

6.23.2. Adequate number of three-pin sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 15 m length of cable to all manholes of

process equipment's and other important areas in the process units. These shall be rated for 15A, 240 V single phase with earth connection. Hand lamps and portable tools shall be earthed through flexible cords. In hazardous areas, flameproof hand lamps shall be rated for 24V.

6.23.3. The enclosure shall have suitable protection for site conditions specified (explosion proof, weatherproof, dust proof, corrosion resistant) etc.

6.23.4. Adequate number of welding receptacles shall be provided at suitable locations to ensure accessibility with a 30 meters length of trailing cable to any point in the process area and substation. These shall be rated for 63A suitable for 415V, 3 phase system with a scraping earth. Minimum welding receptacles shall be two no's in each area. Welding sockets shall be fed from four pole MCCB feeder having 100mA earth leakage protection and shall have shunt trip.

6.23.5. Adequate number of three-pin sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 15 meters length of cable to all manholes of process equipment's. These shall be rated for 15A, 240 V single phases with earth connection. Hand lamps and portable tools shall be earthed through flexible cords. In hazardous areas, hand lamps shall be rated for 24V. Accordingly 240/24V transformers shall-be provided either in the plug or in a separate flameproof enclosure.

6.23.6. The flameproof plugs receptacles and hand lamps shall conform to its respective standard specification

6.24 ACTUATORS FOR MOTOR OPERATED VALVE

6.24.1. MOVs shall be provided with integral 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 the 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 circuit may be A.C. operated for short distance and D.C. operated for extended distances, where required. The MOVs shall be provided with integral starters and shall conform to Instrumentations specifications for MOV.

6.24.2. Necessary contacts and other interfacing devices for integration with control room shall be provided as per process requirement

7. SUBSTATION / MCC ROOM DESIGN PHILOSOPHY

7.1 The sub-stations shall be located in a safe area close to the load center. Proper access shall be provided/ ensured for operation/ maintenance of indoor and outdoor equipment.

7.2 HV sub-station floor shall be raised above grade level and the space below the switchgear room shall be utilized as cable cellar. The cable cellar floor shall be at least 300 mm above the approach road level and shall be paved and cemented. The cable cellar shall have a minimum clear height of 2.5 m and shall house all cable trays and their support.

7.3 MV sub-stations and MCC rooms shall be elevated by compacting the soil so that

a) The finished floor level shall be above the approach road level to the building.

b) The finished floor level shall be minimum 1000 mm above the surrounding grade level.

c) The bottom of the cable trench within sub-station is minimum 150 mm above the surrounding grade level.

7.4 In addition to the entry to substation for operating personnel, a separate entry of minimum 3m x 3m with motorized rolling shutter shall be provided for drawing in all equipment for installation.

The main entry for operating personnel for pressurized substations shall be provided with double door system with an airlock lobby. The Sub-station shall also have an emergency door opening outwards.

7.5 Sub-station wall adjacent to the transformer bays and walls separating transformers shall be 355 mm thick (inclusive of plastering) in case of brick construction or 230 mm thick in case of RCC construction.

7.6 Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization, unless otherwise specified.

7.7 Battery banks shall be located in a separate adequately ventilated room in the sub-station buildings, along with the necessary exhaust system and water connection with sink. Floor of the battery room and walls up to 1.5m height shall have acid/alkaline resistant protective epoxy coating. Light fittings in this room shall be chemical resistant type. However, separate battery room is not required in case of VRLA batteries, as the VRLA batteries can be located in the room housing chargers and UPS systems.

The battery rooms shall be provided with minimum two exhaust fans and louvered opening in opposite wall/door.

7.8 UPS system and other power electronics equipment e.g. variable frequency drive panels, battery chargers, thyristorised heater control panels, etc. shall be located in air-conditioned room, unless otherwise specified in project design data sheet.

7.9 Sub-station shall have fire extinguishers, first aid boxes and other safety equipment as per statutory requirements. Insulating mats of required voltage rating shall be provided in front of switchboards.

7.10 Separation walls between transformers in all substations and safe inter transformer distances for switchyard transformers shall be as per OISD-STD- 173.

7.11 Equipment like transformers, neutral grounding resistors, reactors and HV capacitor banks shall be located in bays adjacent to the sub-station building. All bays shall have well drained floor, surfaced with gravel or other suitable material.

7.12 In order to prevent oil, whether from a small leakage or outflow from transformer tank, from reaching and polluting the water bearing stratum, transformers shall have the following provisions, depending on the oil capacity of the transformer

7..12.1. <u>Oil Capacity up to 2,000 liters:</u>

Transformers installed adjacent to sub-station/buildings or in Switchyards shall be provided with a layer of 100 mm deep stones of about 40 mm granulation, all around the transformer, for a width of 20% of the transformer height subject to minimum width of 800 mm.

7..12.2. Oil Capacity exceeding 2,000 liters:

Transformers installed adjacent to sub-station/building or in Switchyards shall be provided with oil containing pits.

The oil containing pit may be shaped as per OISD STD-173. The pit shall extend all around the transformer for a width of 20% of the transformer height, with a minimum width of about 800 mm around the transformer tank/radiator. In case oil capacity exceeds 9,000 liters, in any chamber, provision shall be made for draining away of any oil, which may escape or leak from the tanks, to a waste oil tank.

7.13 The substation building shall be sized to maintain adequate clearances between equipment for ease of maintenance. The following minimum clearances around various equipment shall be maintained:

Sl. No.	Location	Clearance
a)	Front clearance for HV switchboard	2500 mm
b)	Front clearance for all other switch boards/panels	2000 mm
c)	Rear clearance for panels having maintenance access from front only	Less than 200mm or more than 750 mm
d)	Rear clearance for panels requiring maintenance from rear	1500 mm (HV SWBD) & 1000 mm (MV SWBD)
e)	Side clearance between two switch boards or from nearest obstruction	1000 mm after Considering space for future panels
f)	All around clearance for transformers	1000 mm
g)	All around clearance for NGR	1000 mm on two sides, 200 mm on other two sides
h)	All around clearance for capacitor bank/ series reactor	1000 mm
i)	Battery rack to wall clearance for • Single row, single/double tier • Double row, single tier	• 100mm • 100mm
	• Double row, double tier • Multistep racks	
j)	Battery rack to rack clearance	750mm
k)	Head room clearance below bus ducts or any other overhead equipment	2500mm
l)	Front clearance for wall mounted equipment	1000 mm
m)	Front clearance for operation station/ annunciation/control panel	2500mm

Vertical clearance above the top of the highest equipment shall be minimum 1500mm measured from bottom of roof slab (except transformer bay where same shall be 1000 mm) and minimum 500 mm measured from the bottom of the lowest roof beam. However for the areas with false ceiling, minimum clearance of 1000 mm shall be provided between false ceiling and top of any equipment.

7.14 In all Substations/ MCC rooms, space for future extension of switchboards shall be provided. One panel extension space on each side (for each Bus section) or two panel extension space on one side (in exceptional cases) shall be provided for all HV Switchboards, PCCs, MCCs and ASBs. In addition, space for future extension of the substation/ MCC room building shall be considered, as specified in project design data sheet.

7.15 The DG sets shall be preferably located in a separate building other than the substation, in a safe area to reduce noise level in substation. However in case the same is located in the substation building, the DG set foundation shall be structurally delinked from the slab/floor of the rest of the substation building. Exhaust of diesel engine shall be kept away from the process/hydrocarbon handling areas and diesel day tanks shall be located outside the DG room. Suitable ventilation system shall be provided to avoid heat accumulation in the DG room.

7.16 Fire protection for transformers and switchgear room shall be provided to comply requirements of OISD-STD-173.

The sub-station shall be located in a safe-area close to the load center.

Consideration shall be given to vehicular traffic or any other factor that might affect the operation of the sub-station.

7.17 Sub-station floor shall be raised above grade level and the space below the switchgear room shall be utilized as cable cellar. The cable cellar floor shall be 300 mm above the approach road level and shall be paved and cemented. The cable cellar shall have a minimum clear height of 2.0 m below beam and shall house all cable trays and their supports.

7.18 Cable cellar should have RCC trench meant for ALL HV cables (33kV, l1kV and 6.6kV cables). FRP trays shall be used for routing MV power and control cables.

7.19 All Generator cable trenches /routes /cellars shall be kept independent.

7.20 Communication cables shall be routed well away from power cables, on a suitably sized GI tray for distribution.

7.21 In the small MV sub-stations & MCC rooms (if provided) having few cables shall be elevated at least by 1M by compacting the soil so that the bottom of the cable trench within sub-station is above the surrounding grade level.

7.22 A separate entry of 3.0 m with rolling shutter shall be provided for drawing in all equipment for erection. The main entry for operating personnel shall be provided with single door system. The Substation shall also have an emergency door opening outwards.

7.23 An air-conditioned control room shall be provided in the sub-station for locating the operator station, data acquisition system equipment, VFD 5 panels, battery charger, UPS panels, Heater control Panels etc.

7.24 Sub-station wall adjacent to the transformer bays shall be 355 mm thick in case of brick construction or 230 mm thick in case of RCC construction

7.25 Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization.

7.26 Battery banks shall be located in a separate adequately ventilated room in the sub-station buildings, along with the necessary exhaust system and water connection with sink. Floor of the battery room and walls up to 1.0 m height shall have acid/alkaline resistant protective material coating/tiling. Light fittings in this room shall be chemical resistant type. All electrical equipment installed in the battery room shall be flameproof type if there is possibility of emission of Hydrogen / Hazardous gases.

7.27 Each Sub-station shall have First aid boxes, HV & MV rubber gloves, FRP earthing rods, Shock hazard charts, laminated AC and DC SLDs (final SLDs) at minimum two locations & firefighting system as per OISD norms. HV & MV rubber mats shall be provided in front of all electrical switchgears & Equipment (charger/UPS/heater etc.). Further, contractor shall also supply FRP ladders of 4, 6 and 10 feet of approved make (Reference SUMIP FM 1000 series or any equivalent make) Godrej make key board, Industrial vacuum cleaner, Aqua guard with water cooler of approved make two (2) nos. Godrej or equivalent make Almira's for keeping drawings and instruments one no. MV hand operated megger, one (1) no. HV battery operated megger, one, two (2) nos. Portable battery operated emergency lamp, one (1) digital display tong tester 400A range, one (1) digital display earth tester, one (1) breaker test bench, Fire extinguisher (CO2, DCP) as required. The make of HT Megger, LT Megger, earth tester, and lounge tester shall be AVO Biddle/Fluke make only.

7.28 Equipment like oil filled transformers; neutral grounding resistors etc. shall be located in bays adjacent to the sub-station building. All bays shall have well drained floor, surfaced with gravel or other suitable material. Transformer bays shall have RCC roof. All bays shall have MS gates, main gate for removing the transformer and wicket gate for person entry. The gates shall be lockable. Transformers shall be located deep inside the bay to avoid rain (fine spray) falling on the transformer parts. Suitable rails shall be provided in the transformer bay and these rails shall extend up to the road for ease of maintenance. In each transformer bay, 63Amps power receptacle outlet with plug top shall be provided for oil filtration activities. Partition walls between transformer bays and the ends of the last bay shall be of fireproof type and shall extend at least 600 mm above the height of the equipment. Height of the bay shall be decided so as to facilitate maintenance and easy removal of equipment and requirements of natural ventilation.

7.29 Oil immersed transformers with oil capacity exceeding 2000 liters, shall be provided with a soak pit of sufficient capacity to take the whole of the oil of the equipment. Where oil capacity of transformers exceeds 9000 liters, provision shall be made to drain away the oil to a separate waste oil tank/collection pit located away, through suitable drain pipes of 150 mm or 200 mm in diameter.

7.30 One set of accessories consisting of cell testing volt meter, spanner, face shield, PVC apron, acid proof boots & rubber gloves shall be provided in each battery room.

7.31 The DG sets shall be located in separate room than the substation in a safe area to reduce noise level in substation. Exhaust of diesel engine shall be kept away from the process/hydrocarbon handling areas and diesel day tanks shall be located outside the DG room. Suitable ventilation system shall be provided to avoid heat accumulation in the DG room if required. Stacks shall be provided for the exhaust /f1ue gases as per the statuary norms.

7.32 Fire prevention and protection system for substation building and electrical installations shall conform to OISD-STD-173.

7.33 Fire barriers shall be installed at sub-station building cable entry point

7.34 The toilet with waste disposal system acceptable to local authorities shall be provided at the substation building.

7.35 Telephone sockets shall be provided at appropriate locations and 5 Amps sockets shall be provided at every 15 meter distance in the switchgear room

7.36 Substation building shall have operator room, operator change room, toilet with soak pit, a store room as a minimum.

7.37 Layout of substation shall comply with OISD regulations, IE rules, TAC regulations and any other statutory rules in general.

7.38 Substation shall have minimum three entries, one entry for equipment/normal entry on both sides and another for emergency exit

7.39 Substation shall be pressurized. It shall be ensured that the inlet air of the pressurized system shall be free from the moisture and hazardous mixtures. Positive pressure of 2mm Hg shall be maintained inside the substation. Suitable exhaust shall be provided for the sub-station building. Suitable exhaust fans shall be provided so as to maintain desired air circulations as per HVAC standards.

7.40 Substation lighting (Switchgear room, Cable cellar room) shall be controlled by switches located at the entrance and exit points.

7.41 All drains and pits around the substation and transformer area shall be covered with heavy duty RCC slab. Earth Pits cover top surface shall be matched with RCC paving level for ease of maintenance .Heavy duty RCC slab shall be provided on the Earth Pits.

8. INSTALLATION DESIGN PHILOSOPHY

8.1 GENERAL

The installation work for equipment's, cabling system, earthing system and lighting system shall generally conform to MRPL standard specifications and installation standards.

8.2 CABLING SYSTEM

8.2.1. Cabling system for various areas shall be as specified in Project design data sheet. Total cable route connected to FW pump/motors starting from main receiving substation to FW pump house shall be directly buried underground.

8.2.2. The cable trenches shall be sized depending upon the number and voltage grade of cables. The trenches in hazardous areas shall be filled up with sand. 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.

8.2.3. RCC cable trenches shall be sealed against ingress of liquid and gases wherever the trenches leave or enter a control room or substation. Pipes laid for mechanical protection shall be sealed at both ends. In case of direct burial, cable route markers shall be installed at 30 m interval all along the cable routes and where the direction of cable trench changes. Additionally, markers shall be provided at cable straight through joint locations.

8.2.4. Above ground cables shall be well supported on cable trays and suitably protected against mechanical damage. Routing shall be decided to avoid interference with hot surfaces or places subject to undue fire risk.

8.2.5. Cable trays, racks and trenches shall be sized to allow for 20% space for future cables. Cable installations shall provide minimum cable bending radii as recommended by cable manufacturer. Separate trays shall be provided for HV cables, MV power, and control and plant communication cables to the possible extent. However, where specifically agreed upon in exceptional cases, HV and MV power, control cables may be laid together, with a barrier plate separating HV and MV cables.

8.2.6. Separate cables shall be provided for AC and DC signal/control circuits, except for cables to Local control stations/ local control panels.

8.2.7. Cables connected in parallel shall run together so that their length remains the same.

8.2.8. Type of cable tray and accessories shall be as specified in project design data sheet. For tray system design, in addition to self-load and wind forces, following guidelines for design shall be considered.

a) Maximum Support span — 2500mm for Horizontal & 1500mm for Vertical tray supports

b) Cable load for

- 150 mm wide cable tray — 30 kg/linear meter
- 300 mm wide cable tray — 60 kg/linear meter
- 600 mm wide cable tray — 75 kg/linear meter
- 750 mm wide cable tray — 75kg/linear meter

c) In addition to this, 70 kg concentrated load at center span shall be considered. All structural steel design shall be as per Indian Standards.

8.2.9. Bends, tees, reducers, crosses, droppers etc. shall have the required bending radii as required for various cable sizes with a minimum radius of 300 mm.

8.2.10. All cables shall carry the cable tag numbers for easy identification.

8.2.11. Signal cables i.e. Instrument, communication, fire alarm, LAN and data highway, etc. cables shall preferably not be laid in the same trench/ tray along with electrical cables. In case these are laid in the same trench/ tray, a clearance of minimum 300 mm from electrical cables shall be provided. The overall cable layouts shall be designed for minimum interference between signal and power cables.

8.2.12. The Armour and semiconductor screen of single core cables shall be earthed at one end (except for short cable lengths). The continuity of Armour and semiconductor screen shall be broken at each joint. The unearthed end of Armour and screen shall be insulated.

8.2.13. GI or FRP cover shall be considered for top most cable tray and bottom of the lowest cable trays shall also be covered with GI or FRP sheet. GI or FRP type sheet shall be selected based on the type of cable trays. Tray cover shall be provided for the outermost trays of vertical droppers.

8.2.14. Cabling work shall generally be carried out as to its respective standard specification and Electrical design data.

8.2.15. Additionally all cable trays; trenches and road crossings shall be sized to accommodate 20% additional cables.

8.2.16. Cables connected in parallel shall run together, so that their length remains the same and these shall be suitably secured so as to avoid stresses arising due to short circuits.

8.2.17. Cable glands shall be used for termination of cables in all equipment's. Single compression glands and double compression glands shall be used for indoor & outdoor use respectively. The material of glands shall be nickel plated brass and aluminum for multicore and single core use respectively.

8.2.18. Junction boxes may be used for power circuits in electrical equipment's where the equipment terminal box cannot be designed for customer designed cable size and same shall be subject to PMC / Owner's approval.

8.2.19. Straight through joints shall be avoided to the maximum extent possible. However in no case the same shall be installed in hazardous areas, substation and cable cellar. All cable joints shall be properly identified and marked. HV cable termination and jointing kits shall be unearthed grade.

8.2.20. ERCs shall be provided for all roads, to the maximum extent possible for routing to avoid road cutting at a later date.

8.2.21. Fire proofing of cables shall be done for 1 meter length at indoor equipment entry point and similarly for outdoor equipment entry point.

8.2.22. All entry and openings of cables entering in substation, shall be provided with fire barrier and it shall have minimum three hours rating.

8.2.23. Fire barriers shall also be provided below opening of all HV and MV panels in all substation.

8.2.24. Underground cable routes shall be designed to avoid close pipe crossing and adjacent runs with underground pipelines. A distance of at least 30cms between cable and pipe shall be maintained. Cables shall preferably cross underneath buried pipelines.

8.3 EARTHING SYSTEM

8.3.1. It is recommended that all electrical equipment be suitably earthed. Earthing system shall, in general cover the following:

a) Equipment earthing for personnel safety.

b) System neutral earthing

c) Protection against Static and Lightning discharges.

d) Separate clean earth system for Instrumentation, DCS, ECS etc. as per specified requirements

8.3.2. Plant earthing design shall generally be carried out in accordance with the requirements of Indian Electricity Rules and IS: 3043. The earthing system shall have an earthing network with required number of earth electrodes connected to it. The following shall be earthed:

a) System neutral

b) Current and potential transformer secondary neutral

c) Metallic non-current carrying parts of all electrical apparatus such as transformers, switchgears, motors, lighting / power panels, terminal boxes, control stations, lighting fixtures, receptacles etc.

d) Steel structures, loading platform etc.

e) Cable trays and racks, lighting mast and poles.

f) Storage tanks, spheres, vessels, columns and all other process equipment.

g) Electrical equipment fencing (e.g. transformer, yard etc.)

h) Cable shields and Armour.

i) Flexible earth provision for wagon, truck.

j) Pump handling Hydrocarbon if its base Plate is separate from motor's base plate.

k) Turbo driven pump handling hydrocarbon

8.3.3. Unless adequately connected to earth elsewhere, all utility and process pipelines should be bonded to a common conductor by means of earth bars or pipe clamps and connected to the earthing system at a point where the pipelines enter or leave the hazardous area except where conflicting with the requirements of cathodic protection.

8.3.4. Where installed, lightning protection shall be provided as per the requirements of IS: 2309. Self-conducting structures having metal thickness of more than 4.8 mm may not require lightning protection with aerial rod and down conductors. They shall, however, be connected to the earthing system, at least, at two points at the base. OISD-STD-180 may be referred for details on lightning protection.

8.3.5. The resistance values of an earthing system to the general mass of earth should be as below:

a) 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 4 Ohms. However, the generating stations and large sub stations, this value shall not be more than 1 Ohm.

b) 10 Ohms in the case of all non-current carrying metallic parts of major electric apparatus or any metallic object. For lightning protection, the value of 5 ohms as earth resistance shall be desirable but in no case it shall be more than 10 ohms.

c) Earthing of Tanks shall comply to OISD-STD-173

d) All joints in pipelines, valves, plants, storage tanks and associated facilities and equipment for petroleum shall be made electrically continuous by bonding or otherwise; the resistance value between each joint shall not exceed 1 Ohm.

8.3.6. Earth rods and conductors shall be designed to cope 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 against corrosion.

8.3.7. All the electrical equipment operating above 250 volts shall have two separate and distinct connections to earth grid. Transformers shall be provided with two dedicated earth electrodes for earthing of neutral and transformer tank earthing.

8.3.8. All earth connections should be visible for inspection to the extent possible. In all cases, connection to earth should be made in accordance with IS: 3043.

8.3.9. The main earthing network shall be used for earthing of equipment to protect it against static electricity. An independent earthing network shall be provided for lightning protection and this shall be bonded with the main earthing network below ground, minimum at two points.

8.3.10. An approach for removing fire or explosion danger is to provide means for adequate dissipation and prevention of accumulation of static electricity, thereby ensuring that static discharges do not occur. One of the methods to eliminate risk of static electricity build up is grounding and bonding.

The subject of static accumulation caused by flow of petroleum products and the mitigation methods are dealt in detail in OISD-STD-110 and same should be followed.

8.3.11. Normally earthing system shall comprise of main earth grid along with suitably located disconnecting plates to provide multiple earth connections between earth grid and equipment and for connections between main earth grid and electrodes.

All connections shall be adequately secured against loosening.

Connections between earth electrode and the disconnecting plates shall be done by GI strip. Connection between the disconnecting plate and various equipment shall be done by GI strip, GI wire or GI wire rope.

Earthing and lightning protection system shall be executed as per to its respective standard specification and Electrical design data.

8.3.12. The minimum size of main earth grid around the substation and in plant area shall be 75x10 sq. mm.(GI)

8.3.13. All earth electrodes shall be provided with earth pits.

8.3.14. Lightning Protection shall be provided for all buildings including Pump houses as per 15-2309. The horizontal air terminations and down conductors shall be of 20x3 sq. mm G.I. Strip.

8.3.15. Earthing conductor and connection points shall be as given below:

Sr. No.	PARTICULARS	No. of Earthing Points (Minimum)	Earthing Conductor Size & Specification	Remarks
I	Main Earth Loop(MEL) buried underground as well as along main cable routes and in substation & in plant area	-	75 X 10mm G.I strip	

2	Sub earth loop along cable trays	-	50 X 6mm G.I strip	
3	Sub earth loop along street / Fence lighting cable routes	-	50 X 6mm G.I strip	
4	Equipment such as tanks, vessels & Heat exchangers etc.	2	50 X 6mm G.I strip	
5	Transformers			
5.1	Transformer body	2	75 X 10mm G.I strip	
5.2	Transformer neutral	2	75 X 10mm G.I strip	
6	DEG SET			
6.1	DEG body	2	75 X 10mm G.I strip	
6.2	DEG Neutral	2	75 X 10mm G.I strip	
7	HV (6.6KV) Switchgear	2	75 X 10mm G.I strip	
8	MCC'S	2	75 X 10mm G.I strip	
9	MV Switchgear	2	75 X 10mm G.I strip	
10	Lighting and power panels	2	1 X 25 Sq.mm. YY Cable	
11	Control panels	2	1 X 25 Sq.mm. YY Cable	
12	HV Motors(6.6KV)	2	I X 185 Sq.mm. AYY Cable	
13	Low Voltage Motors			
13.1	Motor up to 7.5Kw	2	I X 6 Sq.mm. YY Cable	
13.2	9.3Kw to 11Kw	2	I X 10 Sq.mm. YY Cable	
13.3	15Kw to 22Kw	2	I X 16 Sq.mm. YY Cable	
13.4	30Kw to 37Kw	2	I X 25 Sq.mm. YY Cable	
13.5	55Kw	2	I X 50 Sq.mm. AYY Cable	
13.6	75Kw	2	I X 70 Sq.mm. AYY Cable	
13.7	90Kw to 110Kw	2	I X 120 Sq.mm. AYY Cable	
13.8	132Kw	2	I X 150 Sq.mm. AYY Cable	
13.9	160Kw	2	I X 185 Sq.mm. AYY Cable	
14	Local Control Station	1	I X 6 Sq.mm. YY Cable	
15	Roof Conductors & Down Conductors for lighting protection	2	32 X 6mm G.I strip	

8.3.16. Independent Electronic Earthing shall be considered for all Electrical Equipment inside Substation such as VSD panels, AVRs /DVRs Heater control panels, RTU etc. Further, electronic earthing and SRR equipment shall be independent. It should run isolated from Electrical Network. Copper insulated cables shall be considered for this purpose. Support insulators shall be used while forming junctions for taking tap from main grid. The earth pits shall be colour coded to identify from Electrical Pits.

8.3.17. Value of earth resistance of an earthing system to be in general mass of earth shall be as follows.

a) For electrical system and equipment, a value that ensures operation of the protective device in the electrical circuit but not exceeding 10 ohm

b) 5 Ohms for plant area

c) For lightning protection value of resistance of 10 Ohm shall be maintained.

d) Overall grid resistance shall be less than 1 Ohm.

e) Number and location of earth pits in the plant shall be subject to PMC/Owner's approval

8.3.18. Underground earthing strips shall be provided with 30% corrosion allowance.

8.4 LIGHTING SYSTEM

8.4.1. Plant lighting system shall comprise

a) Normal lighting

b) Emergency lighting

c) Critical lighting.

Normal and emergency lighting shall be fed by AC supply (415/240V, three phase four wire) while critical lighting shall be fed by DC supply.

8.4.2. All emergency and DC critical lighting (if specified) fixtures and associated Junction Boxes in Hazardous areas shall be Flameproof type.

8.4.3. Normal lighting system shall provide enough illumination so as to enable plant operators to move safely within the accessible areas of plant to perform routine operation including reading of field instruments, operation of all valves etc. and to carry out all the necessary maintenance and adjustment to equipment.

8.4.4. Areas requiring AC emergency lighting shall include, but not be limited to, the following:

- All Areas requiring DC critical lighting.
- Strategic locations in process, utility areas where specific safety/shutdown operation are to be carried out.

Generally 20-25 % of the total lighting fixtures shall be fed from AC emergency supply.

8.4.5. Areas requiring DC critical lighting shall include, but not be limited to, the following:

- Control rooms Substations
- DG shed
- Central fire station
- Fire water pump house

- First aid center

DC critical lighting shall be provided in the pipe rack, exit/entry point only in case considered for process units.

Adequate number of self-contained portable hand lamps and battery operated emergency lighting units shall be provided for immediate use for buildings where no DC supply is available.

8.4.6. During normal operation, both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting load shall be transferred to emergency power supply source. Critical (DC) lighting shall be normally kept 'OFF' and during failure of AC power; battery bank shall feed the critical lighting system.

8.4.7. LED light fixtures shall be used for complete indoor & outdoor lighting system. All chemical handling facilities including battery rooms shall be provided with chemical resistant fixtures. DC critical lighting shall also employ with LED lamps. Tall structures shall have aviation obstruction lighting as per statutory requirements.

8.4.8. Telescopic tubular high masts shall be provided for illumination of tank farm/general area. Where feasible, street lighting poles may be avoided where lighting high masts provide adequate illumination. The high masts shall be of continuously tapered polygonal cross section and fabricated out of steel plates. The masts shall be provided with motorized racking mechanism for lowering and hoisting lantern carriage.

8.4.9. Lighting system shall consist of lighting transformers, lighting distribution boards (LDBs), lighting and power panels, fixtures, junction boxes etc. as specified. All outdoor lighting shall be automatically controlled by means of photoelectric cell/synchronous timers with manual overriding control as specified. Lighting and power panels shall be fed from LDB through 415/415V, Dyn-11, dry type lighting transformer having taps up to ±5%. (Refer clause 7.4.1 above for mine and Oil fields installations). The lighting and power panels shall be provided with MCB and ELCB as incomer and Miniature Circuits Breakers (MCBs) for outgoing feeders control and protection of lighting circuits. ELCBs shall not be provided at the incomers of lighting and power panels, in case ELCBs are provided in the outgoing feeders of LDBs/ASBs feeding to these lighting and power panels. MCBs shall not be loaded beyond 80% of rated capacity. A minimum of 20% of miniature circuit breakers of each panel shall be left as spares. In general, the load on each circuit shall be limited to 1.5 kW. In areas having less lighting load, lighting transformer can be avoided.

8.4.10. Lighting Lux Levels

Lighting system design shall be based on average illumination levels as specified below:

Roads	20
tank farm	60
Pump house, Sheds	100
Main operation platforms and access	60
stairs	20
Ordinary platforms	20
Process area, pipe racks, heat exchanger, Heater, cooling tower, separators etc.	200

Switchgear room, Rack room	300
UPS/ Operator room	300
Cable cellar	100
Battery room	150
Control room (Console area), Laboratory	500
Switchyard Warehouse Office	100
Compressor area	100

8.4.11. Lighting design shall conform to relevant Indian and International Codes and Standards, IES Hand Book and shall take into consideration the requirements from point of view of safety and ease in operation and maintenance. A maintenance factor of 0.8 shall be assumed for lighting illumination level calculations for normal areas. However for dusty areas, maintenance factor as per relevant codes and standards shall be considered.

8.4.12. Wiring for lighting and convenience outlets in outdoor areas shall be carried out with PVC insulated armoured cables run along the column/platforms and structures. Double compression cable glands required for terminating armoured cables in lighting fixtures, control gear boxes and junction boxes in hazardous areas shall meet the requirements of IS/IEC 60079-0. For outdoor/ indoor safe area equipment double/single compression cable glands shall be used respectively.

8.4.13. Adequate number of ceiling fan points shall be provided in Administration Building, Offices, rooms allocated for operating and maintenance personnel etc.

8.4.14. Two pole isolation devices shall be used for controlling lighting fixtures and sockets in hazardous areas to isolate phase as well as neutral. (For all mine and Oil field installations refer clause 7.4.1 above).

8.4.15. For buildings with false ceiling, concealed conduit wiring shall be used below the false ceiling and surface conduit wiring above the false ceiling.

8.4.16. Adequate number of pull boxes shall be used to aid wire pulling and inspection. No joints shall be allowed inside these pull boxes.

8.4.17. Battery room shall have fixtures mounted on wall in order to facilitate easy replacement of fused lamps. Switches controlling the lighting fixtures and exhaust fan shall be installed outside the battery room.

8.4.18. Locally mounted lighting fixtures on plat forms, walkways, stairs shall be installed in such a way that re-lamping can be done without the use of ladders.

8.4.19. During normal operation both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting load shall be transferred to emergency source. Critical (DC) lighting shall be normally kept “OFF” and during failure of AC power, battery bank shall feed the critical lighting system. The circuits shall be located in DCDB with interlocks & contactors with a Test push button to confirm healthiness of the circuit.

8.4.20. Safe area flood light and street lighting shall have LED lamps.

8.4.21. DC critical lighting shall employ CFL lamps with non-integral starter

8.4.22. Wiring for lighting and convenience outlets in outdoor areas and plant buildings shall be carried out with copper conductor, XLPE insulated, armoured and PVC sheathed, FRLS cables run along the column/platforms and structures. The armoured cable shall enter lighting fixture/JB through double compression gland through flameproof glands suitable for area classification. Suitable mechanical protection shall be provided for lighting fixtures (e.g. wire guard).

8.4.23. Concealed conduit wiring shall be provided in Administration Building, laboratory, control room, gate houses, and office area for all the buildings. For building with false ceiling, concealed conduit wiring shall be used below the false ceiling and surface conduit wiring above the false ceiling.

8.4.24. Heavy duty PVC conduits shall be provided for concealed conduit.

8.4.25. Adequate number of ceiling fans shall be provided in Offices, rooms allocated for operating and maintenance personnel etc.

8.4.26. Battery room shall have fixtures mounted on wall in order to facilitate easy replacement of fused lamps. Switches controlling the lighting fixtures and exhaust fan shall be installed outside the battery room.

8.4.27. Locally mounted lighting fixtures on platforms, walkways, and stairs shall be mounted in such a way that maintenance can be done without use of ladders.

8.4.28. The sensitivity of ELCB provided in the lighting Panels shall be 30 mA.

8.4.29. A minimum of 25% spare MCB outgoing feeders shall be left as spare in all lighting & Power Panels.

8.4.30. Adequate numbers of 5A/15A, 3 Pin sockets shall be provided in all the buildings.

8.4.31. The flameproof lighting and power panels shall conform to its respective standard specification

8.4.32. The lighting fixtures for hazardous locations shall conform to its respective standard specification

8.4.33. Lighting work shall be done as to its respective standard specification and of Electrical design data.

8.4.34. All building and sheds should be provided with critical lighting. Inside location and number will be defined during detail engineering.

8.4.35. For all lighting and power panels in hazardous areas, incomers shall be provided with 4 pole MCB’s and outgoings shall be with DP MCBs + ELCBs.

8.4.36. Lighting fittings shall be energy efficient type and all ballasts shall be provided with capacitors for power factor improvement (to 0.95).

8.4.37. Street lighting poles with external junction boxes shall be IP 66 with polycarbonate body and shall be fixed at 1.2 meter height from the finished ground level for re-termination without joints in case of flashover at terminals

9. MV VARIABLE SPEED DRIVES

9.1 Variable speed drives shall be provided with PLC based logic instead of relays / contactor logic. Latching of start / stop command, if required, shall be done in the drive panel. Further VSDs shall be communicable type and shall be able to communicate with DAS and DCS through MODBUS protocol.

9.2 System shall be highly reliable, efficient, and shall provide high power factor, low harmonic distortion, low noise level etc.

9.3 System shall be provided with complete by pass circuit to ensure the power supply reliability in case of VSD failure.

9.4 The system shall be suitable for load characteristics, continuous speed variation and shall be with soft start feature. Drive shall be able to accelerate the load over full speed range (0- 100%) with incoming line voltage regulation of 10%.

9.5 The system shall be designed for 150% over current withstand for 1 Min. The system shall be equipped with an automatic restart facility which shall restart the system in case of voltage dip.

9.6 The system shall be suitably designed with due care for long length of cables, output filters, chokes, motor insulation, cable grades etc.

9.7 The VSD panel shall be installed in dustproof AC room in the substation, however the VSD shall be designed for installation in non AC room. Required local control equipment shall have start, stop, push buttons, ammeter, ON/OFF/READY status, selector switches, etc. as required and shall be installed near the motor. However, all electronics used in the VSD shall be tropicalized.

9.8 Auto Restart facility for drive system within preset time, typically 0-60 sec. in case of supply system dip or complete loss of power shall be provided.

9.9 The VSD panel supplied shall be of proven make.

9.10 Only 4-20mA analog hard wired signal from and to DCS shall be considered for VSD speed control

9.11 The distance between drive and the motor shall be with in recommended limit mentioned by the vendor. If the distance is beyond the limit then suitable filters, sinus filters and/or compensation coils shall be provided.

9.12 The drive enclosure shall be IP -42 for fan cooled type enclosure and IP-52 type for self-ventilated enclosure

9.13 Motor Space heater supply has to be provided from VSD panel. Critical cards which are essential for operation of VSD shall be provided with redundancy

9.14 The control supply for VSD panel shall be 110V AC UPS supply

9.15 VSD shall be provided with Power OFF ride through function to maintain drive operation during voltage dips

9.16 VSD shall be provided with Power OFF ride through function to maintain drive operation during voltage dips.

9.17 Measures shall be taken to contain Electromagnetic interference and harmonics arising out of VSDs. Screened internal cabling shall be used for power and control.

9.18 Substation shall be sized to ensure one number panel extension on each bus section with necessary cut out for all HV/MV switchboards in addition to contractual spare feeder's requirement.

9.19 For building engineering, each office room, in addition to switch /socket for lighting design, shall be provided with minimum 2 no's of telephone sockets and 2 no's of LAN sockets at two different locations as duly approved during detail engineering.

9.20 For fire detection and Alarm system spare fire alarm loop for future shall be 20% or one No whichever is maximum. Each loop shall be engineered to provide the flexibility to add 20% additional detectors in future.

9.21 For plant communication system exchange shall be fully wired for hardware, power supply, software etc. for capacity as required with spare capacity of 20% field call stations with no future modifications in the hardware and software. Public address system Exchange shall be expandable type. i.e. Microprocessor shall support further expansion with a separate I / O cards

9.22 The status of actuation of fire suppression system shall also be wired to fire alarm panel to annunciate at central fire alarm panel.

9.23 Control cables used shall have 1 core spare up to 6 core requirement and 20% or 2 core whichever is maximum for cables having requirement above 6 cores.

9.24 For 4-20mA signal interface between switchboards and DCS, Screened cables shall be used.

9.25 Cables laid in hazardous area shall not have any straight through joints.

9.26 The junction boxes /telephone tag boxes shall be of Polycarbonate type for safe area and die cast Aluminum alloy construction with IP-55 protection suitable for installation in classified hazardous area.

9.27 The Junction boxes shall be suitable for terminating or looping armoured cables. JBs shall be provided with earthing stud and shall be earthed. They shall be suitable for Wall/Column mounting

9.28 Junction boxes installed in hazardous areas shall be explosion proof Ex"d" type.

9.29 Enclosure for convenience receptacle shall be suitable for site conditions such as weather proof, dust proof, corrosion resistance. All convenience and welding receptacle to be used in hazardous area shall be Ex"d" type.

9.30 Adequate no of Welding receptacle (63A, 415V 3 Ph. with scrapping earth) shall be provided in compressor, blower area to provide power to portable equipment

9.31 Adequate no of Industrial type socket outlets 20A shall be provided in the substation. Two no's 3 ph. Receptacle suitable for required motor kW rating to be provided for Hydro Blaster near cooler /Exchanger, if required.

9.32 Lighting feeder, heater feeder or any feeder feeding a load which is single phase or can become single phase in the event of an abnormality in the course of operation shall be provided with 4 CT configuration to avoid spurious E/F operation on single phase loading

9.33 An independent process unit shall be fed from independent and separate MCC

9.34 Monorail shall be provided for motors above 55kW

9.35 Suitable facility for loading /un1oading of Fin Fan cooler motors shall be provided

9.36 Lighting fixtures and junction boxes in DM water plant and cooling tower area shall be of Polycarbonate type. The cable trays in DM plant area shall be of FRP type

9.37 Accuracy class for Load managers shall be of minimum 0.5 or better

9.38 Minimum size of communication cables shall be as per follows.

- Paging system = 3P X 0.8 mm dia.
- Telephone system = 2P X 0.8 mm dia.
- FA system = 2P X 1.5 Sq.mm.

C-2	ENGINEERING DESIGN BASIS
C-2.7	INSTRUMENTATION

MRPL Marketing Terminal Project at Devangonthi, Bangalore

PROJECT : Marketing Infrastructure Projects, MRPL

OWNER : MANGALORE REFINERY AND PETROCHEMICALS LTD

PMC : Nauvata Engineering PVT LTD.

JOB NO. : JBG20005

Rev No.	Date	Purpose	Prepared by	Checked by	Approved by
0	8-02-2021	ISSUED FOR BID	PS	SKH	SV

INDEX

30.3 Selection of Material of Construction

a. Sour or Wet H2S Service
b. IBR Service
c. Services with strong reducing acids
d. Transmitter Electronic Housing
e. Diaphragm Seals

31. Units of Measurement
32. Standards for Instrument Connections, Material & Enclosure
33. General Requirements
34. General Notes
35. Accessibility Requirement for Instruments (New Units)

Annexures

Annexure-1 Instrument Nozzles on Vessels, Tanks, Piping & Heaters.
Annexure-2 Control Room Philosophy

1. General

This design basis covers the general requirements for instrumentation design and installation. Individual specifications shall be referred for more detailed information.

The following priority shall be applied when any contradictions are found between various specifications or drawings.

1st priority	: Engineering Design Basis
2nd priority	: Process Licensor's documents
3rd priority	: Job Specifications
4th priority	: Standard Specifications & Engineering 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**

2. Referred Standards

Design and terminology shall comply, as a minimum, with the latest edition prior to the date of purchaser's enquiry with following codes, standard practices and publications:

AGA American Gas Association
Report No.3 - Orifice Metering of Natural Gas & other related hydrocarbon fluids
Report No.7 - Measurement of Gas by Turbine Meters.
AGA-9 Measurement of Gas: Ultrasonic Meters

ANSI/ASME American National Standards Institute/American Society of Mechanical Engineers.
B 1.20.1 Pipe Threads General Purpose (Inch)
B 16.5 Pipe Flanges and Flanged Fittings
B 16.20 Metallic Gaskets for pipe Flanges, Ring Joint, Spiral wound and Jacketed.
B16.36 Orifice flanges
ASME PTC 19.3 TW Thermowells Performance Test Codes

ANSI/FCI American National Standards Institute/Fluid Control Institute
70.2 Control valve seat leakage classification

API American Petroleum Institute
API 520 Sizing, selection and installation of pressure relieving devices in Refineries.
Part-I - Sizing and selection
Part-II - Installation
API 521 Guide for pressure relieving and depressurising systems.
API 526 Flanged steel Pressure Relief Valves.

API 527	Seat tightness of Pressure Relief Valves.
API MPMS	Manual of Petroleum measurement standards.
API RP 551	Process Measurement Instrumentation
Part I -	Process Control and Instrumentation
API555	Process Analysers
API Std670	Vibration, Axial Position, and Bearing Temperature Monitoring Systems
API 552	Transmission Systems.
S 1101	Measurement of Petroleum Liquid Hydrocarbon by Positive Displacement meter.
S 2000	Venting Atmospheric and low-pressure storage tank non-Refrigerated and refrigerated.
S 2534	Measurement of liquid hydrocarbons by turbine meter systems
S 670	Vibration, Axial-Position and Bearing-Temperature Monitoring Systems

ASME American Society of Mechanical Engineers

ASME Sec-VIII	Boiler and Pressure Vessels Code rules for construction of pressure vessels
ASME Sec-I	Boiler and Pressure Vessels Code. Section-I 'Power Boilers'

ASTM American Society for Testing and Materials.

ASTM A 262	Standard practices for detecting susceptibility to intergranular attack in austenitic stainless steels.

BIS Bureau of Indian Standards

BS British Standards

BS-5308 Part-II	Specification for PVC insulated cables.
BS-7244	Flame Arrestors.

DIN German Standards

DIN-43760	Temperature Vs Resistance curves for RTDs.
DIN-19234	Electrical Distance Sensors; DC interface for Distance Sensor and Signal Converter.
DIN-19250	Safety consideration for fail safe control for control and instrumentation equipment.

IBR Indian Boiler Regulations

IEC International Electro technical Commission

IEC 60079	Electrical Apparatus for Explosive Gas atmosphere
IEC 60085	Thermal Evaluation and Classification of Electrical Insulation.
IEC 60332 Part III Cat. A	Test on bunched wires or cables.
IEC 60529	Degree of protection provided by enclosures.(IP code)
IEC 60534-2	Industrial Process Control Valves-Flow capacity.

IEC 60584-2	Thermocouple Tolerances
IEC 60751	Industrial Platinum Resistance Thermometer Sensors
IEC 61000-4	Electromagnetic compatibility for Industrial Process measurement and control equipment.
IEC 61158	Foundation Fieldbus Specifications
IEC 61131	Parts 1-4 Programmable Controllers
IEC 61508	Functional Safety of Electrical/Electronic/Programmable safety related system
IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry.
IEC 61804	Functional Blocks for process Control
IEC 60801	Electromagnetic compatibility for Industrial Process measurement and Control equipment
IEC 60050-300	International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments
IEC 61518	Mating dimensions between DP measuring instruments

Electrical apparatus for explosive gas atmosphere:

IEC 60079-10 Part 10	Classification of hazardous areas
IEC 60079-14 Part 14	Electrical installations in hazardous areas (other than mines)
IEC 60079-18 Part 18	Construction, test and marking of type of protection encapsulation "m" electrical apparatus
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60534-4	Industrial process control valves
Part 4:	Inspection and routine testing
IEC 61241-10	Electrical apparatus for use in the presence of combustible dust
Part 10	Classification of areas where combustible dusts are or may be present
IEC60079-27	Fieldbus Intrinsically Safe Concept (FISCO) & Fieldbus Non-Incendive Concept (FNICO)
IEC60079-25	Explosive atmosphere. Intrinsically safe electrical systems

Thermocouples& RTD's:

IEC 60584-1 Part 1	Reference tables
IEC 60584-2 Part 2	Tolerances
IEC 60654-1	Industrial-process measurement and control equipment; operating conditions
Part 1	Climatic conditions
IEC 60654-3	Operating conditions for industrial-process measurement and control equipment:
Part 3	Mechanical influences
IEC 60654-4	
Part 4	Corrosive and erosive influences
IEC 60751	Industrial Platinum resistance thermometer sensors

IS Indian Standard

IS-5	Colours for ready mixed paints and enamels
IS-319	Specification for free cutting Brass bars, rods and sections
IS-1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS-1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
IS-1554	PVC insulated (heavy duty) electric cables working
Part I	voltage up to and including 1100V
IS-2147	Degree of Protection provided by enclosures for low voltage switch gear and control gear
IS-2074	Ready mixed paints, air drying, red oxide - zinc chrome
IS-13947	Degree of Protection provided by Enclosures for Low Voltage switchgears and Control gears. Part 1 General Rules.
IS-2148	Flame proof enclosures for electrical apparatus for Explosive Gas Atmospheres – Flameproof Enclosures ‘d’.
IS-3624	Specification for pressure and vacuum gauges
IS-5831	PVC insulation and sheath of electric cables.
IS-7358	Specifications for Thermocouples
IS-8784	Thermocouple compensating cables.
IS-3624	Specification for pressure and vacuum gauges.
IS-2801	Bulk Meter/PD Meter Accuracy.

ISA Instrumentation, Systems and Automation Society

S-5.2	Binary logic diagrams for process operations.
S-7.3	Quality standard for instrument air
S-75.01	Flow equations for sizing control valves.
S.50.02	FF standard for use in industrial control system,
Part 2	Physical layer specification and service definition.
S.71.04	Environment condition for process measurement & control system.
S 75.17	Valve noise calculations
ISA MC 96.1	Temperature Measurement Thermocouples

ISO 5167 Measurement of fluid flow by means of orifice plates, nozzles and venture tubes inserted in circular cross-section conduits.

Part 1	General principles and requirements
Part 2	Orifice plates
Part 3	Nozzles and Venturi Nozzles
Part 4	Venturi Tubes

ISO 5208	Industrial Valves – Pressure Testing of Metallic Valves
ISO 9355-2	Ergonomic requirements for the design of displays and control actuators
ISO 15156	Petroleum and natural gas industries – Materials for use inH2S-containing environments in oil and gas production
ISO 17089-1	Measurement of fluid flow in closed conduits – Ultrasonic meter for gas
Part 1	Meters for custody transfer and allocation measurement

ISO 17292 Metal ball valve for petroleum, petrochemical and allied industries

ISO 4266 Petroleum and liquid petroleum products – Measurement of level and temperature in storage tanks by automatic methods.

NACE National Association of Corrosion Engineers

NACE MR0103 Materials resistant to sulfide stress cracking in corrosive petroleum refining environments

NACE MR0175 Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production

NEC National Electric code

NEMA National Electrical Manufacturer's Association

ICS-6 Enclosures for Industrial control and systems.

NFPA National Fire Protection Association

NFPA-496 Purged and pressurized enclosures for electrical equipment.

OSHA Occupational Safety and Health Authority.

SAMA Scientific Apparatus Maker’s Association

CCOE Chief Controller of Explosives

PESO Petroleum and Explosive Safety Organization

CMRI Council of Mining & Research Institute, India

OISD Oil Industry Safety Directorate

OIML R117 Organisation Internationale de Metrologie Legale for Custody Transfer.

OIML R85 Automatic Level gauges for measuring the level of liquid in fixed storage tanks.

NAMUR NE 43 Standardization of the Signal Level for the Failure Information of Digital Transmitters

NAMUR (DIN 19234) Inductive Proximity Switches

EN 837-1 Pressure gauges – Part 1 Bourdon type pressure gauges - Dimensions, metrology, requirements and testing

EN 10204 Metallic products Types of inspection documents

EN 50262 Metric cable glands for electrical installations

3. Control Philosophy:

■ a) Mode of Plant Operation — Centralized ■

For All process units □
For Marketing Terminal ■
For Offsites □
For Utilities □

Any other _____

Dedicated □

For each process unit □
For Utilities □

Unit wise control rooms are as per Annexure-1.

b) Type of Plant — Grassroot ■
Revamp □
Expansion □
Any Other □

4. Control room/ Satellite Rack Room Requirement (SRR-Satellite Rack Room):

Control room	Satellite Rack Room	Grouping of units	Floor Location
Bangalore Marketing Terminal Control Room	Integrated with Control room	NIL	Ground

Note: Chemical filters shall be used for air condition system in control room, SRR's.

If the package control system location is in corrosive /hazardous area then same shall also be provided with Chemical filters.

5. Type of Control and Monitoring:

Process Control shall be facilitated through:

a. Centralized — DCS based ■ yes

■ Distributed Control System (DCS) with HART transmitters and positioners for control & monitoring.

b. Dedicated — DCS Based ■ yes

PLC Based (Note) ■ yes

Note: Package Units may use dedicated PLC based control system for control and monitoring. This shall be decided during detail engineering based on package. Generally, main plant DCS/ PLC is preferable. For Proprietary control system in packages (like feed filter) dedicated package PLC can be considered.

c. Local — Pneumatic Transmitters /Control System — ■ No

Note-1:

For Control Systems in New Off site units(Marketing Terminal), Non-Fieldbus (4-20 mA/ HART) is considered.

d. Final Control Element — Pneumatic — ■ yes □ no
Hydraulic (If Applicable) — ■yes □no

Note-2:

1.Control valves shall be fitted with HART positioners (Make: Fisher/ Masoneilan/ Metso/ Samson).

2.For Digital Control Valve, Solenoid valve(1 NC and 1 NO) shall be fitted.

6. Interlock and Shut-down system:

a. Logic Representation : As per ISA — ■ yes □ no

b. Interlock Execution Independent of Shutdown System (Note-3) — ■ yes □ no

Note 3: Interlock execution in DCS or other PLC where it is shown in licensor P&ID. In general, all Interlocks by default shall be in ESD PLC.

With Shutdown System — ■ yes □ no

Type of Hardware — Relay — □ yes ■ no

PLC — ■yes □no

SIL3 Rating (IEC61508) — Note -4

PLC with HART Management — ■ yes

Note -4: For Marketing Terminal SIL 3 PLC is considered. SIL-1, 2 or 3 based interlocks/logics shall not be executed in DCS.

c. Shutdown System — Dedicated unit wise — ■ yes □ no
Common for all units — □ yes ■ no

Type of Hardware	Relay	□ yes ■ no
	PLC	■yes □no
	SIL3 Rating (IEC61508)	■yes □no
	SIL3 PLC with HART Management	■yes

d. PLC Configuration for Shutdown/Interlock QMR — Triple Modular Redundant ■ yes □ no; ■yes □no

- PLC configuration Quadruplicate minimum. TMR shall also be acceptable. Hot-Redundancy shall be achieved using separate cards (all types) &modules. For TMR PLC (if applicable) installed spare cards / slots to be finalized during detailed engineering. Redundancy shall not be application program / logic based switch-over.
- PLC's which are for Interlocks execution shall have redundant processor, redundant I/O and redundant communication as a minimum (control processor & resource loading shall be limited to 40%).
- *System Power Supplies (24VDC) shall be separated/isolated from field device power / interrogation supplies.*
- *Operating system for DCS/PLC/Package system shall be of latest test passed as on the date of FAT.*
- *All hardware failures and system status changes shall be hardwired to main plant DCS for alarm logging as Digital Inputs (if not on the same platform).*
- *If common bus is used for interfacing / networking between different PLC processors, the communication bus/networking shall be SIL3 certified.*
- *Licensor specific requirement if any to be considered.*

e.	Process bypass switch	Software	■ yes □ no
	Common Bypass Indication	Hardware	■ yes □ no
f.	Common MOS enable Switch	Hardware	■ yes □ no
	Common MOS Indication	Hardware	■ yes □ no

(PLC console for bypass/reset operation shall be specified with bypass lamp at Hardwired Console. If shown in P&ID as per licensor requirement, then Hardwired process bypass switch with lamp shall be considered)

g.	ESD Switch Location	Local Panel	□
	As Per P&ID	Field	□
		Control Room	□
		Push Type with Mushroom head&	■

Protective cover
(If located in Field)
Pull type with Mushroom head& Protective cover **(If located in Control room)** ■

7. Package Units Control Philosophy

a. Operation Philosophy

Package Description	Control and Monitoring		Interlock and Shutdown	
	Local Panel	DCS	DCS	PLC
Compressor Package	---	√	---	√
Other Packages	---	√	---	√

b. 4-20 mA HART protocol based instrumentation shall be used for monitoring and control.

c. Logic implementation
Plant PLC ■
Package Vendor PLC ■*Note-4a*
Any other

Note-4a: *For proprietary / Utility Packages/ Licensor's specific requirement*.

Considering the sensitivity of the PLC Electronics to temperature/dust all skid based control system (PLC systems) shall be located inside SRR.

d. PLC Configuration for Package systems
Hot-Redundant(Note-5) ■ yes □ no
SIL3 Rating (IEC61508/ 61511) ■ yes □ no

Note-5: Redundancy shall be achieved using separate cards (all types) & modules. Redundancy shall not be application program / logic based switch-over.

e. Programming Language
Ladder Logic □ yes ■ no
Boolean Function blocks ■ yes □ no

- SIL3 rated PLC shall be used in package system based on operational requirements (IEC61511) or licensor specific requirements. Quad or TMR configuration is also acceptable.
- System Power Supplies (24VDC) shall be separated/isolated from field device power / interrogation supplies.
- Operating system for DCS/PLC/Package system shall be of latest test passed as on the date of FAT.

- As a minimum all PLCs which are used for package units shall have redundant processor, redundant I/O and redundant communication. All package PLC's shall have redundant communications with Main DCS systems. Relay based package control systems shall not be used.
- For package control systems (PLC based), the essential control blocks like P, PI, PID, Ratio, Cascade blocks shall be provided as a minimum.
- All hardware failures and system status changes shall be hardwired to main plant DCS/PLC for alarm logging as Digital Inputs.
- Package control system clock shall be synchronised with DCS clock.

- Alternatively for Air Blowers/Fans/ Compressors etc. same may be implemented in main plant DCS/PLC subject to meeting scan time limitations (of DCS/PLC based execution). Main Plant DCS / PLC scan time will be given in package input so that package vendor can confirm whether dedicated ASC is required or not.

Engineering softwares, Original Licenses and final backup ■ yes
Laptop for Engineering (In case Engg Console is not available) ■ yes

f. Speed Governor — Dedicated Redundant controller (Woodward 5009FT/equivalent) ■ yes □ no

- Speed Governor controller shall have Redundant serial communication link with DCS (Modbus over RS485)

Engineering softwares, Original Licenses and final backup ■ yes
Laptop for Engineering (In case Engg Console is not available) ■ yes

g. Location of ASC — Control Room ■ yes □ no
Or Speed governor — Local Panel ■ yes □ no (If Indicated in P&ID)

Exact location shall be decided during Detail Engineering stage.

h. Vibration & Temperature Machine Monitoring — Bentley Nevada 3500 series or Equivalent ■ yes □ no

Location of MMS Display Unit — Local Panel ■ yes

Engineering softwares, Original Licenses and final backup ■ yes

Laptop for Engineering (In case Engg Console is not available) ■ yes

Vibration probes with Wireless Technology shall be adopted wherever possible (e.g. for indication purpose) for non critical machines.

MMS Monitors Location in SRR/ CR subject to distance limitations.

i. Type of local panel

Weatherproof to IP55	■ yes	□ no
Purged (in case of Haz Area)	■ yes	□ no
As per NFPA 496	■ yes	□ no
Type Z (*Note6*)	■ yes	□ no

Note6: If located in Hazardous Area.

j. Local Panel Requirement (Only for package units)

Specific Local panel requirements shall be finalized during engineering stage

Instruments Type	Pneumatic	□ yes	■ no
	Electronic	■ yes	□ no

8. Operational aspects

a. All symbols in P&ID shall be as per ISAS5.1 ■ yes

b. Sensor / transmitter for shutdowns separated from that for control / indication. ■ yes

c. Solenoid valve operation with interlock/ shutdown system only. ■ yes

d. Push buttons and status indication shall be in DCS/PLC console only (except for ESD) ■ yes

e. Auxiliary console for critical indication only. ■ yes

f. Emergency switches shall be hardwired only. ■ yes

g. Hardwired indicators or recorders shall not be used. ■ yes

h. Instruments shall have individual tappings from process lines. ■ yes

i. PLC Operator console for Non safety operations (Operator Bypass/Manual reset etc). ■ yes

j. Start/stop of rotating equipments from DCS/PLC In addition to LCS (*case-to-case basis*) ■ yes

k. Historic Trending on each operator station for DCS ■ yes
(Historical trending in dedicated package operator station will be applicable where there will be HMI in console room for the package)

l. Status indication lamps in control room: (HW console)
All continuously running rotating equipment ■ no

Critical continuously running rotating equipment. ■ yes

Alarm window in control room for all compressors/ ■ yes

Critical equipments. ■ yes

m. Status indication of all rotating equipments (in DCS/PLC) ■yes

n. Startup/shutdown operation from control room

Emergency operations to be enabled from the control room:

Single emergency shutdown of total complex. ■no

Respective unit emergency shutdown. ■yes

Fired heater emergency shutdown (control room and field) ■yes

Critical rotating equipment shutdown (control room and field). ■yes

All rotating equipment shutdown (control room and field). ■no

Note7: All non safety related operations such as start up bypass, manual reset of SOV shall be carried out from PLC operator console located in Control room as indicated on P&ID. Similarly start/stop of non-critical rotating equipments wherever required as per P&ID shall be implemented in DCS console. All other critical operations such as Emergency Shutdown, major equipment trip operations, alarm annunciator / status lamps of critical items shall be provided on the hardwired consoles

9. DCS Requirements

a. Functional Requirement

Control and Data Acquisition System	■
Data Logging and Report Generation	■
Management Reports	■
Advanced Control	□
Plant Optimization	□
Offsite Automation	■
Data Storage and Archival	■
Advance Diagnostics	■
Control system security (*Note8*)	■
Asset Management System	■
Documentation Node	■
Time Synchronisation across units	■
Alarm Management System	■
SOE (DCS and PLC)	■

Annunciator system ■
Integration to RTDBMS System (existing) through Secure Gateway ■

Note8: Shall be DMZ based with double firewall. Security shall also meet ISA/IEC 62443 Standard.

b. Operator Consoles

.

Control Room	Operator HMI and Consoles	Units
Devangonthi Marketing Terminal Control Room	2 Nos. 1 tier OIC and 1 No. TFMS Client and 1 No. CCTV Client.	BMT

Note9-: Operator cum engineering consoles are required in SRR

o. Operator cum engineering console in SRR ■ yes
p. Engineering Console in Control Room ■ yes

Number of consoles in SRR's shall be as follows:

Satellite Rack Room	Operator cum engineering consoles	Units

q. Console configuration Single ■ yes
Stacked (Dual) □ no

r. Type of Monitor CRT □ no
TFT LCD/LED (or latest) ■ yes

s. Size 21" or more ■ yes

t. Open system connectivity (With Secure Gateway) OPC ■ yes

u. Advance Diagnostic Licenses for Field Instruments ■ yes

v. Engineering functions from operator console ■ no

w. Historic Trending on each operator station ■ yes

c. Engineering Consoles Required ■ yes

Number of engineering consoles for each Control Room:

Control Room	Engineering Console for DCS	Engineering Console for ESD	Units

Number of engineering consoles for SRR:

Operator cum engineering consoles are considered in SRRs. For number of consoles, refer (p) above.

d. Type of Reports Required

Hourly	■	Alarm History	■
Shift wise	■	Alarm Summary	■
Daily	■	Shutdown Report	■
MIS reports	■	Others_____	

e. Historical database — Required ■

f. Alarm Management System — Required ■
Can be a part of DCS or Stand alone with DCS connectivity

g. Giant Screen — Required ■
Will be decided during detail engineering

h. SOE recording — Required ■

DCS ■ PLC ■

SOE license shall also be available at one of the Operator Stations located in Control Room as well.

i. Foreign Device Interface with DCS (Refer also point no 14.e below)

Programmable Logic Controllers	■
Analyzer system	■
Chromatographs	■
Tank Gauging System	■
Supervisory Computer	■
LRCS	■
Package PLCs	■
Anti Surge Controller	■
Vibration & Temperature Monitoring System	■
Gas Detection System	■
Alarm Management System	■
RIM Seal Fire Protection System	■
Giant Screen	■
Data concentrator	■
VSD/VFD System	■

j. Maintenance Information System — Required ■ yes to decided during detail engineering.

k. Training KIT ■ No

l. Training Simulator ■ No

m. Redundancy Philosophy (Hot standby) Note-10

Controller	Redundant	■	1:1 redundancy	■
DAS& I/O	Redundant	■	1:1 redundancy	■
Communication	Redundant	■	1:1 redundancy	■
Sub System	Redundant	■	1:1 redundancy	■
Power Supply	Redundant	■*Note-10*	1:1 redundancy	■
History	Redundant	■	1:1 redundancy	■

n. Loading Philosophy

Control Processor	(*Note10*)	60% ■ (Limited to 40% at FAT stage)
Communication Processor		50% ■
Communication Bus		50% ■*Note-10*

Note-10:

- *The maximum number of nodes/Stations in the network shall not exceed 70% of the maximum capacity.*
- *System Power Supplies (24VDC) shall be separated/isolated from field device power / interrogation supplies.*
- *DCS controller CPU loading shall be considered with all FF PID's residing in HOST, at FAT stage.*
- *Operating system for DCS/PLC/Package system shall be of latest test passed as on the date of FAT.*
- *Hot-Redundancy shall be achieved using separate cards (all types) & modules. Redundancy shall not be application program / logic based switch-over.*
- *Redundant Analog Output Cards shall have Fast switch-over response to prevent Valve Positioner from re-booting.*

10. Package Control System Requirements

a. Functional Requirement

Control and Data Acquisition System	■
Data Logging and Report Generation	■
Data Storage and Archival	■
Advance Diagnostics	■
Control system security	■
Time Synchronisation with DCS	■
SOE	■
Annunciator system (In field)	■
Hart Management System	■

b. Operator Consoles in Control Room

No of operator consoles shall be decided during Detail Engineering period. Dedicated Operator consoles (wherever applicable) for critical packages units shall also be provided. Operator Stations (HMI) shall be minimum RAID-1 (with SCSI/SSD hard disks & hardware controller based mirroring).

Control Room	Operator Consoles	No of Display Screens/console	Units

c. Engineering console in SRR ■ yes
(shall be separate from Operator Console/HMI)

d. Laptop for Engineering (In case Engg. Console is not available) ■ yes

e. Engineering softwares, Original Licenses and final backup ■ yes

f. Console configuration — Single ■ yes

g. Type of Monitor — CRT □ no; LED (or latest) ■ yes

Size — 21" or More ■ yes

Open system connectivity (with Secure Gateway) — OPC ■ yes

HMS Interface with Main DCS Asset Management System ■ yes

Advance Diagnostic Licenses for Field Instruments ■ yes

Engineering functions from operator console ■ no

Historic Trending on operator station ■ yes

h. HMI located in Field — Required ■ Yes (Note-11)

Note-11: HMI in field shall be provided only on Licenser/ OEM specific requirement. If provided proper environment protection & cooling arrangement shall be made available.

i. Type of Reports Required — Alarm History ■; Alarm Summary ■; Shutdown Report ■

j. Historical database — Required ■

k. SOE recording — Required ■
SOE Station System will be located in new SRR.

l. Interface with DCS — Required ■
OPC with Tunnelling & Firewall / Modbus RTU (For Small Packages) ■
(will be decided during detail engineering on case-to-case basis)

m. Redundancy Philosophy (Note-12)

Controller	Redundant	■	1:1 redundancy	■
I/O	Redundant	■	1:1 redundancy	■
Communication Sub System	Redundant	■	1:1 redundancy	■
Power Supply	Redundant	■ *Note12*	1:1 redundancy	■
History	Redundant	■	1:1 redundancy	■

Note-12:

- *System Power Supplies shall be separated/ isolated from field device power/ interrogation supplies.*

- *Hot-Redundancy shall be achieved using separate cards (all types) & modules. Redundancy shall not be application program / logic based switch-over.*
- *Redundant Analog Output Cards shall have Fast switch-over response to prevent Valve Positioner from re-booting.*

n. Loading Philosophy- Note-10

Control Processor	60%	■
Communication Processor	50%	■
Communication Bus	50%	■

11. Hard-wired console Instrumentation

a. Type of control panel

	Graphic	□	Closed back	■
	Non-Graphic	■	Open back	□
	Semi-Graphic	□	Console type	■

b. Indicators (Boiler Drum level indicators As per P&ID)

	All	□	Critical	■
Location	Panel	□	Aux Console	■
Size			OEM Standard	■

c. Annunciator

Type	Mosaic type, micro PLC based
Annunciator Sequence	As per ISA S 18.1A
Filter colour of alarm indication	Red for shut-down Amber for Alarm Green for Running

d. Alarm Annunciation (*As per P&ID*) All ■ No Critical ■yes

e. First out sequence Required ■ *As per detail engineering*

f. Auto/Man Selector Switch (*As per P&ID*) Aux console □ PLC Console ■

g. Emergency PB (*As per P&ID*) Aux console ■

h. Process Bypass Switch (*As per P&ID*) PLC Console ■

i. Common MOS Enable Switch (Note-13) SRR ■

j. Status Lamps (Critical equipments) Aux console ■ *As per P&ID*

Note-13: Once MOS switch is enabled, maintenance bypass can be done for any transmitter within a pre-defined time interval after password entry. The location of MOS enable switch will be inside Control room/SRR.In case of any limitations in implementing the same individual MOS switches shall be considered for all Analog Inputs of ESD PLC located at SRR inside PLC cabinet.

12. Hazardous area instrumentation Philosophy

Panels and Wiring (System End)

Input/Output to DCS

a. Zone 0/Zone 1

Conventional (4-20 mA/HART loops)

Analog Inputs/Outputs	Intrinsic safe	■ Yes
	Non Incendive	■ No

(Field wiring block to have Intrinsically Safe outputs)

Digital Input/Outputs	Relays	■ Yes
Fuse Terminal Blocks (TBs)	For DI/DO	■ Yes

(Fuse TB's shall have fuse blown indication on both +ve & -ve terminals)

b. Zone 2/ Safe Area

Conventional (4-20 mA/HART loops)

Analog Inputs/Outputs	Intrinsic safe	■ No
	Non Incendive	■ Yes
Digital Input/Outputs	Relays	■ Yes
Fuse Terminal Blocks (TBs)	For DI/DO	■ Yes

Input/Output to Package control systems and PLC (For interlocks/ ESD)

a. Zone 0/Zone 1

Conventional (4-20 mA/HART loops)

Analog Inputs/Outputs (Note-14)	Intrinsic safe	■ Yes
	Non Incendive	■ No
Digital Input/Outputs (Note-13, 14)	Relays	■ Yes
Fuse Terminal Blocks (TBs)	For DI/DO	■ Yes

(Fuse TB's shall have fuse blown indication on both +ve & -ve terminals)

b. Zone 2/ Safe Area (Note-16a)

Conventional (4-20 mA/ HART loops)

Analog Inputs/Outputs (Note-12)	Intrinsic safe	■ Yes
	Non Incendive	■ No
Digital Input/Outputs (Note-15)	Relays	■ Yes
Fuse Terminal Blocks (TBs)	For DI/DO	■ Yes

(Fuse TB's shall have fuse blown indication on both +ve& -ve terminals)

Note-14: Wherever Intrinsic safe philosophy to be followed for DCS/PLC Conventional I/O's, same shall be achieved using Intrinsic safe Barriers (active type).

Note-15: DI/DO for shut-down circuits to use SIL3 relays.

MAKE OF PANELS/ CABINETS Rittal or Equivalent

- Control panels shall be free standing type and fabricated from 3 mm thick cold rolled steel sheet. Vibration damping pads shall be provided. Panel outer colour shall be RAL7035. Non glossy high satin finish & inside shall be of Pale Cream (IS 352) colour while channel base shall be black. All hinges, screws & other non-painted parts (except related to earthing) shall be of Stainless steel.
- Doors shall be double leaved type with handle and shall be provided with lock and key. Cubicles inside control room shall be provided with exhaust fans and louvers (operating on 230VAC along with min 1 No utility socket).
- System Cabinets/ Cabinets housing IO Cards/ Network Components shall be of Transparent Front door with shatterproof glass for easy visibility of IO/other Component LED's (without opening panel door).
- LED based lamps shall be provided for Cabinet illumination.

Ferrules (for all Instrumentation related Wiring – Field & Control Room) : Single Sleeve with Source & Destination (Direct-Cross Ferruling)

Wiring Colour Code

a) Power supply (230 V AC)	Hot	Red	■ Yes
	Neutral	Black	■ Yes
	Earth	Green	■ Yes
b) DC Wiring (110 V DC)	Positive	Red	■ Yes
	Negative	Black	■ Yes
c) Alarm System		White	■ Yes
d) Control & Shutdown		Yellow	■ Yes
e) Analog Signals (Intrinsically safe)		Light Blue	■ Yes
f) Analog Signals (Non – IS Type)		Grey	■ Yes

13. Power supply requirements

a. Power supply Voltage Level

Power supply	110 V AC 50 Hz UPS	110 V DC	24 V DC	230 V AC 50 Hz Non UPS	415 V AC50 Hz Non UPS
DCS	■				
Supervisory Computer / Operator Station	■				

Package Units	■				
Alarm Annunciator	■				
PLC	■				
Solenoid Valves	■		■		
Transmitters/Positioners			■		
Gas detection System	■				
Gas Detectors			■		
Beacons			■		
Analysers	■		■		
Analyser System	■				
DCS Training KIT	■				
Level Gauge Illumination				■	
Cabinet Lighting/Utility sockets				■	
Local Panel	■			■	
CCTV	■				
Analyser Shelter AC				■	■
Flame scanners/detectors			■		

b. Power supply Distribution

- Local Panel UPS DB ■ Yes SRR DB ■ Yes
  (Above 1 KVA load in LCP shall be from UPS)
- Analyser Shelter UPS DB ■ Yes SRR DB □No
- Instruments & Analyzer UPS DB □ No SRR DB ■ Yes

c. Cable Entry

- Control Room MCT Blocks ■ Yes
- SRR MCT Blocks ■ Yes
- Analyzer Shelter MCT Blocks ■ Yes
- Local control rooms/buildings MCT Blocks ■ Yes

All cables (Instrument & electrical) entering the Control room/ SRR / Local control room shall also be via MCT blocks located above ground (min 1500 mm above FGL).

14. Signal Communication

a. 4-20mA with `HART' protocol ■ yes □ no

4-20mA with `HART' protocol shall be used for field transmitters connected with Interlock/ Shutdown PLC and for control valve positioners where FF is not being used. This shall be applicable for any new projects (Major projects/Expansion projects).
Licensor/ Antisurge equipment vendor specific requirements, if any, to be considered.

b. Output Meter
- ❖ Local Integral with transmitter ■ yes □ no
- ❖ Remote Series Connected ■ yes □ no

c. Wireless communication Note-16 ■ yes □ no
Same shall be battery operated type

Note-16: This technology may be adopted in applications like pump seal plan related instruments, non-critical motor & pump vibration (accelerometer type) & temperature measurements (complete with all analytical softwares), instruments in utility application (non-critical & non mass-balance cases), exchanger Temperature measurements, (non-critical & non mass-balance cases) etc. (Shall be decided during project detailed engineering). Licensor specific requirements, if any, to be considered.

d. Modbus over 485 ■ yes □ no
OPC ■ yes □no

This shall be used for communication between DCS and other digital sub-systems, including package unit control system, analyser systems, package control system/PLC's, Speed Governors, Anti Surge Controllers, etc. All package unit control systems (PLC based) shall have redundant OPC with Tunnelling & Firewall communication interface or Modbus RTU Interface (For Small Packages) with DCS. OPC with Tunneling & Firewall / Modbus over RS485 interface will be decided during detail engineering. For other subsystems like Analyser, MMS, etc. Redundant Modbus over RS485 is also acceptable. Licensor specific requirements, if any, to be considered.

e. Manufacturers' standards ■ yes □ no

Instrumentation such as for machine monitoring, tank gauging, subsystems, for motor operated valves, etc. may have other signal transmission requirements according to Manufacturers' standards. Licensor's specific requirement, if any, to be considered.

f. Pneumatic Signal transmission† (3-15 psi) ■ yes □ no

g. Air Filter Regulator Filter Size †5 micron Max. ■ yes □ no

† This shall be applicable only for control valves and On/Off valves/ Shutdown valves/Analysers. Licensor specific requirements, if any, to be considered.

h. Redundancy of Communication ■ yes □ no

By default Communication between DCS and other third party system shall be Redundant& hot standby.

i. Process Instrument Type for shut-down/interlock/control/indication.
- ❖ Level Transmitter ■yes Process Switch ■ No

❖ Flow	Transmitter	■ yes	Process Switch	■ No
❖ Temperature	Transmitter	■ yes	Process Switch	■ No
❖ Pressure	Transmitter	■ yes	Process Switch	■ No
❖ Pump seals	Transmitter	■ yes	Process Switch	■ No
❖ Package units	Transmitter	■ yes	Process Switch	■ No
❖ Skids etc	Transmitter	■ yes	Process Switch	■ No
❖ Any other	Transmitter	■ yes	Process Switch	■ No

15. ELECTRICAL SAFETY IN EXPLOSIVE ATMOSPHERES

a. Type of Hazardous area protection Note-17
The selection of type of protection shall be in accordance with IEC 60079-14.

ZONE 0 Intrinsic safety
Ex 'ia' ■ yes □ no

ZONE 1 Intrinsic safety or
Ex 'ia' or Ex 'ib' ■ yes □ no

ZONE 2 Ex 'ia' or Ex 'ib' or Ex 'ic'
Intrinsic safety / Non Incendive Ex 'n' /Ex 'nL' ■ yes □ no

Note-17: Increased safety (Ex 'e') or Flame proof (Ex 'd') can be used in Zone 1/ Zone 2 areas if the voltage level involved is of 110 V DC or 110 V AC or 230 V AC, subject to CCOE/PESO approvals.
If Ex "d" is required for 24VDC instruments, these shall be subjected to approval (except for Field Mounted Reset/Shutdown/Vibration Switches).

b. Field transmitters (*Note 18*)
IS ■ Flame proof/Ex Proof □

c. Field switches (*Note 19*)
IS ■ Flame proof/Ex Proof ■

d. Solenoid valves, LCP Lamps, Push Buttons, Tx's requiring separate Power supply, LCP's etc
IS □ Flame proof/Ex Proof ■

e. Positioners
IS ■ Flame proof/Ex Proof □

f. Special Instruments, Analysers, etc
IS ■ Flame proof/Ex Proof ■

g. Pressurized panels (*Note 20*) (Z purge) ■ Yes

h. Intrinsic barrier(If required)

Isolating type	■ Yes
Non Isolating Type	■ No
Zener Barriers	■ No

i. Local Indicators

Integral with Transmitters	■ Yes
Separate Indicator	■ Yes

Loop powered indicators shall not be wired to HART based instruments that form a part of ESD / Sequence Logic / Control Loop.

j. Weather proof class IP65

Junction Boxes		■ Yes
IP65	Field Instruments	■ Yes
IP20	Control Room Panels	■ Yes

Note 18: If Intrinsically safe is not available for any instruments, then it must be Flame proof. MCC I/Os shall be non-intrinsically safe. The shutdown/ interlock inputs to PLC shall be intrinsically safe.

Note 19: Among field switches, only proximity limit switches shall be intrinsically safe.

Note 20: Pressurized panels shall not be used unless unavoidable.

k. Earthing System – Note-21, 22

1. Panels, racks, cabinets, consoles , shelters etc. and all	Electrical earth grid Junction boxes	■ Yes
2. System/Signal earth	Separate Signal earth pit	■ Yes

Note-21: *DCS/ PLC console/ panel & system earthing shall follow ring philosophy / as per DCS vendor recommendation (subject to approval).*
Note-22: *Other package system cabinets/ panels located inside control room/ SRR shall be connected to common panel earth (in the ring network or as per DCS or package vendor recommendation whichever is stringent.). Same is applicable for signal/ system earth also.*

l. Type of cables (*Note-23*):

Flame retardant and low smoke	■ Yes
Flame retardant and Fire resistant	■ Yes (Note-24)

Note-23: *All Cables used shall be of the Armoured type only.*
Note-24: To be considered for branch cables for limit switches and solenoid valves of fire safe valves and deluge valves.

m. HDPE conduits — For FO cables below ground (laid inside Trenches) ■ Yes

n. Cable entry to junction boxes /Panels etc
- Metric thread ■Yes
- Bottom entry ■ Yes

16. Flow Instruments

a) General Service

For 2" lines and above
- Orifice Plate ■
- Vortex Meter ■

Other_____

For 1½" lines and below
- Variable Area meter ■
- Meter Run (as per application) ■
- Integral Orifice ■
- Vortex Meter ■

Other as per licensor

Types of Tap for orifice
- Flange Taps (Note-25) (For line size ≤14 “) ■
- D-D/2 Taps (For line size >14 “) - Note-25 ■

Note-25: For high pressure rating (600# and above), flange tap for line size ≤ 16“.

b) For highly viscous and fouling service
- Mass Flow Meter (Coriolis type) ■
- Ultrasonic ■
- Orifice (Quandrant) *Note-26* ■

Other As per Licensor recommendation

Note-26: Quadrant Orifice shall not be used for heater pass flows, trips & unit mass balance based instruments.

c) Custody and Product Metering (Note-27)

Liquids	Ultrasonic	■	Turbine	□	Mass flow (As per P&ID)	■
	PD Meter	■				
Gas	Orifice	■	Ultrasonic	■	Mass flow (As per P&ID)	■
Performance Metering	Orifice	■	Mass flow	■	Ultrasonic	■

Any other (As per P&ID)

Note-27: 1. DP Type Primary Flow Elements for Product Metering/Unit Mass Balancing to have straight lengths for zero additional uncertainity as per ISO5167.

2. *Temperature Compensation shall be given for Mass flow meter from external Class A RTD and it shall be connected to MFM transmitter in case of pipe line transfer meters.*

d) General Note-28

High Rangeability	Orifice	■	Vortex	■	Mass flow	■	
Flare Flow	Ultrasonic	■	Other _____				
Combustion Air Flow	Venturi	■	Thermal Mass flow	■			
Cooling water	Ultrasonic	■	Magnetic flow	■	(*only in above ground*)		
	Averaging Pitot Tube	■	Orifice	■	(*only in above ground*)		

Note-28:

- Liquid flow measurement process data shall include density at standard conditions (At 15 Deg C) in addition to flowing density and normal / minimum / maximum flows, etc. All liquid flow meters shall be sized for flow density at 15 Deg C. and all Gas flow meters shall be sized for Nm^3/Hr flow (P=1 atm & T=0 Deg C).
- For orifice with rangeability above 1:4 and up to 1:8/1:12 (1:8 for closed loops & 1:12 for open loops) dual transmitters shall be considered. Above 1:8/1:12 (1:8 for closed loops & 1:12 for open loops) rangeability, special flow meters like vortex flow meter and coriolis mass flow meter shall be considered. In general, dual flow Transmitters shall be avoided due to practical issues. Where flow meters are already indicated with dual/multi transmitter or special flow meters like mass flowmeter, vortex, ultrasonic etc in the process package/licensors requirement, the same shall be considered.
- For mass flow measurements, Vortex meters shall not be considered. Vortex Flowmeters shall be sized for the worst possible conditions also (start-up/shutdown/any other abnormal process conditions). Supports shall also be provided for coriolis mass Flow meters to avoid line vibrations affecting measurement.
- For Venturi, DP range shall be min 250 mmH2O & the same shall have high pressure recovery/minimal permanent pressure loss.
- Venturi shall be classical venturi as per ISO5167.
- The variable area flow meter shall be metal tube type including for purge flow measurement.
- Orifice Sizing shall be as per ISO 5167 & Flanges shall be as per ANSI/ASME B16.36. Orifice Flanges shall be min 300#.
- Drain/Vent hole, as applicable shall be provided for Orifice plates installed in horizontal lines.

- Flow Instrument Tappings in general shall be 1/2"NPT, while for viscous/congealing/lines>8"- tappings shall be 3/4"NPT. Viscous/ congealing service will have diaphragm seals, wherever shown in P&ID.

17. Temperature Measurement (Note-29)

a) Temperature gauges — Bimetallic ■ — Filled system □ — Every angle type ■

Case material SS304 ■

All temperature gauges are to be bimetallic type in general upto operating temp. of 350°C. Filled type temperatures gauges are envisaged only for underground locations (like sump), high temp. (above 350°C), Vibration services, long u-lengths (U length more than 500mm). Filled system if used shall be gas filled type with capillary extension. Mercury filled temperature gauge shall not be used. Capillary tubing shall be minimum of SS316 with stainless steel flexible armouring, having PVC covering over armour.

b) RTD (≤400°C) PT-100, 3 Wire, calibration as per IEC 60751 ■
For machine parameters
For Custody transfer Class A type.

c) K type TC(>400°C) as per IEC60584 ■

d) E, T, R, S and other type TC <u>As per licensor recommendation</u>

e) Thermocouple Type — Grounded ■ — Un-grounded □

f) Optical pyrometers — For Furnace chamber temperature (with nozzle purging)

g) Thermo well flange rating

Thermowell Flange Size for Vessels Refer Nozzle Schedule attached Flange
Size for piping 1.5” ■
For multi-point TE's on tanks 3" flanged connection ■
3" flanged connection can be used for Tanks. 4" for special services like SRU Incinerator Package and SRU MCC package.
Minimum 300# Flange Class ■
Screwed thermowells shall not be used.
Other <u>As per licensor’s requirement.</u>

h) The Thermowell immersion length shall be standard as per refinery philosophy as follows.

Line Size: 4” to 6”	Immersion Length: 280 mm
Line Size: 8” & above	Immersion Length: 320 mm
For Vessels	Immersion Length: 400 mm

All temperature elements are expected to have minimum line size expansion of 4", to be implemented in the course of detailed engineering.

The above include Thermowell nozzle projection of 200 mm. (i.e. *Immersion length is based on 200 mm length between flange face and* ***inner wall of pipe)***

All temperature elements are expected to have minimum line size expansion of 4", to be implemented in the course of detailed engineering.

i)	Temperature Transmitter (with Hot Back-up)	Required	■	Not-required	□
j)	Dual Compartment housing	Required	■		
k)	Transmitter Location	Control-room	□	Field	■
		Head-mounted	□	Remote-mounted	■

Note-29:

1. *All temperature elements shall be of duplex type, MgO insulated & SS sheathed (subjected to temperature limitations) with Spring loaded terminals.*
2. *UG Tanks shall use Temperature Elements with built-up thermowells." (Still well is not required as thermowell is provided.)*
3. *Thermocouple Terminals shall be colour coded as per element colour code (IEC).*
4. *Element Sheath diameter for all RTD, Thermocouple & Temperature Gauges shall be standardised to 8mm OD (except for Bearing & Winding Temperatures).*
5. *Skin Thermocouples shall be retractable type with guide assembly (guide assembly shall be part of weld-pad). Heater skin Thermocouples shall have shielding+insulation arrangement for correct measurement in addition to tube clamps/clips. All skin thermocouples shall be with sheath material ofSS-446 / 416 upto 600°C, Inconel 600 for temperature above 600°C and upto870°C unless specified otherwise.*
6. *Wake frequency Calculations shall be generated & furnished for all Thermowells, as per latest ASME PTC19.3 Standard.*

18. Level Measurement(Notes-30)

a)	Level Measurement	DP type	■
		External Guided Wave	■
		Ultrasonic	■
b)	Interphase Level Measurement (Note-32)	DP Type	■
		Magnetostrictive (Note-31)	■
		External Guided Wave	■

Note-31: Shall also have Magnetic LG attached as part. Magnetostrictive type Level Instrument shall be used for interphase level measurements for mixture of liquids or special liquids for which dielectric constant are not available.

Note-32: In vessels for Interface level (Liq/Liq) measurements, it shall be ensured that top level tapping shall always be immersed in liquid phase. LP tapping location with respect to Baffle Plate height shall also be checked.

c)	Chamber for Guided wave Radar instrument	Required	■

GWR LT Chamber - connection Nozzle Size: *2"* ■ yes

Vent & Drain for GWR/any chamber mounted instrument Required ■ yes

d) Following stipulations shall be applied for standpipes (Note-33)

- ❖ Standpipe shall not have instruments other than for level ■yes
- ❖ Standpipe accommodating level gage/transmitter for control shall be separate from standpipe/vessel tappings for level switches/transmitters for alarm and trip ■ yes
- ❖ Standpipe shall not be connected to process lines ■yes

Note-33: Standpipes with a default size of 2"NB shall be considered for only clean, non-viscous and non-crystallising services. Standpipes shall be used if more than 4 vessels nozzles are anticipated for mounting all the level instruments in a given service. (However 2oo3 LT's shall have independent vessel nozzles).

e) Separate standpipes for Trip and Control Required ■

f) Dedicated Nozzles Required ■

g) External Level Instrument connection size and Flange Class Refer Nozzle Schedule attached.

h) *For Level application, First isolation (By piping), Instrument isolation Valve & Vent/Drain valve shall be* ***TSO*** *Gate valve. Valve Trim and Handle shall be of SS material*. For closed vent & drain systems, additional facility (*incl. Valves & filling connections*) for level instrument filling shall be provided.

i) Level Indicators Magnetic Gauges ■
Gauge Glasses ■
Material (All metal parts including studs &bolts) SS316 (min) ■

j) Tank Level Gauging Radar ■ Servo □
Wherever redundant/ two level gages are considered in a tank, their working principle should be different viz. Servo + Radar (e.g. Mounded Bullet storage)

k) TFMS Radar ■ Servo □
Communication with DCS Required ■
Redundancy ■ Yes

l) Special Level Instruments (*As per P&ID/Licensor requirement*)
Nucleonic ■ RF ■
Ultrasonic ■

m) Agar Probes Desalter ■ Slop & crude tanks ■

Level Switch for Tank

Over spill Level switch: An independent hardwired level switch like Vibrating Fork etc. shall be provided for actuating ROSOV. Over spill level switch should be connected to ROSOV through safety PLC for SIL loop compliance.

Notes-30:

- *Level Tappings in the vessel/equipment shall be located such that impingement from process streams flowing into the equipment is prevented. Where necessary, this shall be achieved by installing deflection plates in the equipment (e.g., Stripper Columns, etc).*
- *Standpipes shall not be used for a liquid/liquid interface application using dP measurement.*
- *For Interface measurement with Guided wave radar instrument, the bridle may require additional connections to vessel to assure the interface in the bridle is representative with the interface in the vessel.*
- *Internal level instruments shall not be applied for applications where instrument removal requires shutdown of the process.*
- *The lower level nozzles shall be taken from side only.*
- *Isolation valves for standpipes shall be provided.*
- UG Tanks shall use Still well based GWR LT's or Antenna radar LT's (depending on level to be measured).To be decided during detailed engineering.
- GWR LT's shall not be used for measurements above 1219mm (in AG Vessels). Above shall require pre-approvals in addition to accessibility & removal facilities
- DP Type Level Transmitters shall be installed at the same elevation as the HP Tapping of the instrument.
- LT & LG tapping locations & elevations shall be checked w.r.t Vessel Sketches (in addition to Level Sketches), prior to approval for Vessel Fabrication.
- Servo type level instrument shall have full bore type ball valve for isolation followed by calibration chamber with depressurizing valve and Pressure gauge.
- For pressurized services (e.g. LPG Bullets), double isolation valves shall be provided.

19. Pressure Instruments

a) Pressure Gauges

General Service	Bourdon tube	■
Congealing/Plugging service	Diaphragm Seal type	■
Vibrating applications (*Note-34*)	Oil filled gauges	■

Note-34:

For pulsating pressure applications (typical on the discharge of reciprocating compressors and PD pumps),

Metallic hoses shall be used for connecting filled-PG's at the outlet of pumps.

Pressure Gauge Diameter	150 mm	■
Pressure Gauge case material	SS304	■

- *All Gauge pressure services shall have Solid front & blow-out protection for pressure ranges above 0 - 10 kg/cm2 (g) in addition to Shatterproof Glass of min 3mm thickness, white background with black lettering.*

- *Movement mechanism shall be Hardened SS while the Sensing element, Socket & Tip shall be SS316 (min).*
- *Upto 40 kg/cm2 (g) max operating pressures shall use C-Type Bourdon.*
- *Above 40 kg/cm2 (g) max operating pressures shall use Helical Bourdon.*

20. Gas Detection System and Flame Detectors(*Note-35*)

a) HC, H2 Detectors — Catalytic diffusion ■ Only for H2; IR Type ■ For HC; Any other _____

b) H2S Detectors — Electrochemical ■; Wireless □; Any other _____

c) Other Gas Detectors (As per process package)

d) Beacon For each Detector (Auto Reset) Required ■
LED Type (Rotating/Flashing Type) Required ■
Blue for H2 /Red for HC/Yellow for H2S, Chlorine.

e) Hooter — Area-wise based on audibility Required ■; Pneumatic Type – with SOV or Electric Required ■

f) Hooter Reset — At Field Required ■; At Operator Console Required ■

Note-35:

1. *Gas Detectors and Flame detector shall be minimum SIL-2 certified.*
2. *Gas detectors shall be interfaced with ESD PLC with dedicated I/O's and marshalling.*
3. *Each such PLC shall be interfaced with respective unit DCS.*
4. *Flame detector shall be UV/IR type & It shall not contain any radioactive material.*
5. *HMI's with graphic pages and audio-visual alarms shall be provided in locations like Operating Panel of the Unit in respective Control Room.*

21. Control Valves and On/Off valves (Note-36)

a) Control Valves

Type — Globe ■ — Other type (*As per requirement*) ■

Actuator — Pneumatic diaphragm for Control application ■; Pneumatic Cylinder (**with spring return**)for High DP application ■

Connection — Flanged ■ Minimum as 300# and above as per piping specification

Body Rating	■ Minimum as 300# and above as per piping specification	
Extended Bonnet	For High temperature (>200 Deg C) application	■
	For Cryogenic application	■
	As per service condition	■

Note: Gland packing shall be zero emission type for toxic / aromatic application.

Positioner

For critical applications Like Antisurge etc.	4-20 mA, HART	■

- *All Positioners shall provide continuous Valve position feedback indication at DCS (4 to 20 mA HART).*
- *Positioner mounting to Actuator shall be in accordance with IEC60534-6-1, VDI/VDE-3847, IEC60534-6-2, VDI/VDE- 3845 & NAMUR mounting standards.*
- *AMS Plug-in Software for Advanced Diagnostics of Valve & Actuator along with Licenses (valid for Maximum possible Tags) shall be supplied.*

Leakage class	As per ANSI /FCI 70.2	Class V (min)	■

For Flare applications, leakage class shall be meeting Class VI (FCI 70.2) / API598 (Air & Water), whichever is more stringent.

Sizing calculations	As per ISA S 75.01 (IEC 60534-2-1 Mod)	■
Face-to-face dimensions	As per ANSI ISA 75.08 or IEC 60534	■

Note-36:

- When a control valve is used as a final element of a protective function (valid only for non SIL loops / for loops where an On-Off valve already exists in series with the above mentioned Control Valve), it shall be equipped with a solenoid-operated valve between the valve positioner and the actuator. The primary purpose of the valve remains throttling control. The optional use of a control valve as a final element in a protective function does not make that valve an on/off valve. In case the control valve requires a bypass for operational reasons that bypass shall normally be closed and locked.
- Use of a control valve as a final element of a protective function (permissible only for non SIL loops / for loops where an On-Off valve already exists in series with the above mentioned Control Valve) only affects the requirement for a solenoid-operated valve. It does not affect other requirements such as material selection, stroking time and allowable leak rate.
- The vendor of compressor shall consult vendor of anti -surge system and vice-versa for all compressor anti-surge valve sizing requirements.
- Wherever constant set pressure needs to be maintained (Nitrogen blanketing service, FG service etc) self actuated PCV's may be provided.
- PCV's shall meet Min Class V leakage requirements. Incase not available due to process conditions, class-IV can be considered.

b) Qualification of severe service conditions (all pressures in kPa).

Severe Service Condition	Calculation	Limit	Notes
Cavitating service	dP/(P1 - Pv)	>0.38	Only for liquids P1=Upstream Pressure Pv=Vapor Pressure of Liquid. Other cavitation conditions as per sizing shall also be considered.
Flashing service	P2/Pv	<1.0	Only for liquids P2=Downstream Pressure Pv=Vapor Pressure of Liquid
High pressure drop ratio(choked flow)	dP/P1	>0.6	P1=Upstream Pressure
High turn-down ratio	Qmax/Qmin	>10	
High power conversion	dP(Pa) x Q	>30 kW	It is applicable for liquid service only. The differential pressure across a control valve multiplied with the volumetric flow rate (equals velocity) provides an indication for the power conversion that takes place inside the valve. This energy conversion will be from potential energy into thermal energy (heat), kinetic energy (velocity) and acoustic energy (noise). This figure is an indicator for the intensity of the conversion that takes place inside the control valve. Power (in KW) = DP in kg/cm2 x Flow in m3/hr / 360.
High noise	Noise > 85 dB	> 85 dB	
Erosive applications			Entrained solids

If the process conditions meet any of the above limits, then the valve selected for such service shall be classified as Severe Service and due care shall be taken while sizing and selecting the control valve. The selection of valves for severe service applications shall be based on proven applications experience.

In addition to these criteria, severe service conditions always apply to:

- Compressor anti-surge/spillback valves;
- Minimum flow recycle valves;
- Liquid drain valves on HP separators and knock-out vessels;
- Boiler feed-water valves / Steam service Valves
- Valves that experience heavy out gassing (release of gases absorbed or dissolved in pressurised liquids).

If none of the above conditions apply (including start-up, commissioning and emergency conditions) the application can be met by a general service valve.

All Control Valve characteristics selected should produce a closure member position of 35 to 65 % of travel at normal flow rate & Valve Operating range shall be in range of 10 to 90% of

travel for all of the Flow condition specified. (Shall never be less than 10% opening for min flow & never be more than 90% opening for Maximum flow case).

c) Shut down valves and/or on-off valves

Type	Ball	■	Other type (*As per requirement*) ■
Actuator	Pneumatic Cylinder (Piston Cylinder **with Spring Return,** Note-37)		■

Note-37: Double acting type actuator shall not be used for FO/ FLO/ FLDO/ FC/ FLC/ FLDC type valves. $$

Connection	Flanged	■ Minimum as 300# and above as per piping specification
Body Rating		■ Minimum as 300# and above as per piping specification
Fire Safe Valves		■ As per P&ID

In such cases Valve, Actuator, & all other Accessories including Cabling shall be of Fire Safe design & Valve shall have fire safe monogram. Actuator Fire Proofing shall be easily removable & re-installable for any maintenance requirements without dismantling the actuator (shall be of the Flexible protective jacketed enclosure type)& sealing of entries shall use jacket supplier supplied compounds / materials.

Positioner	For PST applications 4-20 mA, HART	■

- *Positioner mounting to Actuator shall be in accordance with IEC60534-6-1, VDI/VDE-3847, IEC60534-6-2, VDI/VDE- 3845 & NAMUR mounting standards.*
- *AMS Plug-in Software for Advanced Diagnostics of Valve & Actuator along with Licenses (valid for Maximum possible Tags) shall be supplied.*

Leakage class	Zero(NIL) Leakage as per ANSI 70.2 Class VI or For on-off valves minimum TSO as per API -598 (air and water).

d) Valves (On/Off & Control valves) on services required to meet **TSO** (Tight Shut Off or Zero leakage)
Leakage criteria
For on-off valves minimum TSO as per API -598 (air and water) shall be followed. For TSO control valves ANSI leakage class VI for soft seated and leakage class-V for metal seated shall be followed. Minimum leakage class for control valve is class V.

Applications:	Flare application	■ Yes
	Shutdown application	■ Yes
	Drier Application	■ Yes
	Sequence/batch/Regen	■ Yes
	Other As per P&ID	■ Yes

e) Partial Stroke Testing facility

for Critical On/Off valves (*Note*)	Required	■ Yes
	Fail Close valves	■Yes

Fail Open valves ■No

Note: Valves for which PST facility required shall be identified in P&ID review/Licensor documents/HAZOP/SIL study. AMS Plug-in Software for Advanced Diagnostics of Valve & Actuator along with Licenses (valid for Maximum possible Tags) shall be supplied.

f)	Solenoid valve body& enclosure material	SS316	■ Yes
	Insulation Class	Class H	■ Yes
g)	Air Filter Regulator Drain & Handle Material	SS316	■ Yes
	Pressure Gauge	Required	■ Yes

(*AFR/AFR's shall be provided to prevent entry of dust to actuator/ SOV/ Positioner/ Volume Tank/ other connected accessories*)

h)	Fittings, Accessories &Tubing Material	SS316L	■ Yes
i)	Mounting Plates, Linkages & Connecting Rods	SS316	■ Yes
j)	Goose Neck/Vent protection from water	Required	■ Yes

k)	Limit Switch	Proximity Inductive type only	■ Yes
l)	Valve Travel Indication (Local)	SS Scale With Travel marking in %	■ Yes
m)	Packing Type	Live Loadable only (without disconnecting actuator)	■ Yes
n)	Position Transmitter (Integral with positioner)	Required for all control Valves	■ Yes
o)	Any other	Licensor/ Process Requirements / P&ID	

Valve & Actuator Colour Coding shall be decided during detail engineering.

22. Machine Monitoring System (MMS)

Required(As per OEM)	■ Yes
Transient Data Recording Facility (for all MMS/VMS)	■ Yes
For monitoring (As per OEM)	■ Yes
For predictive maintenance	■Yes
Engineering Laptop with Licensed Software	■ Yes
Display of Vibration & Temperature Readings in Local Panel	■ Yes
Dedicated for each Equipment	■ Yes
Compliance to API 670	■ Yes
Voting / Logic in MMS	■ No

(Separate contacts for each of the individual machine protection parameters of Vibrations, Temperatures, Speed, Axial displacements, etc shall be individually wired from MMS System

to ESD System. Hardwired Reset Contact shall be provided for each of the MMS Systems (from DCS/ESD PLC).

23. CCTV System*(Note-38)*

Required	■ Yes
For Process units	■ Yes
Flare	■ Yes
Plant surveillance	■ Yes

Note-38: Recording facility required for all camera points for minimum 1 month. Clock shall be synchronised with DCS clock.
CCTV system shall cover following area:

a. *CCTV shall cover Loading bays, truck parking area, Tank farm area, pump houses, entrances of all buildings, periphery, Gate pass issue area, security frisking area, barrier gates shall be covered by CCTV cameras.*

24. RIM Seal Fire Protection System

Required ■ Yes

Same shall be an Intelligent Automatic self sufficient system without any external control/logic from DCS/PLC. Same shall meet requirements of ASME Sec VIII Div 1, OISD-115, OISD-116, OISD-117 & NFPA-11.

a) Detection		Pneumatic linear heat detection System	■ Yes
		Decentralised (Dedicated to each Tank)	■ Yes
		Hollow Metallic Tube	■ Yes
		Propellant Nitrogen	■ Yes
	Extinguishing	Foam Based Unit	■ Yes
	Mounting Location	Top of Floating Roof Tank	■ Yes
b) Centralized Fire Alarm Panel / Aux Console of DCS		Pushbuttons for Actuation (*in addition to decentralised local actuation Push buttons*)	■ Yes

(Shall not be mixed with Process Alarms & Switches - i.e., to be Segregated.)

		Alarms/Faults of Actuation Required	■ Yes
	Mounting Location	SRR / Control Room	■ Yes

Panel shall be SRR mounted. Indications shall be available at Operator Console. Repeat signal connectivity (redundant) provision to Fire Station shall be provided from the package vendor control system.

Redundant Modbus over RS485 to DCS	■ Yes

25. Electrical & Instrumentation interface

a)	Status indication to control system (DCS/PLC)	Potential free contact at MCC	■ Yes
		Wetting voltage24V DC by DCS/PLC	■ Yes
		For all Drives	■ Yes
b)	Commands from Control system	Potential free contact at SRR ■ Yes	
		Wetting 240 V AC/110 V DC by MCC	■ Yes
c)	Separate Interfacing MCC cabinet for Substation signals	Required	■ Yes
		Location SRR / Substation	■ Yes

Applicable for New Units only and not applicable for Revamp units. Revamp Units shall follow the existing philosophy. However, segregation at Marshalling Level shall be ensured. MCC interface cabinet can be located in SRR or substation.

d)	Termination through isolators & Fuse TB's (For AI/AO signals coming from MCC/Substation)		■ Yes
e)	Interposing relays for MCC DI/DO	Required	■ Yes
f)	Termination through Fuse TB's	Required	■ Yes
g)	Separate contacts for Start and Stop/Trip	Required	■ Yes

(Only one contact shall be considered for stop/ trip)

h)	Local/Remote status	Separate contact by MCC	Required	■ Yes
i)	SS/MCC to SRR cable Entry	Through MCT Blocks	Required	■ Yes
j)	Combining SRR with Substation		Allowed	■ Yes
k)	Remote set point facility in VFD/ Thyristors		Required	■ Yes
l)	Motor Operated Valves used in Interlock	Wetting voltage 24V DC by MOV		■ Yes
		Potential free contact at DCS/PLC		■ Yes

(For Commands from PLC/DCS)

m)	Motor Operated Valves used in Interlock	Limit Switch (Inductive Proximity based)	■ Yes
		Solid State / Micro-switch Contacts	■ No

(For feedback based Interlocks in PLC/DCS – only Proximity based Limit Switches shall be used)

n) In case of DCS start/stop of electrical drives the final relays at DCS/PLC can be
- For START : Energise for the Closure of contact for Starting.
- For STOP/ TRIP/ ESD: The relay shall be de-energise to trip (fail safe) by opening of contact.

- Shall be Close to Start at DCS/PLC end (for Non-Fail Safe cases).
  In-case of any specific Fail-Safe requirements (specified by Licenser/ Package equipment OEM), open to Start shall be considered from DCS/PLC end. Suitable modifications shall be undertaken later at electrical end (during Pre-commissioning/Commissioning).

o) For electrical start operation of drives from DCS/PLC following signals must be available in DCS/PLC
   - Drive local / remote (From Substation)
   - Drive auto/man (DCS/PLC selection)
   - Drive Ready to start (From Substation)

p) For electrical operation of drives that require Start Permissive from DCS/PLC, Latching shall be done at Substation/MCC end.

q) For Electrical Drives having Start / Auto Start requirements, the drive running indication shall preferably be wired to the PLC used for executing such logic.

Where measurement of electrical parameters such as current, voltage, power consumption, speed, torque, temperatures, etc in electrical equipment is required for interlock execution in ESD PLC or for control application, analogue 4 to 20 mA DC signals to the DCS/PLC shall be provided from Substation end.

Where measurements of these electrical parameters are required only for indication and recording in the DCS, redundant serial communication (Modbus over RS 485) shall be provided or hardwired signals as DI to PLC.
Dual redundant port (RS-485) connection over MODBUS-RTU from Data concentrator panel to DCS to be provided. This connection shall be done through 2P, copper, overall shielded, armoured cable. Following status shall be taken through this connection for all the breaker feeders (motors rated above 55kW and incomer breakers of HV/PMCC/EPMCC).

• Current
• Trip circuit healthy
• Breaker ON
• Breaker OFF

r) Uninterrupted Power Supply (UPS): Separate for each SRR shall be ensured.

26. Accuracy of measurement

The required accuracy of a measurement depends on the type of measurement and service and shall meet the tolerance classes and accuracy figures listed below as a minimum.

Type of Measurement	Tolerance Class A	Tolerance Class B	Tolerance Class C
Application	• Custody Transfer • Critical Reactor Feed control	• Internal Accounting (Unit Material Balance)	• Regular Monitor and control

Flow	Liquid*: Better than 0.25 % of reading.* Gas/steam*: Better than 0.5 % of reading.*	Liquid*: Better Than 1 % of reading.* Gas/steam*: Better than 1% of reading.*	*Better than3% of reading.*
Level	*Better than 2 mm (.079 in) (absolute)*	*Better than 5 mm (.079 in) (absolute)*	*Better than 3% of adjusted span*
Pressure	*Will be decided on case by case application*	*Better than 0.25 % of adjusted span*	*Better than 1 % of adjusted span*
Temperature	*− TC type E/K/J: tolerance class 1 as per IEC 60584-2.* *− TC type T/B: tolerance class 2 as per IEC 60584-2.* *− RTD: IEC60751 Class A* *− Others: To be assessed on a case-by-case basis to suit specific requirements.*	*− TC type E/K/J: tolerance class 1 as per IEC 60584-2.* *− TC type T/B: tolerance class 2 as per IEC 60584-2.* *− RTD: IEC60751 Class A* *− Others: To be assessed on a case-by-case basis to suit specific requirements.*	*− TC type E/K/J: tolerance class 1 as per IEC 60584-2.* *− TC type T/B: tolerance class 2as per IEC 60584-2.* *− RTD: IEC60751 Class A* *− Others: Better than 1 % of adjusted span.*

Overall accuracy requirements for Temperature Transmitters shall be better than ± 0.5% & for Pressure/DP type Transmitters shall be better than ± 0.075%, unless higher accuracies are specifically required for the application. SIL2 certified PT/DPT shall be considered.
The accuracy figures include linearity, hysteresis, repeatability, static pressure and temperature effects on the instrument. The accuracy requirements apply under all normal design and operating conditions, including alternative operating modes such as regeneration and emergency operation etc.
The accuracy requirements given above are minimum requirements and licensor specific requirements.

27. Analogue (HART) Transmitters fault detection

All Transmitters shall comply with NAMUR NE-43 recommended values for abnormal signal levels for 4-20 mA type output signals. DCS/ESD PLC shall detect a faulty signal when the signal is less than 3.7 mA or above 20.8 when NAMUR NE-43 is used. Burn-out detection shall be enabled for all ESD/Interlock applications & the direction of burn-out shall be towards the fail safe direction.

28. Proveness Track Record (PTR)

Product life cycle of any instrument shall be at least in the mid of the cycle during procurement.
a) For Instrument Items (Other than Systems) The instruments as being offered / supplied should have been operating satisfactorily in a Hydrocarbon processing industry like Refinery, Petrochemical and Gas Processing Plant under similar process conditions for at least one year.
b) For System Oriented Items i) The system (with all its sub-systems) as being offered / supplied should have been installed and operating satisfactorily in a Hydrocarbon processing industry like Refinery, Petrochemical and Gas Processing Plant for at least one year (as collaborated by user certificate). ii) The system should be supplied, engineered, integrated, tested etc. from a factory from where the system / sub-systems as offered / supplied have already been supplied, engineered, integrated tested etc. and meet the criteria b(i) above.
iii) All the activities including engineering should be carried out by the agency which has carried out the similar activity in the past and meets the criteria b (i) above. However in case of systems specified for confirming to Safety Integrity level (SIL) certified by statutory authorities like TUV etc., the basic engineering for the system shall be carried out by the agency/ manufacturer on whose name TUV certification has been issued by the TUV authorities. iv) The system should be supplied by the manufacturer in fully engineered condition or should be supplied by the manufacturer's representative / subsidiary who have proper infrastructural facilities and meets the criteria b (i) above. v) In any case, the manufacturer whose system is being offered / supplied should have a local representation / subsidiary which has the proper infrastructural facilities like engineering, installation, maintenance, testing, spare part support, system fault diagnosis and other related logistic support for the system and application provided. Systems, which don't have the local base, shall be avoided.

29. Environmental Protection

All instruments, systems and related components shall comply with the environmental conditions as specified in the Project specification. The effects of the local environment on instrumentation shall be considered, and where required additional environmental protection shall be included (tropical requirements, protection from intensive sunlight). Field-mounted instruments shall be suitable for operation in industrial, humid, saliferous and corrosive atmospheres and shall be adequately protected according to the electrical area classification.

Special attention shall be paid to instruments and ancillary equipment that will be used in marine (e.g. jetty) services and/or installed in coastal or offshore environments. In such cases hermetical sealing of the electronic circuitry is required. Depending on site conditions, the contacts of switches/relays may require protection against traces of H2S and SO2 in the indoor and outdoor atmospheres by gold coating (at least 10 μm (394 μin) or by locating them in hermetically sealed housings.

The minimum degree of ingress protection of plant instruments shall be IP 65 as defined in IEC 60529.
For outdoor locations, the climatic conditions of location class D2 of IEC 60654-1 shall also apply. For corrosive influences, classification in accordance with IEC 60654-4 shall also apply. Suitable alternate as per EIL standards can also be considered.

Lightning surge protection is normally not required inside the process unit. However for instruments mounted at Height (Top of column, Structure, etc) or in tank farm areas, surge suppressions shall be made available.

30. Instruments selection guidelines

30.1. General

Instruments with continuous analogue signals (e.g. Foundation™ Fieldbus, HART) shall be used. Foundation™ Fieldbus is the preferred signal type for control and monitoring application. HART is the preferred signal type for trip/interlock application. Discrete (on/off),direct mounted, field switches (e.g. Temperature, Flow, level and pressure switches) shall not be used unless approved by the Client/Licensor

In-line instruments shall comply with the requirements of the piping class or equipment in oron which the instruments are installed (Min 300#).Threaded process connections are not allowed for both on-line and in-line instruments, except for orifice flange tappings, and manifold compression fittings.

For all instruments with flanged connections, flange rating shall be minimum 300#.

30.2. Pressure and Temperature Limits for Pressure containing parts

For in-line instruments, the upper and lower pressure and temperature limits of the pressure containing parts shall meet the requirements of the piping class, as a minimum. For in-line instruments associated with equipment where no piping class applies (e.g. vessels/columns/heaters/package units/etc), the upper and lower pressure and temperature limits of the pressure containing parts shall meet the upper and lower design pressure and temperature of the related equipment, as a minimum.

For on-line instruments, the upper and lower pressure limits of the pressure containing parts shall meet the requirements of the piping class, as a minimum. For on-line instruments associated with equipment where no piping class applies, the upper and lower pressure limits of pressure containing parts shall meet the upper and lower design pressure of the equipment, as a minimum.

In addition to the above, differential pressure type instruments shall be capable of withstanding the upper and lower pressure limit requirements of the piping class in either direction (positive and negative), as a minimum.

The lower pressure limit is relevant for an instrument if its value is below atmospheric pressure (under any process condition – normal/abnormal). In such cases it is important to realise that the instrument shall be capable of functioning under (full or partial) vacuum conditions. The lower temperature limit is relevant for an instrument if its value is below zero degrees Celsius (under any process condition – normal/abnormal).

For process connection to instruments from Equipments/columns/ Vessels/ Tanks/ Piping/ Heater refer the Instrument Nozzle selection table.

30.3. Selection of Material of Construction

Materials shall be selected to suit process and environmental conditions, and shall be corrosion resistant. Material selection is in general related to the material of the equipment and piping. As a general rule, AISI 316(L) will be suitable in systems with austenitic stainless steel or carbon steel equipment and piping, but it may be unsuitable in carbon steel systems containing water with chlorides, in chloride-containing environments or other corrosive services. If chlorides are present, Incoloy 825 tubing with stainless steel fittings shall beused. The stainless steel shall be resistant to intergranular corrosion in accordance with ASTM A 262 Practice E. Where AISI 316L stainless steel tubing and associated fittings are selected over Incoloy 825, and insulation or tracing is required, the effect of the insulation/tracing material contributing to chloride stress corrosion from these products shall be evaluated.

For wetted parts of in-line instruments subject to pressure, temperature, erosion and corrosion, the selection of materials shall meet the minimum requirements of the piping class in addition to the below mentioned requirements.

a. ‘Sour’ or ‘Wet H2S’ service:

The materials selection of parts of instruments and components which under any process condition are in contact with process water or aqueous condensate shall comply with the requirements of ISO 15156 or NACE MR0103, as applicable, and the relevant piping class. NACE Certificates shall be provided for all such Instruments & Components.

b. ‘IBR’ Service

The materials selection of parts of instruments and components which are located on/connected to IBR lines/equipments shall comply with the requirements of IBR, as applicable, and the relevant piping class. Valid Certificates & documents including Form 3C shall be provided for each of those items (e.g. Control Valves, Pressure Relief Valves, Orifice Flanges, Orifice Plates, Level Instruments, Thermowell, etc. incl. Installation materials that are in contact with the Service medium).

c. Services with strong reducing acids

In services (e.g. demineralisation plants) where strong reducing acids such as pure hydrochloric and sulphuric acid are used, all wetted parts (excluding the diaphragms of pressure transmitters, differential pressure transmitters and diaphragm seals) shall be of Hastelloy B-2. The measuring element diaphragm material shall be Tantalum (Ta).

The measuring element diaphragm material shall be selected in accordance with the above-mentioned requirements. The following additional requirements apply:

Services containing hydrogen and ‘Sour’ or ‘Wet H2S’ services require special attention to be paid to instrument diaphragms to prevent hydrogen penetration.

These diaphragms shall be gold-coated (min 3µ for direct mounted type transmitters & min 5µ for diaphragm Seal type Transmitters) in the following cases:

- Dry hydrogen service / Dry Hydrogen Containing Services - if the partial pressure of hydrogen is above 700 kPa (abs) (100 psia) and the temperature is above 30 °C (86 °F) use SS316L as base material with Gold Plating. Dry H2S containing services may also preferably use SS316L with gold plating.
- For 'Sour' or 'Wet H2S' or "Wet H2 + H2S" services, Hastelloy C or better metallurgy (as base material) shall be provided to prevent corrosion.
- Vendor to provide higher thicknesses based on internal calculations, if required.

d. Transmitter Electronic Housing

Transmitter electronic/electrical component enclosures shall be copper free aluminium/SS with the manufacturer's standard baked-on epoxy coating. For offshore or near shore (Jetty) saliferous environments, use of 316SS electronic housing is recommended. All Transmitters shall have Dual compartment housing.

e. Diaphragm Seals

For pressure, flow or differential pressure and level measurement, diaphragm seals shall be used, instead of standard pressure transmitters with impulse piping/hook-up, in the following applications:

i. In Waxy, sticky, plugging services.
ii. In viscous (>200 cSt) applications (subject to the manufacturer's temperature limit on the diaphragm).
iii. Where the impulse fill fluid is not stable (e.g. may boil / weather out /density change by greater than 5% / requires frequent refilling).
iv. Where impulse lines require process tracing and to prevent clogging/freezing. Where there are plugging concerns that would otherwise require rod out facilities.
v. If the fluid temperature at the instrument under any normal or abnormal operating condition exceeds the maximum allowable temperature of the sensing element.

For crystallising services like Coker pass flow, Crude/ Vacuum Heater pass flow services Ultrasonic meters shall be used.

The diaphragm seal size shall be selected to obtain the required instrument accuracy (Also refer Instrument Nozzle selection table for process connection to instruments from Equipments/ columns/ Vessels/ Tanks/ Piping/ Heater). For instruments with remote seals, the capillary material shall be stainless steel AISI 316(L) and shall be mechanically protected by flexible stainless steel armouring. All capillary shall be neatly dressed on FRP cable Trays / 30mm Angle supports neatly fabricated & installed at location.

The length of the capillary tubing shall suit the application but shall be at least 3 m.

Filling fluids for capsules and diaphragm seals shall not present a hazard to the environment in the event of a diaphragm failure(shall be inert & compatible with process fluids).Fill liquid shall such that under all ambient and process temperature conditions,acceptable response time(>5sec) will be achieved.

Diaphragm seals used in vacuum service, i.e. services with a sub-atmospheric lower design pressure shall have fill liquids and connections suitable for vacuum service.
Transmitter with diaphragm seals in vacuum service shall be mounted at least 50 cm below bottom equipment tapping.

Calibration (spacer) rings shall be provided for each diaphragm seal so the transmitter may be calibrated without being removed from the process isolation valve.

31. Units of Measurement

Flow	Liquid	m^3/ hr (Note-39)	■
	Gas	Nm^3/ hr (Note-39)	■
	Steam	Kg/ hr (Note-39)	■
Level		%	■
Pressure		kg/cm^2 g	■
Absolute Pressure in Vacuum Service		mmHg	■
Temperature		°C	■
Viscosity		cP	■
Density (For liquids)		kg/m3	■
Molecular Weight (For gases)		MW	■
Differential Range Units for Flow Measurement		mmH_2O	■

Note-39: Unless otherwise recommended by Operations/ Licensor. Liquid flows to be in m3/hr with Density at 15 Deg C. Gas flows to be in Nm3/Hr with Temp=0 Deg C and Pressure =1.033 Kg/cm2 (a).

32. STANDARDS FOR INSTRUMENT CONNECTIONS, MATERIAL & ENCLOSURE

Instrument connections, material of construction and type of enclosure protections shall be as per following codes & standards

Flange	ANSI /ASTM
Thread	NPT
Material	ASTM
Sour Services	NACE
IBR Services	IBR
Hazardous area certification	
For imported instruments	IECEx, ATEX, CENELEC, UL, CSA
For indigenous make	CCOE & CMRI certificate/ approval instruments /accessories

All imported instruments shall also have PESO (CCOE)Approval.

33. General Requirements

a) Instrument Installation

Close Coupled	■ Yes
Remote Mounted	■ Yes

(*Case to case basis where instruments are inaccessible, subject to approval*)

b) Prefabricated **Close Coupled Hook Up** (Note-40)

Flow	■ Yes
Pressure(PG, PT)	■ Yes

Note-40: *Hook up shall be standard bought out with prefabricated and pre-hydro tested. For steam application Piping with condensate POT may be used. Certificates for Hydrotest, Material test, PMI, Radiography, Helium Leak test (as per PMS requirements), IBR (as per PMS requirements), NACE (as per PMS requirements) shall be provided. Material of construction of close coupled hook up shall be minimum SS316.*

Wherever Prefabricated Close coupled hook ups are used, first isolation valves shall be a part of hook up assembly. In such cases separate First isolation valve by piping is not required. First isolation valves for prefabricated hook up shall follow Clause (i) requirements provided below.

EPCM/DEC/LSTK/ Package Vendor shall develop site installation procedure for pre-fabricated/ close-coupled hook-up's in consultation with Pre-fabricated hook-up vendor & shall furnish the same for MRPL review.

c) Piping with tubing at Instrument end	Level	■ Yes	
	DPT	■ Yes	
Equalising Leg for Level application	Required	■ Yes	
d) Impulse Piping with Close Coupled Hook ups Example: Air, N_2, Water, etc	Utilities	■ Yes	
e) Impulse Piping with Close Coupled Hook ups	HC service	■ Yes	
f) Impulse Tubing Size (With 1.2 mm wall thickness (min), higher thickness required based on working pressure)	12 mm OD	■ Yes	
g) Impulse Piping without Close Coupled Hook up	High Pressure Service	■ Yes	
	Steam Flow	■ Yes	

h) Instrument valve manifolds

i)	For pressure gauges	Integral	■	Fabricated	□
ii)	For flow / DP transmitter	Integral	■	Fabricated	□
iii)	For Others	Integral	■	Fabricated	□

Note: *Wherever Prefabricated Hook-ups are selected, Manifold shall be part of pre-fabricated close coupled hook ups*

i) Impulse line valves (After First isolation valve by piping)

Isolation valves	Gate	■	Ball	■
Vent/drain valves	Gate	■		
Equalising valve	Gate	■		

j) Junction Boxes (Note-40 a)

- For conventional Analog Signals (4-20 mA/HART, RTD, T/C), Low voltage Digital signals like Proximity

MOC	Die Cast aluminium Alloy (Non IS: Grey colour, IS/Non-Incendive - Sky Blue) or Polished Stainless Steel (Note-40 b)	
Weather protection	IP65/NEMA 4X	
Hazardous Area Certification	Exe or Ex d or Ex ia	
Wiring Terminal Blocks	Cage clamp Type	■ Yes
Wiring Terminal Blocks	Front entry	■ Yes
Terminal Numbering	Top to Bottom	■ Yes
Shield Terminal	Every Third Terminal	■ Yes
Shield Terminals	Isolated from Body	■ Yes
Body Earthing	External to JB	■ Yes
Junction Boxes cable entry	Bottom	■ Yes
Hinged covers with Self locking	SS Allen screws	■ Yes
Cable Gland Thread	Metric thread	■Yes
Spare Cable entries	(20% of each Type)	■ Yes

Note-40 b: For Coastal areas Stainless Steel Junction boxes meeting the hazardous area requirement shall only be used. However, only for Ex-proof signals, Die Cast aluminium Alloy junction box meeting the hazardous area requirement can be provided.

- For Ex-proof Signals (SOV, Field Push Buttons, other Switches, Power Cables, etc)

MOC	Die Cast aluminium Alloy (Grey colour) (Note-40 b)	
Weather protection	IP65/NEMA 4X	
Hazardous Area Certification	Ex d	
Wiring Terminal Blocks	Cage clamp Type	■ Yes
Wiring Terminal Blocks	Front entry	■ Yes
Terminal Numbering	Top to Bottom	■ Yes
Shield Terminal	Every Third Terminal	■ Yes

Shield Terminals	Isolated from Body	■ Yes
Body Earthing	External to JB	■ Yes
Junction Boxes cable entry	Bottom	■ Yes
Hinged covers with Self locking	SS Allen screws	■ Yes
Cable Gland Thread	Metric thread	■Yes
Spare Cable entries	(20% of each Type)	■ Yes
MOC	Polished Stainless Steel	
Weather protection	IP65/NEMA 4X	
Hazardous Area Certification	Exe or Ex d or Ex ia	
Wiring Terminal Blocks	Cage clamp Type	■ Yes
Wiring Terminal Blocks	Front entry	■ Yes
Terminal Numbering	Top to Bottom	■ Yes
Shield Terminal	Every Third Terminal	■ Yes
Shield Terminals	Isolated from Body	■ Yes
Body Earthing	External to JB	■ Yes
Junction Boxes cable entry	Bottom	■ Yes
Cable Gland Thread	Metric thread	■Yes
Hinged covers with Self locking	SS Allen screws	■ Yes
Spare Cable entries	(20% of each Type)	■ Yes

Note-40 a*: Field wiring block to have Intrinsically Safe outputs for usage in Zone-0 / Zone-1. Junction Boxes shall have CCOE/PESO approvals for the area of usage.*

k)	Cable Glands	Double Compression	■ Yes
		SS316	■ Yes
		Flame proof	■ Yes

Cable Glands & Adaptors shall be certified for the area classification.
Spare Cable Entries shall be plugged with SS316 Flameproof Plugs, rated for the area classification

l)	Heat Tracing Method	Steam Trace	■
		Electric Heat Trace	■

- *Note: Each instrument shall have a dedicated steam supply and condensate return line with isolating valves, labeled with the instrument tag number. The steam supply to one instrument shall not be divided into parallel sections, i.e. for each instrument a single continuous path is required from the steam supply point up to the steam trap. Each tracer line shall terminate in a condensate return line via a steam trap. Steam tracing to have traps every 40 mtr for long lines & dedicated steam traps for every steam tracer.*
- *Note: Electrical Tracings shall have suitable short-circuit/ground/fault protections.*
- *Adequate Insulation & Cladding shall be provided to eliminate effects due to heavy monsoon.*

m) Tubing — Copper Tube of 8 mm OD ■

n) Steam Jacketing (e.g., Control Valves) — Required ■ Yes

o) GROUNDING (Note-41)

❖ Control room mounted panels, racks, cabinets, consoles -body earth (Includes panel mounted bulk power supply earth)	Separate Dedicated Earth pit
❖ System Earth (Electronic Circuit ground, shields, drain wires,etc)	Separate Dedicated Earth pit
❖ UPS body earth	Electric Earth Grid
❖ Junction Boxes	PVC insulated GI wire
❖ Field Mounted Panels (Body & System Earth)	Same as Control Room Mounted Panels

Note-41: *System/Shield/Signal earth shall be less than 1 Ohms while Body Earth shall be less than 5 Ohms (unless lesser values are required by System Vendors).*
All UPS & 24VDC supplies shall be floating type. Any specific system that requires grounded 110VAC Neutral (e.g., Package PLC Systems, Air Demand Analyser, etc) shall have isolation Transformer dedicated for the individual requirement (so that overall supply does not get grounded).

p) INSTRUMENT CABLING
In general over head cable routing to be followed & all cables shall be armoured. In case any special cables/sensor cables are available only as un-armoured, they shall be laid along its entire length in Anaconda (or equivalent type) conduit having durable, flame retardant & low smoke PVC integral jacketing over Cable Trays/ducts. The same shall be glanded at both ends using appropriate special gland fittings.

i. Cable Routing

- ❖ Main cable way — Cable duct ■ Yes
- ❖ *Process Unit contractor/DEC shall extend & connect the Unit's Cable duct from Unit's Battery Limit to Offsite Battery Limit. Necessary structural work including installation shall be performed by the process unit contractor/DEC.*
- ❖ Branch cable way — Perforated Branch Tray ■ Yes
- ❖ Material — FRP ■ / GI ■

Generally GI cable trays shall be used. But in units like DM plant, Sulphur units FRP cable tray shall be used.

ii. Cables
For DC mA signals — Single pair for individual runs

	Multi-pair for main runs (Use 6 pair / 12 pair)
For RTD cables	Duplex Triad for individual runs Multi-triad for main runs (Use 6 Triad / 8 triad)
Modbus RS485 Cables	Two Pair
For T/C (or compensating Cables)	Two pair for individual runs Multi pair for main runs
Gas Detectors	Single Triad for individual runs Multi-triad for main runs (Use 6 Triad / 8 triad)
For Power Supply (2.5 mm^2 min) (*Cable size requirements to be Calculated & arrived at*)	2 or 3 core for individual runs (12, 24 core) For Multi-core cables
For Control Cable	Single pair for individual runs (Solenoids) (1.5 mm2) (2.5 mm2 for SOVs where total distance is more than 500 Mtrs) Multi-pair for main runs (Use 6 pair / 12 pair)

Cable specification

All cables shall be of low toxic, low halogen FRLS type (both Inner and Outer Sheath) with water and chemical resistivity. IS cables shall be Blue & Non-IS cables shall be black All Multipair/Multi-Triad Cables shall have min 20% spare.

Cables shall not be routed near heater body/heat dissipating equipment. In case the same is unavoidable, such cables used shall be moisture resistant & shall have high temperature insulation.

iii. DC mA signal, Proximity Signal and mV signal (except Thermocouples)

Rated Voltage	1100 V
Core size	1.5 mm^2 for single pair /0.5 mm^2 multi pair. 1.5 mm2 for Duplex Triad- for RTD's 1.5 mm2 for Multi-triad- for RTD's. 2.5 mm2 for Single Triad (Gas Detectors). 2.5 mm2 for Multi-triad (Gas Detectors)
Core Material	Copper, 7 strands, 0.53 mm dia for Single pair/ Single Triad/ Two Triad/Multi-triad. Copper, 7 strands, 0.3 mm dia for Multi pair.
Core Insulation Material	XLPE conforming to BS-5308 / IS-7098.

Insulation thickness	Conductor Insulation: 0.6 mm (Min).
Sheath Material	Flame retardant, Low smoke, Low toxic, PVC/XLPE. (Note-42)
Individual screen for single pair	Required.
Individual and overall screen for multi pair	Required.
Armouring	Required with round GI wires.
Spares	Minimum 20% per multi pair cable Wired & connected at both ends.

iv. AC Power Supply, SOV and On-off Switch Signals

Rated Voltage	1100V
Core size	2.5 mm² min. for Power supply (subject to power cable sizing requirements). 1.5 mm² Paired for Solenoid Valves & others. (2.5 mm2 for SOVs where total distance is more than 500 Mtrs)
Core Material	Multi-stranded Copper.
Core Insulation Material	XLPE conforming to BS-5308 / IS-7098.
Sheath Material	Flame retardant, low smoke, lowtoxic, PVC/XLPE . (Note-42)
Armouring	Required with round GI wires
Spares	Minimum 20% per Multipair/ Multipair cable wired & connected at both ends.

Note-42 Fire resistant cables to be considered for branch cables for limit switches and solenoid valves of firesafe valves and deluge valves meeting IEC60331.

v. Compensating cable / Extension wire for Thermocouple

Applicable code	IEC 60584
Core size	1.5mm² or 16AWG for Two pair. 1.0 mm² or 18 AWG for multi pair. (For length up to 300m) 1.5 mm² or 16 AWG for multi pair. (For length >300m)
Core Insulation Material	XLPE conforming to BS-5308 / IS-7098.
Sheath Material	Flame retardant, low smoke, low toxic, PVC/XLPE.
Individual screen	Required
Individual and over all screen for multi-pair	Required
Armouring	Required with round GI wires
Spares	Minimum 20% per multipair cable Wired& connected at both ends.

vi. Fire Optic Cable Armouring Required

Core Insulation Material	Multiple Insulation layers.
Sheath Material	Flame Retardant.
Armouring	Required with round GI wires & Tape armouring (Double Armouring)
Rodent Resistance	Required
Outer Insulation Colour	Orange for Single Mode. Yellow for Multimode.
Spares	Minimum 8 fibers per cable spliced & connected at both ends.
LIU (Link Interface Unit)	Required
Patch Cords & Converters	Required (Redundant)
OFC Converter Power Supply	110VAC

q) INSTRUMENT AIR SUPPLY PIPING/TUBING

Air supply method for local instruments	Through SS316 Air header, SS316 pipe,SS316 air manifold & SS316 tube laid & clamped in FRP/GI cable trays.	
Piping material	SS316	
Valve Type & material	Ball valve, SS316 (for each inlet, individual branches & also for drain line)with locking provision -in full open condition.	
Air tubing size	12mm & 6mm.	
Instrument Air Distribution	By Direct Piping	■ No
	Air Distribution Manifold	■ Yes

Note-43: Distribution shall be from the sides of air manifold & Drain Valve complete with nipple & cap shall be provided at the lowest accessible location.

Air Supply Pressure at B/L	3.5 Kg/cm^2 g (Min)
Spare tapping points in Air Manifold	Yes (20%). Shall be complete with Ball Valve & Plug.

Note: PVC or Poly Ethylene/Poly urethane jacketed SS316 tubing shall be used in acid handling units like DM plant, Cooling tower etc.

r) Minimum instrument connection rating on vessel/ column/equipment 300# ■ Yes

For all instruments with flanged connections, flange rating shall be minimum 300#.

s) Size of Instrument Nozzles — Refer Instrument Nozzle details attached.

t) Any Analyzer/ GC Installation

	Analyzer Shelter	■ No
	Analyzer Cabinets	■ Yes
Analyser& System Preservation Required		■ Yes
Analyser Cooling arrangement	Vortex Cooler	■ Yes
	Ex-proof AC (*in Redundant*)	■ Yes
Analyser Tubing/Piping	SS316(min)	■ Yes

Analyser& Probe Online Maintenance	Required	■ Yes
Analyser Sample Handling System (SHS)	Required (Note-44)	■ Yes

Note-44:

- *Removal of dust/fines using duplex filters, Pressure Regulation, Flow Control, Auto Sample cut-off with alarm in abnormal/high moisture/low temperature situations, Excess Flow limiting, Fast Loops, NRV's at Sample return points, isolations, Heating of probe & Sample (incl avoidance of Sulphur/other applicable dew points under abnormal conditions), Vaporisation/Cooling, Moisture Removal, etc shall be ensured as part of SHS to avoid any sort of worst-case damages to analyser system.*

u) Safety valve, Class V/ VI, TSO Control/On_Off Valve testing at site:

At Site	By Contractor	■ Yes
Testing jig	Required	■ Yes
All Valves	Required	■ Yes

Testing at Site is in addition to the testing at Manufacturer's Works.

v) Wiring Terminal Blocks	Cage clamp Type	■ Yes
Control Room /Local Control / Panel / Field Junction Boxes (Wago or equivalent)	Front Entry type	■Yes

w) Prefabricated FRP Canopy (Machine moulded)

Junction boxes	■ Yes
All Field Transmitters	■ Yes
All Field Pushbuttons	■ Yes
Positioners	■ Yes
Temp Elements	■ Yes
Radar Instruments	■ Yes
Solenoid valves	■Yes
Special Instruments	■ Yes
Local Panels	■ Yes
Field Cabinets	■ Yes
Any other_____	

- *FRP canopy design shall be approved by Client (UV Resistance Type).*
- *Canopy to cover the instrument from all sides with a front window & openable shutter for terminal side (for Transmitters) & with a front openable shutter for Junction Boxes.*
- *All canopy drawings & arrangements shall be furnished for review & approval. Tag number shall be painted on Canopy.*

x) Advance Diagnostic Softwares	Positioners	■ Yes
	Field Instruments	■ Yes
Plug-In software for AMS (Maximum Tag licence)		■ Yes
y) Vibration Switch Contacts (Fin Fan)	Min 2 Sets of DPDT /Switch	■ Yes

- *Facility for Vibration measurements from Fin fans: Vibration switches (as indicated above) to be used in revamp units. Transmitter using suitable Velometer/ Accelerometer to be used in new units.*
- *Vibration Measurements in Cooling Tower shall mandatorily be based on proximitor/ Velometer/ accelerometer based analog readings (for Trip/ indication).*

z) ***SIL Calculations*** *(For all SIL Loops)* Required ■ Yes

Using Third Party Softwares (*like Exida exSILentia / equivalent, Note-45*) Required ■ Yes

Performed by Safety Certified Engineers (Note-45) Required ■ Yes

All Relevant Certificates & FMEDA Reports Required ■ Yes

Note-45: SIL verification (as applicable) with third party softwares (*like Exida exSILentia / equivalent*) and performed by safety certified engineers to be considered in DCS / PLC vendor scope. $$

aa) **Closed Sampling System** (based on Sample Type)

i. Quick Connect/Release coupling (min SS316) at Both ends Required ■

ii. Non Return Valves (min SS316) at I/L, O/L & flare connection in Sampling system. Required ■

iii. Excess Sample Releasing facility (Note) Required ■

Note: Sample Bomb (min SS316) with facility to release excess sample trapped b/w isolation valves (of sample bomb & inside sampling system) at both ends by vent/drain valves: The same shall be integral to sample bomb isolation Valve.

iv. SS Flexible hose at 1 end for connecting to sample bomb Required ■

v. Sample bomb holder inside Panel (rigid-for connecting Bomb to Sampling System) Required ■

vi. SS316 Drain / Vent connections complete with bulkheads for outside panel connection Required ■

vii. Vent/Drain Connection to Flare/Atm/Blowdown (Based on service) Required ■

viii. Isolation Needle Valves (min SS316) Required ■

ix. SS Enclosure for Sampling System Required ■

x. Pressure Gauge for both filling & emptying out Sample Bomb – inside Sampling System enclosure Required ■

xi. Bypass from Sample Inlet to Sample Outlet with Needle Valve Isolation (min SS316). Required ■

xii. Dispensing Unit complete with Valves & Gauges For collecting sample from bomb to bladder (to be installed at MRPL QC Lab. Shall be complete with venting out facility) Required ■

xiii. Spare Valves, hoses, QC Connectors (10%) Required ■

xiv. Spare O-Rings (200%) Required ■

bb) **Calibration Bench at Workshop (**Note-46**)** $$ Required ■
(with following minimum facilities)

i. Reference Pressure Instrument (with Calibration Certificate)of -1.00 to 30.00 kg/cm2 (g), as a minimum with ½"NPT connection.
ii. 110VAC, 110VDC, 230VAC, 24VDC Regulated Power supplies incl distribution & isolation facilities.
iii. Instrument air supply complete with AFR, Calibration Facility & Hook-up for instruments (12mm OD SS Tube).
iv. A separate heavy duty workbench with bench & pipe vices
v. 1 No key shelf
vi. 2 Nos of metallic documentation Cabinets (min 4 Shelves each to keep A4 size Box files in standing position – approx 1mtr wide) of reputed make with front glass window & liftable cover.
Note-46: Design of Workbench shall require MRPL approval.

cc) **Configuration & Troubleshooting** Laptop/s with licensed software/s & connecting accessories for
i. Radar/any other Special Instruments
ii. 5 sets of Intrinsically Safe Hand held Communicator & Configurator (HART) with complete license & upgrade package along with Carrycase & 2 Sets of additional connecting cables. $$

34. General Notes:

a) Control room shall not have false flooring (even in rack room). Cable trench and cable vault philosophy.
b) Trip related instruments shall be stenciled using Red lettering on white background.
c) DCS related instruments shall be stenciled using black lettering on yellow background.
d) ESD Push Buttons/Reset Push Buttons shall have their service/specific function Stencilled.
e) All Field, LCP & Cabinet Mounted ESD Push buttons shall have a protective liftable cover to prevent mal-operation & shall have min 2 sets of DPDT micro switches.
f) All bolts used for mounting & interconnecting cable ducts, for the mounting of Instruments & Junction Boxes shall be of SS.
g) All System oriented items & Analysers shall require Client inspection.
h) All Utility/Power Sockets & Power Plug/Adaptor shall be having L, N & E meeting Indian requirements (Plug Type D).
i) Tuning of all Control Loops shall be the responsibility of the Unit Contractor. The Contractor shall have his own/external specialist during commissioning of the unit.
j) Tuning of Batch Controller and DCV for desired batch accuracy shall be responsibility of Package supplier /LSTK Contractor.
k) Unit Licensor/ Package Equipment Vendor (OEM) shall provide schematics, complex loop algorithm & write-up's for the various process control loops & also the relevant cause & effect drawing and write-up for Interlocks (in addition to FBD's).

l) It shall be contractor/package vendor/ EPCM//DEC's responsibility to ensure compliance of Design Basis requirements in packages as well.
m) Custody transfer flow meter model shall be Indian legal metrology approved.
n) Flow Meter and Batch controller shall have Weights & Measure lock (both hardware and software lock)
o) Control valves/Shut down valves/On-Off valves/line mounted Flowmeters/Analyser probes shall be installed only after final line flushing and hydrotesting activity. Flushing/Hydro Test schemes shall be developed accordingly during Pre-commissioning/Construction.
p) Electronic Instruments shall have the following information stamped:
Instrument Tag No., Make / Model no., Serial number, Range of measurement Body and element material, Area Classification.
q) All instrument datasheets shall be prepared using ISA Formats / formats approved by Client.
r) Any type of license shall be perpetual type/license for life (all licenses shall be for maximum possible with the system) & all licenses shall be purchased in the name of MRPL.
s) FAT & SAT Procedure for (Factory / Site Acceptance Test) of PLC, DCS & Analyser Systems shall be furnished for MRPL review. EPCM/DEC/LSTK (involved in the procurement of the system) shall co-ordinate all FAT & SAT activities.
t) Point database for DCS & PLC (per Unit) shall include Main Plant & all Packages, as a single document. The point database for packages shall be prepared by the respective vendor in the common format. DEC shall integrate all Package documents & shall be provided as a single document during the course of detail engineering.
u) Steam Traps/Drip Legs/CRS Collection Funnels shall not be located near Electronic Instruments & Junction Boxes.

Owner's Specific Requirements:

All points marked with $$.

Owner's Additional Specific Requirements:

a) All Package Control Systems (including PLC's), any System Oriented Items (like ASC, Speed Governor, CCTV, etc): Shall consider 1 No Hardwired Input for Time Synchronization with the Main Plant DCS. This can be done across PLC's, MMS/VMS, Governors, CCTV Systems. This is a normal technical requirement for any post-event analysis.
b) Cause & Effect Graphics with First Event (First-up), wherever applicable, shall be provided for all Package Based Control Systems (having dedicated HMI) by respective package vendors.
c) GPS Time Synchronization shall be considered. The Main Plant DCS, PLC, CCTV & all other Package Systems shall be time synchronized.
d) For all New Units SRR shall have SOE Station in addition to the DCS & PLC Engineering Stations.

35. ACCESSIBILITY REQUIREMENT FOR INSTRUMENTS (NEW UNITS):

Accessibility identifies the effort required for a healthy human being to reach devices such as an instrument, measuring element, instrument process connection, instrument utility connection, block valve or sampling point for the purpose of operational attention or regular maintenance. It includes the ability to reach such a device with all tools required to perform such operational attention or maintenance. In this context, four accessibility levels are defined as follows:

Note: *Pre-fab hook-up based Pressure/Differential Pressure type instruments under the following categories (which can be accessed using mobile platforms/mobile ladders) are excluded from accessibility requirements listed under this clause:*

- *located on the first tier (bottom-most tier at max 4.50 mtr elevation from FGL) of ISBL pipe-rack.*
- *Instrument complete with close coupled pre-fab hookup located at less than 5.00 mtr from FGL.*

a) Permanent accessibility

A device is considered permanently accessible if it is located not more than 0.2 m horizontally away from and not more than 1.5 m vertically above grade, platform or walkway, if no obstructions are in place and if such locations can be safely reached from those levels during plant operation. Such a device shall not be located near steam trap/condensate collection points which are likely to see steam venting/draining during normal/abnormal/start-up operations.

b) Limited accessibility

A device has a limited accessibility if it is located not more than 0.5 m horizontally away from and at a height between 1.5 m and 3.0 meter directly above grade, platform or walkway, if no obstructions are in place **and if** such locations can be safely reached during plant operation by means of a mobile platform or ladder. Such a device shall not be located near steam trap/condensate collection points which are likely to see steam venting/draining during normal/abnormal/start-up operations.

c**) Poor accessibility**

A device has a poor accessibility if it is located more than 3.0 m above grade, platform or walkway **or at** any other location that can only be safely reached during plant operation by installing temporary facilities such as scaffolding or cranes.

A device is also considered to have a poor accessibility if it can only be reached after removal or disassembly of other devices or components, such as thermal insulation, other equipments/instruments or equipment noise hoods.

d) Inaccessibility

A device is considered inaccessible if it cannot be safely reached during plant operation for the purpose of operational attention and maintenance.

The tables provided below indicate the minimum accessibility requirements for field instrumentation.

Process variable	Minimum accessibility requirements for plant instruments			
Instrument type	**Permanent**	**Limited**	**Poor**	**Inaccessible**
		(see note below)		
NOTE: Instruments involved in Trip shall be permanently accessible.				
Analysers				
- Transmitters	□			
- Isolation Valves & Probes	□	□ (case-by-case basis)		
Flow				
Custody transfer, any type.	□			
Coriolis				
- body		□		
- electronics	□			
Differential head type element: orifice/ venturi / nozzle/ annubar		□		
Differential head type element: integral orifice		□		
Differential head type transmitter	□ (purged)	□ (not purged)		
Electromagnetic		□		
Flow limiters				□
Positive displacement	□			
Restriction orifice				□
Thermal Flow Meters (Probe & Electronics)	□			
Turbine	□			
Ultrasonic meter				
- Body	□			
- Electronics	□			
Variable area meter	□			
Vortex		□		
- body		□		
- electronics	□			

Process variable	Minimum accessibility requirements for plant instruments			
Instrument type	**Permanent**	**Limited**	**Poor**	**Inaccessible**
		(see note below)		
NOTE: Instruments involved in Trip shall be permanently accessible.				
Level				
Custody transfer, any type.	□			
Capacitance type / Magnetostrictive Type / Conductivity Type	□			
Differential head type transmitter	□(purged / not purged))			
Displacer/float	□	□		
Radar / GWR / Gauges	□	□		
Remote diaphragm seal	□			
Nucleonic Type (Source, Probe & Electronics)	□			
Tank gauging	□			
Tuning fork		□		
Ultrasonic device		□		
Pressure				
Gauges	□			
Switches	□			
Transmitters	□(purged / not purged))			
Custody transfer	□			
Temperature				
Dial thermometers	□			
Resistance Temperature Detector (RTD)		□		
Thermocouple (T/C)		□		
Transmitters	□			
Custody transfer	□			

Process variable	Minimum accessibility requirements for plant instruments			
Instrument type	**Permanent**	**Limited**	**Poor**	**Inaccessible**
		(see note below)		
NOTE: Instruments involved in Trip shall be permanently accessible.				
Final control elements				
Throttling control valves, including all accessories	□			
On-off Valves including all accessories	□			
Regulators, all Types	□			
Actuators on fans, louvers, dampers etc.	□	□ (case-by-case basis)		
Miscellaneous instruments				
Receiving indicators		□		
Local panels	□			
Junction boxes	□			
Flame/Fire detectors, Gas Detectors, etc	□			
Limit switches	□			
Manually operated devices:	□			
- switches/pushbuttons	□			
- indication lamps	□			
Hook-up materials				
Air filter and air filter regulator	□			
Isolating / vent and drain valves	□	□		
Steam Tracer Isolation Valves		□		
Purge needle valve	□	□		
Seal fluid refill connections and associated valves	□			

It shall be ensured that all piping take-off points (related to instrumentation) during the engineering & construction stage shall be verified by instrument design & construction engineers (of EPCM/DEC/LSTK/Package) so as to change the accessibility level & correctness of an instrument.

Annexures:

1. Annexure-1 Control Room Philosophy – 1 Sheet
2. Annexure-2: Instrument Nozzles on Vessels, Tanks, Piping & Heaters. – 9 Sheets

ANNEXURE-1 TO EDB-005: INSTRUMENT CONNECTIONS ON VESSELS, STANDPIPES AND TANKS

S. NO,	TYPE OF INSTRUMENTS	VESSEL / STANDPIPE CONNECTION	FIRST BLOCK VALVE	INSTRUMENT CONNECTION
1	LEVEL GAUGE ON VESSEL	2" FLGD.	2" FLGD.	3/4" SCRD.
2	LEVEL GAUGE ON STANDPIPE	3/4' S.W./FLGD. *	3/4" S.W./FLGD. *	3/4" SCRD.
3	D.P. INSTRUMENT ON VESSEL	1 1/2" FLGD.	1 1/2" FLGD.	1/2" SCRD.
4	D.P. INSTRUMENT ON STANDPIPE	3/4' S.W./FLGD. *	3/4" S.W./FLGD. *	1/2" SCRD.
5	DIAPHRAGM SEAL D.P. INSTRUMENT ON VESSEL	3" FLGD.	3" FLGD.	3" FLGD.
6	EXTENDED D. P. INSTRUMENT ON VESSEL	4" FLGD.	-	4" FLGD.
7	DIP TUBE LEVEL INSTRUMENT	1 1/2" FLGD.	1/2" SW	1/2" SCRD.
8	TANK LEVEL INSTRUMENT (MECH.) ATM. PRESSURISED (4)	1 1/2" FLGD.	- 1 1/2" FLGD	1/2" SCRD.
9	TANK LEVEL INSTRUMENT (SERVO) ATM. PRESSURISED (4)	6" FLGD.	- 6" FLGD	6" FLGD.
10	PRESSURE INSTRUMENT ON VESSEL	1 1/2" FLGD.	1 1/2" FLGD.	1/2" SCRD.
11	DIAPHRAGM SEAL PRESSURE INSTRUMENT ON VESSEL (SCRD.)	1 1/2" FLGD.	1 1/2" FLGD.	1/2" SCRD.
12	DIAPHRAGM SEAL PRESSURE INSTRUMENT ON VESSEL (FLGD.)	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.
13	THERMOWELL	1 1/2" FLGD.	-	1 1/2" FLGD.
14	STANDPIPE / EXTERNAL CHAMBER MOUNTED LEVEL INSTRUMENT	2" FLGD.	2" FLGD.	2" FLGD.

NOTES:

1. FOR ANY OTHER INSTRUMENT NOT REFERRED ABOVE, THE CONNECTION DETAILS, SHALL BE AS PER INDIVIDUAL REQUIREMENT.
2. ALL FLANGE/SW RATINGS SHALL BE AS PER PIPING SPECIFICATION. (MIN 300#)
3. IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED FIRST ISOLATION VALVES ARE PROVIDED, BOLTING AND GASKET SHALL BE IN PIPING SCOPE.
4. DOUBLE ISOLATION VALVES SHALL BE PROVIDED FOR PRESSURISED SERVICES.

* AS PER PIPING SPECIFICATION.

ANNEXURE-1 TO EDB-005: INSTRUMENT CONNECTIONS ON PIPING

S. NO.	TYPE OF INSTRUMENTS	WHERE PIPING CLASS PRESCRIBES SCREWED CONNECTIONS			WHERE PIPING CLASS PRESCRIBES S.W. CONNECTIONS			WHERE PIPING CLASS PRESCRIBES FLANGED CONNECTIONS		
		PROCESS CONN.	1st BLOCK VALVE	INSTRUMENT CONN.	PROCESS CONN.	1st BLOCK VALVE	INSTRUMENT CONN.	PROCESS CONN.	1st BLOCK VALVE	INSTRUMENT CONN.
1	ORIFICE FLOWMETER	1/2" SCRD.	1/2" SCRD.	1/2" SCRD.	1/2" SCRD. *	1/2" S.W.	1/2" SCRD.	1/2" SCRD. *	1/2" FLGD.	1/2" SCRD.
2	AVERAGING PITOT TUBE	1 1/2" FLGD.	1 1/2" FLGD. (BY INST.)	1 1/2" FLGD.+	1 1/2" FLGD.	1 1/2" FLGD. (BY INST.)	1 1/2" FLGD.+	1 1/2" FLGD.	1 1/2" FLGD. (BY INST.)	1 1/2" FLGD.+
3	PRESSURE INSTRUMENT	3/4" SCRD.	3/4" SCRD.	1/2" SCRD.	3/4" S.W.	3/4" S.W.	1/2" SCRD.	3/4" FLGD.	3/4" FLGD.	1/2" SCRD.
4	DIAPHRAGM SEAL PRESSURE INSTRUMENT (SCRD.)	3/4" SCRD.	3/4" SCRD.	1/2" SCRD.	3/4" S.W.	3/4" S.W.	1/2" SCRD.	3/4" FLGD.	3/4" FLGD.	1/2" SCRD.
5	DIAPHRAGM SEAL PRESSURE INSTRUMENT (SCRD.)	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.	1 1/2" FLGD.
6	THERMOWELL	1 1/2" FLGD.	-	1 1/2" FLGD.	1 1/2" FLGD.	-	1 1/2" FLGD.	1 1/2" FLGD.	-	1 1/2" FLGD.

NOTES -

1 FOR ANY OTHER INSTRUMENT NOT REFERRED ABOVE, THE CONNECTION DETAILS SHALL BE AS PER INDIVIDUAL REQUIREMENT.

2 ALL FLANGE/SW RATINGS SHALL BE MIN 300#.

3 IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED FIRST ISOLATION VALVES ARE PROVIDED, BOLTING AND GASKET SHALL BE IN PIPING SCOPE.

4 INSTALLATION OF ALL IN LINE INSTRUMENTS SHALL BE IN PIPING SCOPE.

* SEAL WELDING REQUIRED.

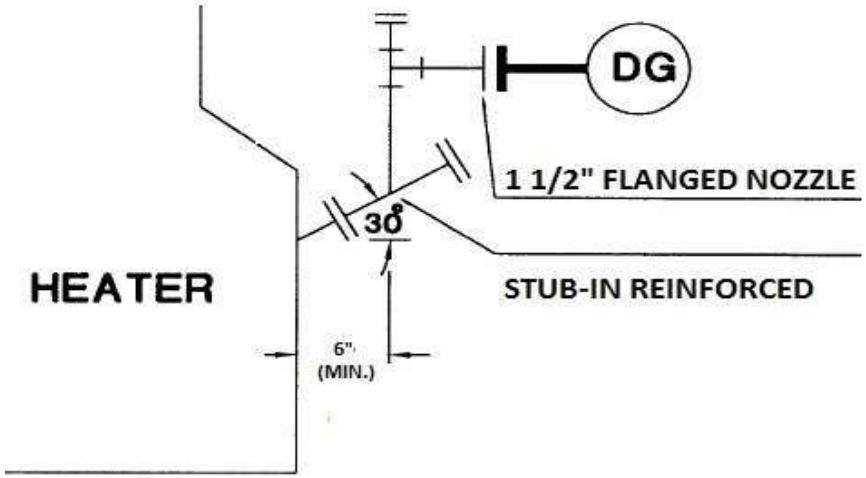
+ CONNECTIONS FOR D.P. INSTRUMENT 1/2" SCRD.

ANNEXURE-1 TO EDB-005: INSTRUMENT CONNECTION ON FIRED HEATER

S. NO.	TYPE OF INSTRUMENTS	VESSEL/LINE CONNECTION	FIRST BLOCK VALVE	INSTRUMENT CONNECTION
1	FLOW ELEMENT - AVG. PITOT TUBE (ON DUCT)	1 1/2" FLANGED	1 1/2" FLANGED (BY INST.)	1/2" NPT (F)
2	FLOW ELEMENT - VENTURI TUBE (ON DUCT)	1/2" S.W.	1/2" S.W.	1/2" NPT (F)
3	PRESSURE INSTRUMENT (ON HEATER)	1 1/2" FLANGED	1 1/2" FLANGED	1/2" NPT (F)
4	PRESSURE INSTRUMENT (ON COIL)	1 1/2" FLANGED	1 1/2" FLANGED	1/2" NPT (F)
5	DRAFT GAUGE (REFER TYPICAL BELOW)	1 1/2" FLANGED	1 1/2" FLANGED	1/2" NPT (F)
6	TEMPERATURE INSTRUMENT (ON HEATER)	1 1/2" FLANGED		1 1/2" FLANGED
7	TEMPERATURE INSTRUMENT (ON COIL)	1 1/2" FLANGED		1 1/2" FLANGED
8	SKIN THERMOCOUPLE	1" PIPE		
9	FLUE GAS ANALYSER	4" FLANGED	4" FLANGED	4" FLANGED

NOTES:

1. PRESSURE RATING OF FLANGE CONNECTION SHALL BE 150# FOR INSTRUMENTS MOUNTED DIRECTLY ON HEATER.
2. PRESSURE RATING OF FLANGE CONNECTION ON TUBE SIDE SHALL BE MIN 300#.
3. ALL PRESSURE & FLOW INSTRUMENTS SHALL HAVE MECHANICAL ISOLATION VALVES IN ADDITION TO INSTRUMENT ISOLATION & VENT/DRAIN VALVES.



ANNEXURE-2

CONTROL ROOM PHILOSOPHY

1.0 Marketing Terminal Control System Architecture shall be completely integrated with different system kept at different location.

i. Control room
ii. Rack Room/Engineering Room
iii. Main Security Room
iv. Planning/Invoice Room
v. Terminal Manager Room

1.1 Control Room :

1.1.1. Control Room Shall have two Operator Stations(OIC).
1.1.2. One OIC(3) shall be connected to Large Video Screen(LVS) with KVM switch, The Screen shall be able display both OIC and TFMS data.
1.1.3. One CCTV Client on LED Screen. The LVS and LED Screen shall be of same size.
1.1.4. One TFMS Client PC for displaying tank readings.
1.1.5. Provision shall be made to give Fire panel data in OIC else Separate Station shall be provided.
1.1.6. Control room shall have 2 Laser printer and One dot matrix printer.

1.2. Rack Room/Engineering Room:

1.2.1. Rack Room Shall have System Cabinets, Power Supply distribution board Panel and Marshalling Cabinets.
1.2.2. All Servers(LRCS,TFMS,GATEWAY) shall be mounted in rack panel and this panel shall be kept in Blast proof room which is connected to Rack Room. These Servers shall be redundant servers.
1.2.3. CCTV system shall have Separate panel with Servers and Storage system, All converters/recording system shall be kept in the cabinet with one Server/Client for viewing the CCTV.Access Control System System/Software shall be loaded on the same CCTV system.This System shall also be kept in blast proof room.
1.2.4. Engineering room shall have Glass/Aluminium partition and It shall consist of Engineering Work Station(DCS), Engineering Work Station(PLC), SOE PC.If Access Control system cannot be loaded in CCTV server then Separate PC shall be provided.
1.2.5. Rack Room shall have one more Glass/Aluminium partition for installing IT Hardware and Telephone System.All Networking Panel, Lease line OFC etc shall be installed at this location.
1.2.6. Engineering room shall have two Laser printers.

1.3. Main Security Room :

1.3.1. One CCTV Client with LED Screen. This station shall be combined with Access control system and F&G.

1.4. Planning and Invoice Room :

1.4.1. Two TTES system, One for Planning and Entry System and other one for Invoice.
1.4.2. Four SAP-TAS PC.
1.4.3. Planning room shall have 2 nos. Laser printers and 2 nos. dot matrix printer.

1.5. Terminal Manager Room :

1.5.1. One CCTV Client on LED Screen.
1.5.2. One OIC.
1.5.3. Terminal Manager room shall have one Laser printer.

Note1: Security office CCTV Station shall be combined with Inputs from F&G and Access Control System.

Note2:

ANNEXURE - 2 CONTROL ROOM PHILOSOPHY

Sl. No	Unit	New/Revamp	SRR	Control Room	System	Remarks
1	DMT	New	SRR-XX	BMT	a)Control Room : 2 no.Operator Station & One station to LVS , 1 no. TFMS Client station, 1 no. CCTV client b)SRR : 1 no. DCS Engineering station, 1 no. PLC engineering station,1 no. SOE station. c)Terminal Manager Room : 1 no. Operator station and 1 no. CCTV stations. d)Planning Room : 2 nos. TTES Station and 4 nos. SAP Sation. e) CCTV client in Security Room. f) All Server in One rack Mounted Panel.	All Servers to be placed in Rack Panel.

C-2	ENGINEERING DESIGN BASIS
C-2.8	SAFETY REQUIREMENTS FOR CONTRACTOR

MRPL Marketing Terminal Project at Devangonthi, Bangalore

PROJECT : **Marketing Infrastructure Projects, MRPL**

OWNER : **MANGALORE REFINERY AND PETROCHEMICALS LTD**

PMC : **Nauvata.**

JOB NO. :

Rev No.	Date	Purpose	Prepared by	Checked by	Approved by
0	19-02-2021	Issued for BID	SP	ASN	ASN

BIDDER:

-Bidder shall furnish HSE policy and HSE Manual of Bidders Company along with the bid and his track record in safety for past three years.

Bidder shall furnish details of their safety department with CVs of safety officers in his bid document. One of the safety officers shall be present during the kick off meeting and from the day one of mobilization date.

A penalty of 5% of contract value will be levied on the contractor for absence of safety officer during kick off meeting and INR 10,000/- per day for subsequent absence from the date of site mobilization.

-The contractor MUST employ Qualified Safety Officers as per the table below, having about 5 years of relevant experience in construction and erection of Petrochemical Plants or refineries, as per The Building and other construction workers (Regulation of Employment and conditions of service) Act 1996 and Central Rules 1998 / The Karnataka Factories Rules 1969. Contractor shall ensure that all his workmen are aware about the nature of risk involved in their work and have adequate training for carrying out their work safely. Such Safety Officers appointed shall be dedicated and responsible only for safety. They should not be given any other responsibility. The contractor and his sub-contractor, if any, shall comply with the instructions given by MRPL Engineer In- Charge or his authorized nominee regarding safety precautions, protective measures, house-keeping requirements etc. Engineer-In-Charge from MRPL shall have the right to stop the work of the contractor, if in his opinion, proceeding with the work will lead to an unsafe and dangerous condition. Engineer-In-Charge shall get the unsafe condition removed or provide protective equipment at the contractors cost, which ever is applicable.

Table

Upto 250 Persons deployed by him at site	Deploy one qualified Safety Officer and additionally deploy Three Safety Supervisors
For 251 to 500 Persons	Two Safety Officers, Six Safety Supervisors and Ten Safety Stewards
For more than 500 persons	Three Safety Officers, Ten Safety Supervisors and Twenty Safety Stewards

Qualification criteria of safety officer:

BSc (Physics Chemistry only)/Diploma (Mech/Elect/Civil only) with post graduate Diploma in Industrial safety as per factories act 1948 and CLI (central labor institute) with min of 5 years experience in supervisory cadre.

OR

BE/BTech (Mechanical/Electrical/Civil only) with post graduate Diploma in Industrial safety as per factories act 1948 and CLI (central labor institute) with min of 2 years experience in supervisory cadre.

Qualification criteria of safety supervisor:

BSc (Physics Chemistry only)/Diploma (Mech/Elect/Civil only) with qualification in industrial safety with relevant experience.

PERSONNEL :

- Personnel / workmen (age 18 years & above) deployed at site should be physically / medically fit.

Labours/workers shall not bring children/babies to project site.

- Contractors and their workmen should restrict their activities to the site allocated to them.

- All contract men shall wear IS make PPEs like gloves, goggles, face shields, safety belt, Safety Helmets, Safety Shoes etc during construction. They will not be permitted to enter the construction site without wearing safety helmet & safety shoes. Damaged PPEs shall be taken out from use and disposed off properly.

- The contractor shall ensure that their men do not tamper with the facilities in operation. They shall not operate any Valves/ Switches etc.

- The contractor shall ensure that his workmen do not move around freely inside refinery premises other than the assigned place of work & also do not sleep anywhere inside refinery premises.

- The personnel engaged by the Contractor shall maintain good conduct and discipline Commensurate with Industrial standard. If in the opinion of the Engineer-in-charge any of the personnel have not maintained good conduct and discipline, the Contractor shall remove such personnel immediately from MRPL premises and provide alternate personnel.

- The contractor Supervisors and Engineers must get themselves conversant with MRPL's standard safety procedures, safety norms, Rules and Regulations that are in force. They must also be conversant with the MRPL's Emergency Procedures and Emergency telephone numbers and should ensure display of same at prominent place.

USE OF FIRE WATER :

Contractor will have to seek written permission from MRPL's Engineer-In-Charge, before using Firewater for any hot work within the refinery.

SAFETY PROCEDURE TO BE FOLLOWED :

GENERAL :

- Special safety precautions to be taken by the bidder or their personnel working in an operating refinery are given below. The safety procedure may undergo a change from time to time, which will be intimated and its bidding for the contractor to follow and implement the them.
- In addition to the following minimum safety requirements, the contractor must comply with the safety requirements, norms, rules and regulations as per the Factories Act 1948 and Karnataka Factories Rules 1969, ILO's (International Labour Organisation) published hand book titled "Safety and Health in Building and Civil Engineering".
- The contractor must prepare a detailed "Safety Programme" and submit it Engineer In-charge of MRPL immediately after the finalization of contract / placing of LOI / order. This will include HSE Policy, Safety Responsibilities at various levels, Formations of Safety Committees and meetings, Method statements, Job Safety Analysis (JSA), Safety inspections, various pre-inspection checklists, Safety manuals, HSE Audits, Emergency Plans, Safety procedures to be implemented for all the activities, deputation of Safety Officers, enforcement of safety practices, compensation in case of accidents, Life Insurance and ESI coverage as per the Labour Laws for contractor's employees etc.
- Bidder shall devise a procedure on Accident Reporting. All accidents including Near Misses and property damages to be reported as per the Accident Reporting Procedure in force. All Accidents including Near Misses to be communicated immediately to owner /Project consultant over

telephone / verbally / and later submit the accident report. All accidents must be investigated, classified and analysed. Monthly Accident statistics must be developed and circulated. Bidder shall maintain a register of all such accidents.

- During the mobilization, equipments, machines, tools, tackles etc. to be inspected at the site from where it is being mobilized. Damaged ones should be discarded and ensured not mobilized at MRPL site. The statutory checks, inspections and certification is carried out before mobilizing at MRPL site. Necessary repairs and maintenance to be carried out and equipment, machine, tools, tackles etc. is mobilized at MRPL site in working condition. The previous records of maintenance and the competent persons certificates to be made available during mobilization and submitted to MRPL / Project consultant. The equipments, machines, tools, tackles, etc to be tagged and mobilized.

- A Safety Committee must be formed to discuss accidents, Unsafe Acts and Unsafe conditions. This should be chaired by the High ranking Official / Project-In-Charge with equal participation both from supervisory and non-supervisory cadres of employees. Engineer In-Charge of MRPL also should be involved in such meetings as an observer. The frequency of meetings shall be once in a month minimum and actions taken to avoid recurrence of Nearmiss, Minor injuries etc.

Circular of the meeting must also be issued to Owner /Project consultant at least one week in advance. Minutes of the meetings to be prepared on the same day and submitted on next day of the meeting.

The contractor shall take all safety precautions during the execution of awarded work and shall maintain and leave the site safe at all times. At the end of each working day and at all times when the work is temporarily, suspended, he shall ensure that all materials, equipment and facilities will not cause damage to existing property, personal injury or interfere with other works of the project or station. The contractor shall comply with all applicable provisions of the safety regulations, clean up programme and other measures that are in force at the site.

- HSE Audits to be conducted once in three months by a team of Senior Officials of the contractor. Report on findings of such Audit to be submitted to the owner / Project consultant and compliance report of the suggestions on findings to be submitted weekly to owner /Project consultant.

Joint inspection of safety and audit of safety to be conducted every month and the report and protocol signed by all parties safety officers with signatures of RCMs of contractor and consultant shall be part of subsequent RA bill.

- Method statement along with Job Safety Analysis to be submitted at least 15 days in advance before starting of any activity.

Prior information of high risk jobs as planned shall be informed with short details of the work, job safety analysis report to the consultant / owner at least 48 hours before starting of such jobs.

High risk jobs like fabrication at height, lifting and shifting, erection of equipments etc shall be video recorded by the contractor.

- The contractor shall provide and maintain all lights, guards, fencing, warning sign, caution boards, other safety measures and provide for vigilance as and where necessary or as required by the Engineer-In-Charge or by any duly constituted authority for the protection of workers or for the safety of others. The caution boards shall also have appropriate symbols visible during night also.

- Adequate lighting facilities, including emergency lighting, such as floodlights, hand lights and area lighting shall be provided along with ELCBs by the contractor at the site of work with isolation switch known to all at site with proper display, storage area of materials and equipment and temporary access roads within his working area. The contractor shall obtain written approval of the Engineer-In-Charge to the lighting scheme and place of tapping prior to its installation.

CCTV cameras to be installed by the contractor to cover all construction spots.CCTV monitor with automatic screen switching shall be available inside RCMs office. Recorded video from all CCTV cameras shall be retrievable for previous 10 days.

Number of cameras to be considered shall have area as the basis. EPCM consultant shall decide the same.

Use of devices like Distress alarm system for all personnel entering into confined space to be mandatory.

Staircases shall have temporary hand rail and guard till permanent handrails are fabricated and installed.

The contractor shall plan his operations so as to avoid interference with the other departmental works, other contractors or sub-contractors at the site. In case of any interference, necessary coordination shall be sought by the contractor from the Department for safe and smooth working.

The contractor shall be held fully responsible for non-compliance of any of the safety measures, procedures and delays, implications, injuries, fatalities, property damage and environmental degradation and compensation arising out of such situations or incidents. The contractor should device a procedure to maintain head count of his personnel manually or with an installation of punching machine at site and ensure evacuation of his personnel through defined emergency exit in case if situation demands.

- Smoking is prohibited in the work site / offices.

Consumption of alcohol and any other intoxicating material shall be also treated as safety violation and heavy penalty of INR 10000/- shall be levied on the main contractor per person consumed.

- Radiography source and also the Explosives used for controlled blasting will not be permitted to be stored at site.

Accidents/Incidents shall be reported to MRPL/Project consultant EIC immediately over telephone/mobile. Contractor shall record the same in site register of such reporting with time of report.

Detailed accident report with photographs to be submitted to factory manager and project In-charge from MRPL/consultant within 12 hours of such incident/accident.

CERTIFICATION FOR CONTRACTORS EQUIPMENTS :

- Contractor's Vehicles/Engines and approved electrical / mechanical equipments & lifting tools / tackles, welding generator that are to be used at construction site are to be certified by competent authority. Statutory checks are to be carried out and records are to be maintained by contractors to ensure healthiness. These certificates will be regularly checked by MRPL engineer in-charge.

- The Contractor shall ensure that all industrial consumables such as Oxygen, Acetylene, Argon, Nitrogen, welding electrodes etc. are approved by MRPL, tested and records maintained by the contractor as per Gas Cylinder Rules before they are used for the job. LPG for gas cutting purpose is not allowed.

- The Fire prevention / protection and safety equipments (including Personal Protective Equipments) should be certified by MRPL engineer in-charge.

HEALTH AND HYGIENE :

- Sufficient number of toilets shall be provided by the contractor for its workmen and hygiene standard should be maintained.

Contractor to ensure no water stagnation at site.

Potable water facility for all workers shall be provided and maintained by the contractor.

Inspection of drinking water,sanitation,waste collection,house keeping shall be done every Monday,Thurseday and Saturday by the consultant/owner. If any observations are made, the same shall be treated as safety/HSE violation and shall attract a penalty of Rs 10,000/- per violation.

Availability of dust masks shall be ensured by the contractor at site.

Contractor to maintain affordable hygienic canteen for the workers.

- The contractor must maintain record of medical examinations of its employees as per The Building and other construction workers (Regulation of Employment and conditions of service) Act 1996 and Central Rules 1998 and The Factories Act 1948 and The Karnataka Factories Rules, 1969. This will include eye test of crane operators, vehicle drivers and all others.

- Adequate means and personnel for rendering first aid should be readily available at site and during working hours at places where work is carried out.

- Medical aid for First-Aid should be available.

- First Aid kits or boxes, as appropriate, should be provided at the workplaces and on motor vehicles, locomotives and be protected against contamination by dust, moisture, etc.

- Stretchers or carrying baskets so constructed that persons can be transported without having to be transferred from the stretcher or the carrying baskets should be readily available.

Contractor shall keep well equipped ambulance as per factories act 1948 at site which shall be checked for its functioning on daily basis.Ambulance driver shall be available at site 24 hours and shall be filled with fuel always to run atleast 100 Kms.

- When workers are employed underground or beneath structures or pits or other conditions in which they may need to be rescued, suitable rescue equipment like tripod with pulley and safety

belt should be readily available at site at or near the construction site along with trained rescue workers.

VEHICLE MOVEMENT :

- The contractor shall conduct his operation so as not to interfere with the use of existing roads at or near locations where the work is being performed.
- Special precautionary measures should be taken during transportation of long sized cargo, route as defined should be followed and for safety of personnel (with proper escort) and damages to the facilities should be avoided. Procedure for vehicle entry and Speed limits in Refinery should be strictly followed. Vehicles and cargos passing through refinery should have approved spark arrestor fitted.
- When interference to traffic is inevitable, notice of such shall be given to the Engineer- In-Charge of MRPL well in advance with the details of start of the work and time required, storage of materials, and details of the proposed methods of providing the required facilities for safe and continuous use of roads and obtain his clearance.
- The contractor shall exercise full care to ensure that no damage is caused by him or his workmen, during the operation, to the existing water supply, sewerage, power or telecommunication lines or any other services or works. The contractor shall be required to provide and erect before construction, substantial barricades, guardrails and warning signs. He shall furnish, place and maintain adequate warning lights, signals etc, as required by the Engineer-In-Charge.
- Vehicles must have green and red flags for the cleaner to guide driver. All vehicles entering MRPL premises shall have driver and cleaner.
- The vehicles must be maintained as per the preventive maintenance schedule of the manufacturer / supplier.
- Vehicles to be inspected fortnightly by trained technicians as per the inspection checklist. Pre-inspection checklist to be formed to that effect.
- All vehicles to bear a sticker. “If you notice this vehicle is over speeding then please inform on telephone no……..”.
- Tractors and trucks should not be used for transporting personnel.

- Every vehicle should have the contractor's name prominently displayed on Tractor Trolleys, trucks, jeeps, cranes, JCBs, Poclains, trailers. The display board should be put on front and rear side of each of the vehicle.

Tractor trolleys must have independent brake systems both on tractor as well as trolleys.

- All vehicles must be fitted with spark arrestors once the hydrocarbon is introduced inside the units.

Tippers/trucks carrying debris and soil/mud/sand shall ensure that there is no spillage of material to road. If any such spillage observed the same need to be cleaned and cleared by the contractor immediately. Wheels of the trucks and vehicles shall be clean and free from mud.

- Contractor to maintain Inspection and maintenance logs for every vehicle.
- Any kind of repair work on contractor's vehicle is to be carried out only inside the work shop or designated place and not allowed inside the battery area or any where at on road or at site.

SAFE MEANS OF ACCESS :

- The contractor must possess adequate numbers of self retractable type fall arresstors (of different sizes viz. 6 m, 20m, 40m, and 60 m), Safety nets and Safety Belts (ISI approved).
- Adequate and safe means of access and exits shall be provided for all work places, at all elevations. Using of scaffolding members (avoiding a ladder) for approach to high elevation shall not be permitted.
- Suitable scaffolds shall be provided for workmen for all works that cannot be done safely from the ground, or from solid construction except such short duration work as can be done safely from ladders. Ladder shall be of rigid construction having sufficient strength for the intended loads and made of metal and all ladders shall be maintained well for safe working condition. If the ladder is used for carrying materials as well, suitable foot holds and handholds shall be provided on the ladder. Ladders shall not be used for climbing carrying materials in hands. While climbing both the hands shall be free. Ensure positioning of person at base / grade level while it is in use. All ladders, platforms, safety belts and safety nets should be inspected regularly and records should be maintained. Damaged items shall immediately be taken out of service and disposed off.

- Scaffolding staging more than 3.5 m above the ground or floor, swung or suspended from an overhead support or erected with stationary support and ladder shall conform to relevant IS specification. Timber bamboo scaffolding shall not be used.
- Working platforms of scaffolds shall have toe boards 15cms in height to prevent materials from falling down.
- A sketch of the scaffolding proposed to be used shall be prepared and approval of the contractor's Safety Officer obtained prior to start of erection of scaffolding. All scaffolds shall be examined and certified with proper display by contractors Safety Officer before use.
- Safe means of access shall be provided to all working platforms and other elevated working places. Every ladder shall be securely fixed. No single portable ladder shall be over 9m in length. For ladders upto 3m in length the width between side rails in the ladder shall in no case be less than 300mm. For longer ladders this width shall be increased by atleast 20mm for each additional metre of length. Step shall be uniform and shall not exceed 300mm.
- Working platform and gangway along the side of pipe racks shall be provided. Under no circumstance the contractor employees should step on pipes at pipe racks.

EXCAVATION, TRENCHING AND EARTH REMOVAL :

- A Work Permit must be taken for any excavation or earth removal inside the existing refinery premises from Engineer In-Charge MRPL, as the area of construction work has underground pipelines, cables etc.
- All trenches 1.2m or more in depth shall at times be supplied with at least one ladder for each spacing of 3.0m in length or fraction thereof. Ladder shall be extended from bottom of the trench to at least 1m above the surface of the ground.
- The sides of the trench which are 1.2m or more in depth shall be stepped back to give suitable slope (angle of repose) or securely held by timber bracing (i.e. shoring of the excavated trench or pit should be done), so as to avoid the danger of sides from collapsing. The excavated material shall not be placed within 2m of the edges of the trench or half of the depth of the trench, whichever is more. Cutting shall be done from top to bottom. Under no circumstances under-cutting shall be done.

- The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and the works.
- Open excavations shall be fenced off by railing (ledger pipes) and warning signals installed at well-lit places so as to prevent persons falling into the excavations.
- All blasting operations shall be carried out on the basis of procedures approved by Inspector of explosives. All works in this connection shall be carried out as per IS code of practice. Barricades, Warning signs etc. shall be placed on the roads / open area. Prior approval of such operation shall be obtained from Engineer-In-Charge of works. The blasting procedure being followed by the contractor must be submitted with MRPL engineer in-charge.
- The contractor must submit the methodology, safety aspects, schedule, License and other relevant features of control blasting operations.
- Wherever manual removal of earth is involved, earth shall be removed from the top by maintaining the proper slope equal to the angle of re-pose of the earth. Manual removal of earth / lowering of person in a pit should be done with tripod and pulley besides use of Safety belt by person.
- Such work shall be constantly supervised by the contractor's responsible persons.

DEMOLITION :

Before any demolition work is commenced and also during the progress of the work :

- Proper approvals shall be taken from Engineer in-Charge MRPL before commencing demolition.
- Area around shall be barricaded with cautionary signs and posting of security guards or supervisors for preventing unauthorised entries of personnel.
- All roads and open area adjacent to the work site shall either be closed or suitably protected. Appropriate warning signs shall be displayed for cautioning approaching persons.
- No floor, roof or other part of the building shall be overloaded with debris or materials as to render it unsafe.
- Entries to the demolition area shall be restricted to authorized persons only.

Contractor to place separate collection facility of waste like metal, on metal non degradable and bio degradable wastes and shall dispose to designated place daily basis.

Contractor shall be responsible to clear dry grass and wooden items etc from and around his construction site/storage/fabrication yard etc to prevent any fire accidents.

PERSONAL PROTECTIVE EQUIPMENTS :

- All proper "ISI" marked Personal Protective Equipments (PPEs) as considered necessary by the Engineer-In-Charge shall be kept available by contractor for the use of the persons employed on the site and maintained in a condition suitable for immediate use. Also the contractor shall take adequate steps to ensure proper use of equipment by those concerned. The PPEs are to be provided by the contractor.
- All persons employed at the construction site shall use safety helmets and safety shoes and goggles as minimum safety gears. For other types of works, persons working in that area shall also use the required PPEs, as advised by the Engineer-In-Charge of MRPL .
- Workers employed on mixing asphaltic materials, cement and lime mortars shall use Gumboots, safety goggles, hand gloves and proper respirator.
- Persons engaged in welding and gas-cutting works shall use suitable welding face shields. The persons assisting the welders shall use suitable goggles. Protective goggles shall be worn while chipping and grinding.
- Stonebreakers shall use protective goggles. They shall be seated at sufficiently safe intervals of distance.
- Persons engaged in or assisting in shot blasting (Sand blasting is prohibited) operations and cleaning the equipment after shot blasting shall use suitable gauntlets, overalls, dust mask, dust proof goggles, safety shoes and protective hood supplied with fresh air.
- All persons working with 3M lifeline and hook at height above ground or floor and exposed to risk of falling down shall use safety belts which should be properly secured to solid object (ISI marked) unless otherwise protected by cages, guard railings, etc. In places where the use of safety belts is impractical, suitable safety net of adequate strength fastened to substantial supports shall be employed under proper valid permit.
- When workers are employed in sewers and inside manholes, which are in use, the contractor shall ensure that the manholes are opened and are adequately ventilated at least for an hour. The

atmosphere inside the space shall be checked for the presence of any toxic gas or oxygen deficiency and recorded in the confined space entry permit, availability of standby person at manhole must be ensured before the personnel are allowed to get into the man-holes. The manholes opened shall be cordoned off with suitable railing and provided with warning signals or caution boards or barricade tape to prevent accidents. There shall be proper illumination in the night.

PAINTING :

- Respirators shall be provided by the contractor for use when paint is applied, safety of personnel in vicinity also should be considered while painting.
- Overalls shall be supplied by the contractor to the workmen and adequate facilities shall be provided to enable the painters for decontamination at the cessation of work.
- All solvent-based paints, thinners shall be stored in separate storage kept under proper surveillance.
- Smoking, open flames or sources of ignition shall not be allowed in places where paints and other flammable substances are stored, mixed or used. A caution board, with the instructions written in national / regional language, "SMOKING – STRICTLY PROHIBITED" shall be displayed in the vicinity where painting is in progress or where paints are stored. Symbols shall also be used for caution boards.
- Suitable IS marked First Aid Fire Fighting equipments shall be kept available at a place where flammable paints are stored, handled or used.
- When painting work is done in a closed room or in a confined space, adequate ventilation shall be provided. Workers shall wear suitable supplied air type breathing apparatus. Work shall be carried out under a valid work permit.
- Epoxy resins and their formations used for painting shall not be allowed to come in contact with the skin. The workers shall use PVC gloves and / suitable barrier creams.
- Adequate ventilation shall be provided especially when working with hot resin mixes.
- Increased personal hygiene shall be practiced to control inadvertent contact with the resin and eliminate its effects.

- Workers shall thoroughly wash hands and feet before leaving the work. Work clothes shall be changed and laundered frequently.

-Care must be taken while carrying out painting inside confined space. There shall be safety devices to monitor the personnel working inside confined space like vessels during painting of internal surface. Suitable painting methods shall be adopted as specified elsewhere.

LIFTING MACHINES TOOLS AND TACKLES :

- Supplier's / Manufacturer's manual for operations / safety / periodical maintenance of all Cranes, winches, JCBs, Poclains, Excavators, Trucks, tractors, Vehicles, etc. MUST be made available at site from the moment it is brought at site and the same should be strictly adhere to.

- Lifting machines, tools and tackles shall be of good mechanical construction, sound material, adequate strength, free from any defects and shall be kept in good working condition.

- Lifting machines, tools, tackles, equipments etc. to have identification tags of steel plate of size 2"x 2" tied to it using steel wire of 4 mm size. The details like reference number, Safe Working Load (SWL), date of testing etc. to be punched on this plate.

- Contractor must produce Competent Authority's (Authorised by The Directorate of Factories, Karnataka state) Certificate of testing in the prescribed form of Lifting Machines, Chains, ropes and lifting tackles well in advance. Only valid Lifting Machines, tools etc. to be used and to be re-certified before expiry of certificate. Also, these equipments will be inspected by Engineer In-Charge of MRPLas and when required. The same procedure is applicable for all other Electrical Equipments, tools, machines, D.G sets, compressors, etc.

Lifting equipments for testing by competent authority to include JCB, Poclain, Excavators, etc.

The ringer crane to be tested and certified every time by Competent Person it is dismantled and reassembled. This certification must also include stability of soil on which it is assembled.

Use of Hydra is not permitted inside refinery/construction premises. Hydraulically jacked lifting machines to be used.

- Lifting machines, tools, tackles, equipments etc. to be inspected in addition to the Competent Authority's certification. This should be done fortnightly by experienced trained mechanical foreman and technicians and record of such inspection to be maintained.

- Every rope and sling used in hoisting or lowering of materials or as a means of suspension shall be of good quality and adequate strength and free from any defect.

- Every crane operator or lifting appliance operator shall have a driving License for Heavy Vehicle, proper physical fitness such as eye sight etc. and with adequate experience. No persons under the age of 21 years shall be in charge of any hoisting machine or give signal to operator of such machine.

- In case of every lifting machine (and of every chain, ring, hook, shackle, swivel and pulley block used in hoisting or as means of suspensions) the safe working load shall be ascertained and clearly marked. In case of a lifting machine having a variable safe working load, each safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load.

- The contractor shall notify the safe working load of the machine to the Engineer-In- Charge whenever he brings any machinery to site for work and get it verified by the Engineer-In-Charge, supported by a valid test certificate by the competent person.

- Motors, gearing transmission, couplings, belts, chain drives and other moving parts of hoisting appliances shall be provided with adequate safeguards. Hoisting appliances shall be provided with such means as to reduce to the minimum risk of any part on a suspended load becoming accidentally displaced or lowered.

- The contractor must have a team of Experienced Mechanical Personnel (having minimum of 5 yrs. experience in carrying out safety inspection and testing of Lifting machines, Tools and Tackles etc.), to conduct periodical (Daily, fortnightly, monthly and quarterly) inspection and testing of Lifting machines, Tools and Tackles and to maintain its records.

- Crane shall not be used as hoist. Incase cranes are used as hoist then factory Inspector's permission to be taken in advance and to be subject to biannual testing by competent person as required for hoist under Factories Act 1948. Also, the design of cage to be got approved by the competent person well in advance. Two ropes or chains to be provided to the cage, separately

connected with the cage, suspended independently and capable of carrying the whole weight of the cage.

- Contractor to maintain operation, inspection and maintenance logs for every lifting equipment, tool and tackle.

TEMPORARY SHEDS :

- Before erecting temporary shelters like sheds or tents anywhere at site, written permission of the concerned Engineer In-charge must be obtained.
- Temporary sheds for site office should be avoided. Instead contractor shall arrange for portal cabins for site office / stores.
- Temporary shed should not be erected using scaffolding pipes. Te shed should be made of safe construction material.
- The temporary shed should be erected after proper designing following engineering design practices in conformance with normal safety standards to ensure the stability and safety.
- Temporary shed should bear the contractor's name.
- Temporary piping, hose connections and electrical wiring to these temporary sheds must be laid in such manner that they do not cause tripping, hitting or electrocution hazards.

ERECTION :

- At the planning stage consideration should be given, by those responsible for the design, to the safety of the workers who will subsequently be employed in the erection of such structures. A detailed erection scheme / schedule shall be furnished well in advance for all the critical erections.
- Care should be exercised by design engineers and other professional persons, not to include anything in the design which would necessitate the use of unwarrantably dangerous structural procedures and undue hazards, which could be avoided by design modifications.
- Facilities should be included in the design for such work to be performed with the minimum risk.
- Detailed Safety Procedure should be submitted as a part of Heavy Equipment erection scheme. Heavy Equipment erection scheme must be submitted at least one month in advance.
- Erection engineer to conduct training on rigging before every heavy lift / erection for crane operator, foreman and riggers.
- Erection of structural platforms, gratings and hand rails to be done on priority. The procurement of gratings, structural members for hand rails to be done on priority.

- Prefabricated parts should be so designed and made that they can be safely transported and erected.

- As far as practicable the safety of prefabricated parts while erection should be ensured by appropriate means, such as provision and use of :

a) Ladders;
b) Gangways;
c) Fixed platforms;
d) Platforms, Buckets, boatswain's chairs, etc. suspended from lifting appliances;
e) Safety belts and lifelines; and
f) Safety nets or catch platforms.

- Ladders to be inspected fortnightly by experienced trained mechanical foreman and mechanical technicians and record of such inspection to be maintained.

- The boatswain's chairs/ platforms used in structural erection to be inspected and checked once in fortnight and record maintained.

- In addition to the conditions of stability of the part when erected, when necessary to prevent danger the design should explicitly take into account:

a) the conditions and methods of attachment in the operations of stripping, transport, storing and temporary support during erection; and
b) Methods for the provision of safeguards such as railings and working platforms, and, when necessary, for mounting them easily or prefabricated parts.

- The hooks and other devices incorporated in prefabricated parts that are required for lifting and transporting them should be so shaped, dimensioned and positioned as:

a) to withstand with a sufficient margin the stresses to which they are subjected; and
b) not set up in the part stresses that could cause failures, or stresses in the building not provided for in the plans.

- Prefabricated parts made of concrete should not be stripped before the concrete has set and hardened sufficiently to ensure the safety of the operation.

- Store places should be so constructed that:

a) There is no risk of prefabricated parts falling or overturning; and

b) Storage conditions generally ensure stability having regard to the method of storage and atmospheric conditions.

- Prefabricated parts made of concrete should not be erected before the concrete has set and hardened to the extent provided for in the plans.

- While they are being stored, transported, raised or set down, prefabricated parts should not be subjected to stresses prejudicial to their stability.

- Trailers only to be used for transportation of pipes. Crane to be used for erection at site.

- Every lifting appliance should :

a) be suitable for the operation; and

b) be approved by a competent person, or tested under a roof load 20 percent heavier than the heaviest prefabricated part.

c) Ringer mode of a heavy crane MUST be inspected, checked and certified by competent person every time it is dismantled and erected. The report must bear the stability of the soil on which it is erected.

- Lifting hooks should have the maximum permissible load marked on them.

- Tongs, clamps and other appliances for lifting prefabricated parts should :

a) be of such shape and dimensions as to ensure a secure grip without damaging the part ; and

b) be marked with the maximum permissible load in the most unfavourable lifting conditions.

- Prefabricated parts should be lifted by methods or appliances that prevent them from spinning accidentally.

- The temporary basket cages / Platforms / Buckets / boatswain's chairs, etc. used for lifting / working at height suspended from lifting appliances or suspended from structures or beams MUST be certified by competent person and provisions or conditions as stipulated during certification to be adhere to.

- While prefabricated parts are being lifted measures should be taken to prevent workers from being struck by objects falling from a height and area around such site should be barricaded with cautionary signs.

- When necessary to prevent danger, before they are raised from the ground, prefabricated parts should be provided with safety devices such as railings and working platforms to prevent falls of persons.
- If workers are exposed to danger when releasing prefabricated parts from lifting appliances, adequate safety measures should be taken.
- At workplaces adequate instructions should be given to the workers on the methods, arrangements and means required for the construction, storage, transport, lifting and erection of prefabricated parts.
- When it is not practicable to install protective guardrails and toe boards the workers should be provided with and use safety belts and lifelines to limit the height of the fall.
- Overhead screens to be provided to prevent workers from being struck by falling objects.
- The safety devices (guard-rails, toe-boards, safety belts and lifelines) should not be removed so long as the risk remains.
- Precautions should be taken to prevent fires being caused by rivet-heating equipment.
- Rivet heaters should extinguish their fires before leaving work.
- Extra care should be taken to prevent fall of objects, tools, etc. from height.
- Before structural steel parts are lifted, care should be taken that any object that could fall is fastened or removed.
- Structural steel parts should not be dragged while being lifted if that could cause danger.
- Steel trusses that are being erected should be adequately shored, braced or guyed until they are permanently secured in position.
- While structural members are being moved into place the load should not be released from the hoisting rope until the members are securely fastened in place.
- Structural members should not be forced into place by the hoisting machine while any worker is in such a position that he could be injured by the operation.
- No load should be placed on open-web steel joists until they have been placed in position and secured.
- Erection of pipes to be done using web belts only. Web belts must be inspected and checked fortnightly internally by the contractor and records maintained. Damaged ones to be cut to pieces

and record to be maintained.

- Nipples and other accessories used for hydrotest and subject to high pressures to be inspected, checked and tested by experienced trained mechanical foreman and mechanical technicians and records maintained. Damaged parts to be replaced immediately with the new ones.
- Discarding criteria of web belts to be procured from the supplier / manufacturer by the contractor and submitted to MRPL / Project consultant.

WORK ON TALL CHIMNEYS :

SCAFFOLDS :

- All workmen should be certified medically fit by medical practitioner before working at height. Mock up drills MUST be conducted by the contractor for all these workmen and issue Working at Height passes to only those who has experience of working at height, is declared medically fit and shows confidence during mock up drills.
- For the erection and repair of tall chimneys and vertical structures scaffolding should be provided. Scaffolds after erection should be certified by competent mechanical engineer for its strength before use and be displayed with a tag “Certified for use”.
-Scaffolds should confirm to relevant standards.
- Fixed inside scaffolding should be securely anchored in the chimney wall.
- The scaffold floor should always be at least 65 cm (26 in) below the top of the chimney.
- Under the working floor of the scaffolding the next lower floor should be left in position as a catch platform.
- Suspended outside platform (inspection scaffolds) should be provided as per the relevant standards as stated above.
- Use of Catch platforms, stairs, ladders and Iron rung, lifting tools, tackles and work with hot asphalt, tar should be carried out as per the procedures outlined in relevant ILO manual.
- Safety belts with lifelines (of various sizes 2’, 5’ and 9’ double lanyards) and safety nets being used should confirm to relevant standards and are to be inspected, tested, periodically and records be maintained. Damaged safety belts and nets should be discarded, taken out of service and disposed off.

- Safety belts must be used while working at height. The life lines (lanyard) MUST be tied to firm support. Incase of absence of firm support provision of wire rope of adequate size tied with lifting tackles to be made to tie the safety belt life line (lanyard).
- All Safety belts to be inspected once in a month and damaged ones to be discarded. Suppliers / Manufacturers Discarding criteria of safety belts to be submitted to MRPL. The record of inspection and the results to be maintained. And a copy to be submitted to owner / Project consultant.
- The scaffolds to be inspected and certified by the competent mechanical Engineer before use and subsequently, at least once in a week.

Safety of Electrical works:

Before starting work in live electrical panels, proper electrical isolation shall be ensured. The same to be inspected by the electrical in charge and necessary isolation tag shall be attached. Proper electrical isolation permit system along with LOTO system shall be maintained by the contractor.Triplicate copy of such permits shall be submitted to project consultant/MRPL.

CATCH NETS :

- Where workers cannot be protected against falls from heights by other means they should be protected by catch nets.
- Catch nets should be made of good quality fiber cordage, wire or woven fabric or material of equivalent strength and durability.
- The perimeter of catch nets should be reinforced with cloth-covered wire rope, manila rope or equivalent material.
- Catch nets should be provided with adequate means of attachment to anchorage.
- Catch nets to be inspected fortnightly, tested and records maintained. Damaged safety nets should be discarded and record maintained.

PROTECTION AGAINST MOVING VEHICLES :

Workers who are regularly exposed to danger from moving vehicles should wear;

a) distinguishing clothing, preferably bright yellow or orange in colour; or

b) devices of reflecting or otherwise conspicuously visible material.

HANDLING MATERIALS :

- Mechanical means should be provided and used for lifting and carrying loads.
- Personnel should have knowledge of safe ways of material handling.

STACKING AND PILING :

- Materials and objects should be so stacked and unstacked that no person can be injured by materials or objects falling, rolling, overturning, falling apart or breaking.
- Area earmarked for stacking and piling should be barricaded and only authorised personnel be allowed to carry out stacking and piling jobs.
- Proper stacking and piling should be done as per the guidelines of ILO.

WELDING AND GAS CUTTING :

- Welding and gas cutting operations shall be done only by qualified and authorised persons and as per IS specification and code of practice.
- All the hoses used on compressed gas cylinders (Acetylene, Oxygen etc.) to be as per IS.
- Welding and gas cutting shall not be carried out in places where flammable or combustible materials are kept and where there is danger of explosion due to presence of flammable / gaseous mixtures.
- Welding and gas cutting equipments including hoses and cables shall be maintained in good condition.
- Barriers shall be erected to protect other persons from harmful rays from the work. When welding or gas cutting is done in elevated positions, precautions shall be taken to prevent sparks or hot metals falling on persons or flammable materials.

- Use of proper PPEs by personnel involved in Gas cutting / Electric Arc welding should be ensured. Use of Welders Helmet with face shield by the welders is a MUST.
- Fire extinguisher shall be available near the location of welding operations. Valid permit shall be obtained before flame cutting / welding is taken up.
- Contact of personnel with the electrode or other live parts of electric welding equipment shall be avoided.
- Extreme caution shall be exercised to prevent accidental contact of electrodes with ground.
- The welding cables shall not be allowed to get entangled with power cables. It shall be ensured that movement of materials does not damage the cables.
- Oxy-Acetylene cylinders must be mounted on trolley with chain holding the compressed gas cylinders. The compressed gas cylinders must have pressure gauges fitted over it and Oxy-Acetylene Gas cutting set should be fitted with flash back arrestor at both the torch and cylinder ends.
- Under no circumstance the compressed gas cylinder should be taken inside the confined space or excavated pits. Hydraulic test certificates of all compressed gas cylinders should be maintained and furnished as and when required by ~~safety officer of MRPL~~.

GRINDING :

- All portable grinders shall be used only with their wheel guards in position to reduce the danger from flying fragments should the wheel break during the use.
- Grinding wheels of specified diameter only shall be used on a grinder – portable or pedestal- in order not to exceed the prescribed peripheral speed.
- Helmet with face shield shall be used during grinding operation.

HOUSE KEEPING :

The contractor shall at times keep his work spot, site office and surroundings clean and tidy from rubbish, scrap, surplus materials and unwanted tools and equipment.
- Welding and other electrical cables shall be routed as to allow safe traffic by all concerned.

- No materials on any of the sites of works shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The Engineer-In-Charge may require the contractor to remove any materials which, are considered to be of danger or cause inconvenience to the public.
- At the completion of the work, the contractor shall have removed from the work premises all scaffoldings, surplus materials, rubbish and all huts and sanitary arrangements used / installed for his workmen on the site.
- House keeping of the workplace shall be done strictly by the Contractor on daily basis or as required by the Engineer-in-charge. Contractor to collect all debris/ scrap and dump at designated Scrap Yard as defined by MRPL authorities.
- A separate house keeping team to be formed and made available round the clock.

FIRE SAFETY :

- Adequate number of duly calibrated Explosimters, Oxygen meters, Hydrogen Sulphide detectors (Portable / Fixed) or any other multiple gas detector should be made available at site by the contractor.
- Quantities of combustible materials like timber, bamboos, paints etc. shall be minimum required in order to avoid unnecessary accumulation of combustibles at site.

Containers of paints, thinners and allied materials shall be stored in a separate room, which shall be well ventilated, and free from excessive heat, sparks, flame or direct rays of the sun. The containers of paint shall be covered or properly fitted with lid shall not be kept open except while using.

- Fire extinguishers as approved by Engineer-In-Charge shall be located at the construction site at appropriate places.
- Adequate number of contract workmen shall be given education and training in fire fighting and extinguishing methods.

WORK PERMIT SYSTEM :

- MRPL's Work Permit system to be strictly followed.

- All jobs within refinery (for tie-in etc.) should be executed with a safety work permit only. These will be issued by the concerned operating personnel of MRPL (Refinery Shift Manager or any authorised person). However, he can withdraw the permit when the stipulated conditions are not complied with at the work spot.

- Area is okay for performing the Work.

Responsibility of Performing Authority :

To obtain an approved Work Permit duly filled and signed by authorities as per the MRPL's Work Permit System before starting the work in the area.

- To visit job sites and ensure that it is prepared accordingly.
- The person performing the job shall be in possession of the permit till the completion of the job. The permit should be produced for inspection at any time. As far as possible the Work Permit should be displayed at job site in the plastic folder.
- To understand the scope of the work and implications involved.
- To restrict the work to the area / equipment specified in the work permit.
- To comply with the instructions given on the Work Permit.
- To follow Plant Safety Rules and Procedures.
- To be alert at all times for the development of unexpected situations.

To stop the work immediately on detecting any unsafe condition and promptly inform the Issuing Authority.

- To return the Permit duly signed after completion of the job to the Issuing Authority. Contractor must adhere to work permit system and other safety regulations for activities at places other than construction site.

WORK IN AND AROUND WATER BODIES :

When the work is done near any place, where there is a risk of drowning, all necessary rescue equipment such as life buoys and life jackets shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision shall be made for prompt first-aid treatment of all injuries likely to be sustained during the course of the

work. Persons who do not know swimming shall not be engaged alone for any work where risk of drowning exists. Sufficient number of life buoys or life jackets shall be provided.

PUBLIC PROTECTION :

The contractor shall make all necessary provisions to protect the public. He shall be bound to bear the expenses for defense of every action or other proceedings of law that may be brought by any person for injury sustained owing to neglect of any precaution required to be taken to protect the public. He shall pay the damage and cost which may be awarded in any such suit, action or proceedings to any such person, or the amount which may be fixed as a compromise by any such person.

OTHER STATUTORY PROVISIONS :

Notwithstanding the above clauses there is nothing in these to exempt the contractor from the provisions of any other Act or Rules in force in the Republic of India. In particular all operations involving the transport, handling, storage and use of explosives shall be as per the standing instructions and conform with Indian Explosives Act, 1884 and the explosives Rules, 1983. The Factories Act 1948 and The Karnataka Factories Rules, 1969, Handling, transport, storage and use of Compressed gas cylinders and Pressure vessels shall conform with the Gas Cylinders rules 1981 and Static and Mobile pressure Vessels (Unfired) Rules 1981. In addition, The Building and other construction workers (Regulation of Employment and conditions of service) Act 1996, The Indian Electricity Act, 1910 and Indian Electricity Rules 1956, The Atomic Energy Act 1962, The Radiation Protection Rules 1971, Radiation Protection Manual of Nuclear Facilities and the Atomic Energy (Factories) Rules 1988 and various rules and Act relevant to the activities being performed shall also be strictly complied with.

- No Child labour should be brought in for work.
- MRPL holds the right to issue warnings / Heavy penalties (monetary fine) / suspend work at any time or terminate the contract for a loss / damage and a pattern of frequent failure to adhere to

Safety Laws, regulations and Onsite Safety procedures. In general a heavy monetary fine will be deducted straight from the contractor's bill for each violation of Safety Rules / Unsafe Act / Unsafe Condition observed, for each First-Aid injury, for each Lost Time injury / Near Miss Accident and for each fatality.

GUIDELINES AND GENERAL PROCEDURES FOR SUPPLY AND USE OF ELECTRICITY AT SITE :

Following safety requirements shall be complied with before the contractor uses the power supply.

- The contractor shall submit a list of licensed electrical staff to be posted at site.
- It shall be the responsibility of the contractor to provide and maintain complete installation on the load side of the supply point with regard to the safety requirements at site. All cabling and installation shall comply with the appropriate statutory requirements given below and shall be subject to approval of the Departmental Engineer-In-Charge / Electrical Engineer.

(a) Indian Electricity Act, 1910

(b) Indian Electricity Rules, 1956

(c) National Electric code, 1985

(d) Other relevant rules of Local bodies and Electricity Boards.

- Where distribution boards are located at different places the contractor shall submit schematic drawing indicating all details like size of wires, overhead of cable feeders, earthing etc. The position and location of all equipment and switches be given.
- The contractor shall make his won arrangements for main earth electrode and tapings thereof. The existing earth points available at site can be used at the discretion of the Departmental Electrical Engineer with prior permission. Method of earthing, installation and earth testing results shall conform to relevant I.S. Specifications.
- Overhead High Tension (HT) cable routes to be marked and physically barricaded to prevent crane coming in contact with it.

-All three-phase equipment shall be provided with double earthing. All light fixtures and portable equipment shall be effectively earthed to main earthing.

- All earth terminals shall be visible. No gas pipes and water pipes shall be used for earth connection. Neutral conductor shall not be treated as earth wire.

- Every electrically operated machine or equipment to be independently earthed.

- Earth pits to be provided near DG sets, electrically operated machines, equipments etc.

DG sets used for construction shall be installed inside acoustic enclosure to minimise noise pollution.

Exhaust of DG sets shall be routed to safe height.

- Continuity and resistance of all earth connections to be inspected and checked and tested fortnightly and records to be maintained.

- The contractor shall not connect any additional load without prior permission of Departmental Electrical Engineer.

- Joints in earthing conductors shall be avoided. Loop earthing of equipment shall not be allowed. However, tapings from an earth bus may be done.

- The entire installation shall be subjected to the following tests before energisation of installation including portable equipment :

a) Insulation resistance test

b) Polarity test of switches

c) Earth continuity test

d) Earth electrode resistance

- The test procedures and their results shall conform to relevant IS specifications. The contractor shall submit a test report for his complete installation every 2 months or after rectifying any faulty section in the specimen test report. One such test report for the complete installation shall be submitted before onset of monsoon.

- Only persons having valid wireman's license shall be employed for carrying out electrical work and repair of electrical equipment installation and maintenance at site. The job shall be supervised by a qualified licensed supervisor.

- Electricians to be provided with red helmet for easy identification.

- Electrical equipment and installations shall be installed and maintained as to prevent danger from contact with live conductors and to prevent fires originating from electrical causes like short

circuits, overheating etc. Installation shall not cause any hindrance to movement of men and materials.

- Materials for all electrical equipment shall be selected with regard to working voltage, load and working environment. Such equipment shall conform to the relevant standards.

- The minimum clearance to be maintained for all overhead lines along roads and across roads shall be as per the statutory requirements.

- Grounding conductor of wiring system shall be of copper or other corrosion-resistant material. An extra grounding connection shall be made in appliances / equipment where chances of electric shock is high.

- Electric fuses and / or circuit breakers installed in equipment circuits for short circuit protection shall be of proper rating. It is also recommended that high rupturing capacity (HRC) fuses are used in all circuits. The Earth Leakage Circuit Breaker (ELCB) shall be provided in the circuits.

- Wherever cables or wires are laid on poles, a guard wire of adequate size shall be run along the cables / wire and earthed effectively. Metallic poles as a general rule, shall be avoided and if used shall be earthed individually. Anticlimbing guards and danger notices shall be provided on poles. Each equipment shall have individual isolating switches.

-Wires and cables shall be properly supported and an approved method of fixing shall be adopted. Loose hanging of wires and cables shall be avoided. Lighting and power circuits shall be kept distinct and separate.

-Reinforcement rods or any metallic part of structure shall not be used for supporting wires and cables, fixtures, equipment, earthing etc.

- All cables and wires shall be adequately protected mechanically against damages. In case the cable is required to be laid underground, it shall be adequately protected by covering the same with bricks, Plain Cement Concrete (PCC) tile or any other approved means.

- All armored cables shall be properly terminated by using, suitable cable glands. Multistranded conductor cables shall be connected by using cable lugs/sockets. Cable lugs shall preferably be crimped. They shall be of proper size and shall correspond to the current rating and size of the cable. Twisted connections will not be allowed.

- All cable glands, armoring and sheathing of electric cables, metal circuits and their fittings, metallic fittings and other non-current carrying parts of electrical equipment and apparatus shall be effectively grounded.

- All the Distribution Boards, switches fuse units, bus bar chambers, ducts, cubicles etc. shall have MS enclosures and shall be dust, vermin and water proof. The Distribution Boards, switches etc. shall be so fixed that they shall be easily accessible, change shall be done only after the approval of the Departmental Electrical Engineer.

- The contractor shall provide proper enclosures / covers of approved size and shape for protection of all the switchboards, equipment etc. against rain. Exposed live parts of all electrical circuits and equipment shall be enclosed permanently. Crane trolley wires and other conductors which cannot be completely insulated shall be placed such that they are inaccessible under normal working conditions.

- Iron soclad industrial type plug outlets are preferred for additional safety.

- Open type Distribution Boards shall be placed only in dry and ventilated rooms; they shall not be placed in the vicinity of storage batteries or otherwise exposed to chemical fumes.

- Isolating switches shall be provided close to equipment for easy disconnection of electrical equipment or conductors from the source of supply when repair or maintenance work has to be done on them.

- In front of distribution boards a clear space of 90cm shall be maintained in order to have easy access during emergency.

- Adequate working space shall be provided around electrical equipment, which require adjustment or examination during operation.

- As far as possible electrical switches shall be excluded from a place where there is danger of explosion. All electrical equipment such as motors, switches and lighting fittings installed in workroom where there is possibility of explosion hazard shall be explosion proof.

- All connections to lighting fixtures, starters or other power supplies shall be provided with PVC insulated, PVC sheathed twin/three/four core wires to have better mechanical protection for preventing possible damage to equipment or injury to personnel. Taped joints shall not be allowed.

Electric starter of motors, switches shall not be mounted on wooden boards. Only sheet mounting or iron framework shall be used.

- All the lighting fixtures and lamp holders shall be of good quality and in good condition. Badly repaired or broken holders, etc. shall not be used.
- Only PVC insulated and PVC sheathed wires or armoured PVC insulated and sheathed cables shall be used for external power supply connections of temporary nature. Weatherproof rubber wires shall not be used for any temporary power supply connections.
- Taped joints in the wires shall not be used. Incase joints are required on electrical cables then only heat shrinkable PVC sleeves will be allowed.
- The bulbs/lamps used for illumination and testing purpose shall have cover or guard to protect them from accidental breakages. Only 24V supply system shall be used for hand lamps etc. while working inside metallic tanks or conducting vessels.
- After installation of new electric system and or other extensive extensions to existing installations, thorough inspection shall be made by Departmental Electrical Engineer before the new system or new extension is put in use.
- All persons who work with electrical installation/equipment shall be aware of the electrical hazards, use of protective devices and safe operational procedures. They shall be given training in fire fighting, first aid and artificial resuscitation techniques.
- The supervisor shall instruct the workers in the proper procedure, specify and enforce the use of necessary protective equipment such as adequately insulated pliers, screw drivers, fuse pullers, testing lamps and similar hand tools. Only wooden ladders shall be used to reach the heights in electrical work.
- No material or earthwork shall be allowed to be dumped below or in the vicinity of the bare overhead line conductors.
- Separate work permits shall be issued for individual group leaders working on the same system which shall be returned after the completion of the work to the Engineer-In-Charge.
- Before any maintenance work is commenced on electrical installations/equipment, the circuits shall be de-energised and ascertained to be dead by positive test with an approved voltage testing

device. Switches shall be tagged or the fuse holders withdrawn before starting the work. Adequate precautions shall be taken in two important aspects viz.

- That there shall be no danger from any adjacent live parts and
- That there shall be no chances of re-energisation of the equipments on which the persons are working. (Tag and lock system to be strictly followed).
- While working on or near a circuit, whenever possible the use of one hand may be practiced even though the circuit is supposed to be dead. The other hand may preferably be kept in pocket.
- When it is necessary to touch electrical equipment (for example when checking for overload of motors) back of the hand may be used. Thus, if accidental shock were to cause muscular contractions, one would not "freeze" to the conductor.
- Operation of electrical equipment shall be avoided when standing on wet floor or when hands are wet.
- Before blown fuses are replaced, the circuit shall be locked out and an investigation shall be made for the cause of the short circuit or overload.
- When two persons are working within reach of each other, they shall never work on different phases of the supply.
- When structural repairs, modification or painting work are to be undertaken, appropriate measures shall be taken for the protection of persons whose work may bring them into the proximity of live equipment / circuit.
- It shall be ensured that the insulation and wire size of extension cords is adequate for the voltage and current to be carried.
- While tapping electricity from the socket, plug top must be used. It shall be ensured that no extension boards are over loaded while tapping. Only standard three pin plugs shall be used for tapping electricity. Broken sockets/plugs shall be replaced immediately with good ones. Only joint free cables shall be used for connecting equipment/apparatus.
- Floors shall be kept free from trailing electrical cables to avoid tripping hazard.
- Power supply to all the machines and lighting fixture shall be switched off when not in use.

- Temporary electrical connections shall be removed as soon as the stipulated work is over. After completion of the works, the contractor shall dismantle the distribution boards and the other facilities he may have erected.
- Unauthorised tapping of power by others from distribution boards under the control of the contractor shall be prohibited at all circumstances.
- No flammable materials shall be stored in any working area near the switchboards.
- Safety work permits shall be used for switching off the main feeder and equipment by the contractor.
- "MEN ON LINE" "DO NOT SWITCH ON" "DANGER" or "CAUTION" boards as applicable shall be used during maintenance works on the electrical equipment.

PORTABLE ELECTRICAL EQUIPMENT :

- Portable electrical tools must be examined, maintained and tested daily, fortnightly and quarterly so that the equipment and its leads are in good order. Register shall be maintained for inspection recording the testing dates and results of the equipments. Inspection checklists to be formed to that effect. The recertification of lifting tools, tackles, equipments etc. must be carried out well before the expiry of its validity period.
- All portable appliances shall be provided with three core cable and three pin plugs. The third pin of the plug shall invariably be earthed. It shall be ensured that the metal part of the equipment shall be effectively earthed.
- All connections to portable equipment or machines from the panel/distribution board/extension board shall be taken using 3 core double insulated PVC flexible copper wire in one length. No joints shall be allowed in this flexible wire. In case length of wire is not sufficient for a particular location then the supply can be tapped by providing another extension board comprising of switch and socket.
- Flexible cables for portable lamps, tools and apparatus shall be regularly examined, tested periodically and maintained to ensure safety.
- For excavations, one time clearance from electrical is required for a particular area.
- Contractor shall get their welding machine / Stress Relieving (SR) electrical equipment / all

portable machine certified by MRPL / MRPL authorised contractor and seal will be fixed on machine to that effect. Certificate from third party mentioning the checks carried out, repairs carried out and safe to use to be submitted to owner /Project consultant.

Revalidation to be done once in 4 months. Incase contractor does not comply, it will be done by MRPL and four times the cost of repair will be back charged to contractor.

- Incase of welding, separate return cable from job piece to welding machine to be connected. Wires not to be used. PVC insulated cables only to be used.
- All lighting circuits/temporary connections for portable machine should have ELCB's of 30mA capacity max.
- All ELCBs to be tested once in 15 days using ELCB testers (and not by the lamp with open wires) and record maintained.
- Earthing of Neutral, which will act as return path, is not allowed.
- Electricians should have wireman license.
- During monsoons, monsoon protection for electrical equipment to be done.
- All feeders in contractor distribution panel to be clearly lettered with load details for isolation incase of emergency.
- Insulated tools like screwdriver, cutting plier, tester to be used.
- Each contractor should have one set of multimeter and tong tester.
- First aid kit to be available.
- The contractor must have a team of Experienced Electricians (having minimum of 10 yrs. experience in carrying out safety inspection and testing of Electrical Equipments, tools, portable electrical machines and appliances etc.). to conduct periodical (Daily, fortnightly, monthly and quarterly) inspection and testing of Electrical Equipments, tools and portable electrical machines, tools and appliances and to maintain its records.
- All power cable ends should have industrial plug on one side and other end directly into the machine. (No naked end pinning into will be permitted).
- For any job within MCC / SRR a work permit will be issued by MRPL operation. Job should not be started without these permits.

ROLE OF CONTRACTOR INCASE OF EMERGENCY AND SIREN :

- Contractor shall instruct his workers to follow instructions strictly in case of fire siren / emergency or if advised or felt necessary by Engg. In-charge. If evacuation is ordered they must leave the work site and proceed towards the designated assembly point for project site, OM&S building if in Lower Plateau. The contractor and its employees MUST follow specific instructions (Roles and Responsibilities incase of fire / onsite emergency) that will be given during training from time to time. All contractor employees MUST undergo such training, before their deployment at the work site. Contractor shall arrange & conduct such trainings for his employees and also employees of sub-contractors.
- Contractor shall instruct his workers to stop all jobs immediately incase release of liquid/gas/toxic/hazardous chemicals etc, and inform the concerned MRPL personnel available at site.

TRAINING :

- The contractor to conduct Induction training of all employees and record maintained.
- The contractor will have to depute all his employees (including Engineers, supervisors and workmen), before they commence work for the first time at MRPL site and subsequently once in a year, to undergo Fire and Safety training.Their photo gate passes will be stamped after the completion of the training. If these are not stamped then they will not be allowed to enter the site premises.
- Tool box talks to be conducted every day before starting of each sift and before commencing of work after lunch break.

LIST OF PERSONAL PROTECTIVE EQUIPMENTS

The contractor must poses the following minimum safety Items cum Personal Protective Equipments. All Personal Protective Equipments used at site to be of approved make by project consultant / Owner.

MANDATORY FOR THE CONTRACTOR EMPLOYEES WHILE WORKING AT SITE :

* Deployment of adequate nos. of safety officers as per table above and making available the mandatory items as per the minimum list below is a MUST as a part of mobilization activity.

1. Helmet.
2. Safety shoes (Conforming to IS standards with steel toe and anti-skid / acid, alkali and water proof soles).
3. Hand gloves (Leather impregnated cotton hand gloves).
4. Spectacle type goggles with toughened glass lenses, plain face shields with and without chin guards.

The contractor must use the "ISI" marked Personal Protective Equipments specific to the job .

It is mandatory to have minimum backup stock of all the PPEs in addition to what is already in use at site.

SPECIFICATIONS FOR SAFETY HELMETS-HDPE.

1) Helmet Safety Industrial HDPE white colour.
2) Contractor's Logo at front side.
3) Conforming to IS 2925, ISI marked & DGMS approved.
4) Nape strap type adj. type 6 point adj. head band & sweat band with 3/4"Cotton Chin strap.

* Green helmets for Safety Personnel and Red helmets for electricians to be provided and used by them.

SPECIFICATION FOR SAFETY BELT

Safety belts must be double lanyard type with hook having self closing latch (spring type). Different type of hooks to be available based on the nature of job / type of support. Safety belts should be ISI marked and should conform to IS 3521 and DGMS approved and stamped.

Safety belts, safety straps, lifelines, permanent anchors and connections should both separately and when assembled :

a) be capable of supporting safely a suspended load of at least 450 kg (1,000 lb) ; and
b) have a breaking strength of at least 1,150 kg (2,500 lb).

If hooks are used for attaching safety belts to fixed anchors, they should be self closing safety hooks of various types and sizes.

When a lifeline or safety strap is liable to be served, cut, abraded or burned, it should consist of a wire rope or a wire-cored fiber rope.

Safety straps should be so fastened to safety belts that they cannot pass through the belt fittings if either end comes loose from its anchorage.

Metal thimbles should be used for connecting ropes or straps to eyes, rings and snaps. Safety belts, safety straps and lifelines should be so fitted as to limit the free fall of the wearer to 1m (3ft 3in).

SPECIFICATION FOR FALL ARRESSTOR DEVICE

Fall arresstor device with self-retracting cable integrating locking mechanism combined with an energy deception element fully automatic having cables of various lengths, ISI and DGMS and or any international approval.

SPECIFICATION FOR DUST MASK

Dust Mask made of superior quality non-aging chemical-resistant rubber half face piece with reflex sealing flaps for protection against nuisance dust, (<0.5 micron) toxic dusts, gases and vapours with replaceable filters.

SPECIFICATION FOR REPLACEABLE FILTERS

For protection against nuisance dust, toxic dusts, gases and vapours upto a concentration of 500 ppm. To be fitted on aforesaid Dust Mask.

SPECIFICATION FOR SAFETY SHOES

1. Safety Shoes, Jodhpury style- as per is 11226- 1985 with guarantee for 1& 1/2 years (all weather).
2. Acid/ alkali/ waterproof heat resistant, antiskid green PVC Nitrile sole.
3. Steel toe cap as per relevant “IS”.
4. Upper plain leather, high ankle, with metallic 4 eyelets.
5. ISI marked.

6. The supplier should give guarantee of use of safety shoes during rainy season.

STANDARD SPECIFICATION FOR PVC HAND GLOVES

Hand contoured for greater comfort & feature an embossed nonslip grip for handling wet or greasy objects cotton flock lining absorbs perspiration maximises easy on/off black with straight cuff each pair pack.

SPECIFICATION FOR ELECTRICAL PPE (SHOCK PROOF)

Hand gloves used for live electrical works shall be of proper electrical rating.

Electrical (shock proof) Safety Shoes (Jodhpury type) with acid/ alkali/ water proof, heat resistant, antiskid sole with guarantee for 1&1/2 years (all weather).

1. Upper plain leather.
2. ISI marked & latest certificate of testing from any of the govt. recognised institution for electrical resistance.
3. GUMBOOTS with steel toe should be used by personnel during rainy season.

The aforesaid guidelines are the minimum safety requirements and the contractor should exceed them so as to achieve "ZERO ACCIDENT" which is our MOTO.

PENALTY / FINE :

Heavy penalty / fine will be imposed on contractor for…

1. Any accident, near misses resulting into serious bodily injury, property damage and degradation of environment on and around MRPL.
2. Violation of standard safety practices, norms and Rules, carelessness and negligence.
3. Violation of proper use of PPEs by workmen.
4. Lack of supervision.
5. Violation of work permit procedures at construction site and process plant areas.
6. Improper planning of critical jobs if resulted into Accident, Injury or Fire.

7. Failure to take corrective actions as advised by Engineering In-charge or Safety Officer.
8. Frequency or Severity Rate of Accident is found to be high.
9. Improper planning of activity / ies if results into nearmiss and bodily injury to personnel.
10. Unauthorised entries into process plant areas.
11. Horseplay.
12. Failure in taking corrective actions on unsafe conditions / acts as and when noticed and advised by Engineer In-Charge or ~~Safety Officer of MRPL~~.
13. Misuse of Fire Prevention / Protection and safety equipments.
14. Personnel working under intoxication.
15. Smoking.
16. Deployment of child labours.
17. Penalty charges are as below

Fatality:INR 20,00,000/-

Permanent disability:INR 15,00,000/-

Major injury: INR 10,00,000/-

Minor injury with absence to duty after accident: INR 10,000/- per day of absence due to injury or max INR 5,00,000/-

For safety violation:INR 10,000/- per violation.

For not wearing PPE: INR 5,000/- per case.

Consumption of alcohol and any other intoxicating material shall be also treated as safety violation and heavy penalty of INR 10000/- shall be levied on the main contractor per person consumed.

****

C-2	ENGINEERING DESIGN BASIS
C-2.9	FIRE PROTECTION SYSTEM

MRPL Marketing Terminal Project at Devangonthi, Bangalore

PROJECT : **Marketing Infrastructure Projects, MRPL**

OWNER : **MANGALORE REFINERY AND PETROCHEMICALS LTD**

PMC : **Nauvata.**

JOB NO. : **JBG20005**

Rev No.	Date	Purpose	Prepared by	Checked by	Approved by
0	19-02-2021	Issued for BID	SP	ASN	ASN

CONTENTS

1.0 SCOPE

This standard covers design basis for basic philosophy and facilities for fire fighting for plants. The provisions are as per statutory rules and safe engineering practice.

2.0 REFERENCE PUBLICATIONS

.

- OISD Standard 116 (Fire Protection Facilities for Petroleum Refineries and Oil / Gas Processing Plants).
- OISD Standard 117 (Fire Protection Facilities for Petroleum Depots and Terminal & Pipelines Installations.
- OISD Standard-163 (Process Control Room Safety) 2001 edition
- OISD Standard-164 (Fire proofing in oil & gas industry)
- Fire Protection Manual (Internal Appliances, Fire Engines/ Trailer pumps and Hydrant Systems) by Tariff Advisory Committee (TAC).
- OISD Standard 173 (Fire Prevention and Protection System for Electrical Installations)
- Rules of TAC for
  a. Sprinkler System
  b. Water Spray System
- OISD-150 (Design & safety requirement for Liquefied Petroleum Gas Mounded storage).
- BIS Codes for Fire Fighting Equipments.
- NFPA Codes for Clean Agent, CO_2 System and Foam System.
- Process Licensors requirement, if any

3.0 FIRE PROTECTION SYSTEM

3.1 GENERAL

This functional specification described below gives design and functional requirements for fire protection system for Phase III Refinery Project of MRPL at Mangalore. The **Fire Protection** system shall be conceived to operate both in prevention and fighting mode, depending on the relevant actions has been selected either manual or automatic. The fire fighting system shall be based on the following fighting agents.

- Water
- Foam
- CO_2

- Clean agent system
- Dry Chemical Powder (DCP)

3.2 DESIGN PHILOSOPHY

- Process plants, storages, utilities etc. shall be fully covered by hydrant system as per OISD-116, Tariff Advisory Committee (TAC) manuals, NFPA standards, design requirements, safe engineering practices and process licensor's requirements.
- Hydrant system shall be capable to fight two simultaneous major fires at a time anywhere in the complex. The complex shall be considered as High Hazard (B) category.
- For units, licensor's recommendation shall also be taken care.
- Roof sinking case as per OISD shall be considered.
- The facilities like transformers, hydrocarbon storage tanks, mounded bullets, etc. shall be protected with fixed installation e.g. water spray, foam system, rim seal protection system only for crude oil tanks etc. as described in TAC Spray Rules/ OISD as applicable.
- The fire hydrant network in and around hydrocarbon tank farm area shall be designed for water demand assuming tanks to be protected by water spray & foam system.
- For cable cellar water spray system shall be provided.
- Computer room, console room, UPS room, battery room, rack room etc of control room shall be protected by clean agent system as per NFPA-2001.
- **For process plants, OISD requirement and licensor's recommendations shall be followed.**
- Fire protection facilities will be based on following:
- Monitoring and Alarm by alerting, locating fire and operating advise.
- Detection of fire and toxic gas.
- Action by water/ foam/ Clean agent/ Dry Chemical Powder.
- **Design criteria for various facilities:-**

i. Process Unit Handling Hydrocarbon

a.	Water Application Rate for process unit (General)*	As per OISD 116 and TAC
	* Hydrocarbon handling pump	Water spray system as per OISD 116 & process licensor's requirement

	* Vessel : Un-insulated of holding cap. over 50 m^3	Water spray system as per OISD 116 & process licensor's requirement.
	* Air Fin Coolers	Located above pipe rack -Water spray system as per OISD 116 & process licensor's requirement.
b.	Water Application Rate for protected Equipment with deluge system	Refer OISD-116/ TAC & process licensor's requirement
c.	Dry Risers	Elevated platforms/ Tall towers.
d.	Landing Valves	On technological structures.
e.	Hose Reels	With each landing valves & at 40m distance along pipe rack.
f.	First Aid Eqpt.	As per TAC/ OISD norms.
g.	Remote Operated Long Range Monitor	Remote controlled long range water monitors (Aqua fog/ jet type) shall be provided at elevated towers for all columns/ vessels/ equipments above 25M height or inaccessible to normal monitors. (While designing LRM , operating pressure of 7Kg/SqCM to be considered and not the static pressure) (Long range monitor with adequate boosting arrangement (boosting arrangement shall be provided if adequate pressure is not available shall be considered.)
h.	Spray System on columns	The columns which are not covered by remote operated long range monitors. - Water application rate: 10.2 lpm/m^2 -Maximum spacing of ring: 5M

II. Offsite facilities

A. Hydro carbon Storage Tanks

- ❖ Spray system -As per OISD 116 & TAC rules
- ❖ Foam system -As per OISD 116 & TAC rules

In addition to above, provide linear heat detection system and automatic actuated fixed foam system for all floating roof hydro carbon storage tanks. For the protection of tanks provision of HVLR monitors for full tank surface protection.

B. **Pressurised storage**

- ❖ Automatic deluge system -As per TAC rules with

Spray cooling of Process piping within paved area or 15 m from storage which ever is more. Deluge system piping should be with flange joints (threaded joints should be avoided)

C. **Transformers & Cable Cellars**

Automatic (deluge) high velocity water spray system shall be provided for critical transformer of having oil capacity more than 2000 liters (each transformer). Cooling water application rate of 10.2 lit/min/sqm shall be provided as per OISD-173 and rules of TAC for Water spray System. Total horizontal projected surface of the prism-enveloped plus 1m each side shall be considered for cooling. Actuation of deluge valve shall be with the help of Quartzoid bulb (QB).

Medium velocity water spray system shall be provided for cable cellars as per OISD-173 and rules of TAC for Water Spray system, the same shall be actuated through smoke detectors.

D. **Buildings & Other Miscellaneous Structures**

- Fire hydrants and monitors shall be provided on elevated platforms of technological structures, Process building/ structure with loop to feed from two sides.
- Fire hydrant, for protection of pipe rack.
- Landing valves for multi storied buildings at first floor and above and at sub-stations with cellars as per TAC rules.
- Hose reels near landing valves.
- First Aid Equipments as per TAC / OISD rules as applicable.
- Clean agent for control room as per NFPA 2001.
- Gaseous protection system on equipments recommended by suppliers.
- Detection and actuation as per Electrical and Instrumentation specifications.

3.3 DETAILED DESIGN BASIS

3.3.1 Fire Water Hydrant System

A. Network sizing

i. TAC norms is to be followed for design and checked for OISD.

ii. Calculate the firewater demand as per TAC/OISD/ Licensor's requirement.

iii Establish sizes of fire water network based on 150% of installed capacity of pumps.

a. Fire water network shall be analysed for 100% using “PIPENET” software.

b. The velocity in the system should not exceed 5.0m/sec. with minimum residual pressure at remotest point as 7.0kg/sqcm.

c. *Two major fire with discharge of 50% of installed capacity at each fire point shall be considered*. Network system shall be capable to fight two simultaneous major fires at a time anywhere in the complex. The complex shall be considered as High Hazard (B) category.

d. For all kind of storage tanks, a case of roof collapse shall be considered and header around tank farm shall be sized accordingly to fight full surface tank fire.

iv. Refer TAC manual and OISD codes for details.

B. System description

- Underground ring main network system shall be laid at one meter earth cushion and above ground ring main network laid on sleepers 500 mm above FGL / Paved Area, independent of process lines near to road side.
- Flushing and pressure gauge points shall be provided on all headers.
- Network shall be laid in a closed loops.
- The firewater header and branch lines shall be laid above ground on independent sleepers for offsites and utilities areas. For road crossings and crane / vehicle movement area the same shall be laid underground with sleeve. Encasing shall be provided as applicable. All firewater headers around units shall be kept underground with suitable corrosion protection. *Also, all firewater headers and branch lines, which are in RCC paved area shall be laid in RCC trenches with sand filling and removable pre-cast cover with sealing. Headers should be laid in such a manner that it should not touch the bed level of the RCC trench.*
- The minimum header size for hydrant and monitor branches shall be as under:

Hydrant connection	-	4"
Water Monitor/Foam Monitor connection	-	6"
Long Range Monitor Connection	-	8”
Minimum Size of Network	-	8”

- Radiography requirements as per TAC.
- *All underground FW headers including the headers in RCC trench with sand filling shall be provided with corrosion protection coating as per SMMS specification Pipe shall be laid on 100mm thick sand in FW trench*.
- Above ground fire water piping shall be painted with Fire Red Paint to shade No. 536 of IS:5 as per painting specification.
- All fire water networks shall be hydro tested to a pressure of 1.5 times of design pressure.
- At least 10% of all welded joints shall be radiographed and shall be found in order. At least 50% of welded joints selected for radiography shall be field joints.

C. Restriction Orifice

- RO at Hydrant outlets to reduce the pressure to : 7kg/cm2
- RO at tappings of water spray system to keep the system pressure in the range specified in the TAC/ OISD rules.

D. Isolation valves

- Isolation valves shall be provided in such a way that not more than 4 (four) hydrants are isolated at a time and at crossings (Junctions) to ensure easy maintenance and uninterrupted water supply in case of break down.
- Isolation valve shall also be provided below monitor and at all hydrants.
- Water monitor shall have ball valves also for immediate line up in addition to gate valve for maintenance purpose.
- All underground fire water isolation valves shall be above ground with loop and with operating accessibility.
- Isolation valve shall be provided at all tapping points on firewater headers.
- Only carbon steel valves shall be used. CS valves shall be provided with gear operations including equalizing lines for dia 12" and above valve sizes. No cast iron valves shall be used.
- All the valve flanges to meet ASTM STD

E. Hydrants, Monitors, Hose Reels & Hose boxes

Hydrant shall be BIS approved with following detail

Outlet	:	63mm double headed
Pipe size	:	4" CS
Capacity	:	36 cum/hr
Type	:	Oblique angle type as per TAC Requirement Additional hydrant bonnet holding clamp shall be provided as per the MRPL practice.

Monitor shall be BIS approved with following detail

Nozzle bore size	:	38mm (Water– cum - foam diffuser type)
Pipe size	:	6" CS
Capacity	:	144 cum/hr

FM / UL listed High Volume Long Range water cum foam monitor shall be provided around units / tankages

Capacity	:	1000 GPM/2000 GPM/ 4000 GPM
Horizontal range	:	80 m

Hose reel shall be 40m long of 20mm bore size.

Hose shall be reinforced rubber line type B (RRL) 2 nos 15m each kept in each hose cabinet

Hose cabinet shall be BIS approved installed at every alternate hydrant points and every landing valves.

F. Landing Valve

- Double headed
- To be provided on landings of first floor and above as per design criteria.

G. Material of Construction

Material used for fire protection system shall be in accordance with TAC requirements and client specific requirement.

Broad specifications of material are as follows:

Pipe, fittings, valves - Carbon steel as per piping material specification

- GI pipes for water spray with standard flange fittings (threded fittings to be avoided) (Down stream of isolation valve)

Hydrant, Monitors, landing valves :Bureau of Indian Standards

Hose reels, hose Boxes and Accessories: (BIS) marked /TAC approved

H. Water Supply and Storage

a.	Supply	From Raw Water Reservoir.
b.	Storage capacity	Based on 6-hour storage of installed capacity of pumps.
c.	Material of construction	Open earthen reservoir lined with PE film and concrete for raw water and fire water reservoir
d.	Make up water	From Raw Water Reservoir through make up Pump
e.	Emergency connection	From RW reservoir

I. Fire Water Main Pumps

a.	Capacity	To fight two major fires simultaneously or as per TAC rules, which ever is higher.
b.	Type	Centrifugal pumps
	Note: Pump capacity and head are to be finalised during detail engineering.	
c.	Standby pumps	50% standby pumps
d.	Drive	Electrical / diesel engine as per OISD.
e.	Power supply to Electrical driven pumps	To meet the requirement of the OISD.

f.	Diesel Driven Pumps		To meet the requirement of OISD
			Diesel - day tanks capacity to meet requirement of TAC and shall be placed outside fire water pump house. (minimum12 Hour running storage)
			Starting of DE with trickle charged battery
			Diesel engine should be provided with acoustic enclosure.
g.	Mode of Operation		
	Starting of pumps		Automatic through pressure switches and manual
	Stopping of pumps		Manual only
h.	Fire water Jockey Pumps		
		-Capacity	Based on OISD/ TAC requirements
		-Head	0.5kg/cm^2 more than main pump head
		-Type	Centrifugal pumps
		-Stand-by	100%
		-Drive	Electric (Normally) To run on emergency power as well.
		Mode of operation	Automatic through pressure switches with provision to start and stop manually.

J. Fire Water Pump House

Firewater pump house shall be RCC frame construction having R.C.C. roof with brick walls as per TAC norms. It shall have provision for separate battery room, operator room and toilet block. A HOT/EOT crane shall be provided for maintenance and erection. A local fire control panel in operator's room shall be provided for all controls of firewater pumps.

3.3.2 Water Spray System

- Water spray system provided on hydrocarbon tanks, transformers, process equipment, etc. shall meet the requirements of TAC/ OISD. The rate of water applications & mode of operation shall be as per Table-1 and as per process licensor's requirement.
- All hydro carbon gas compressors to be necessarily provided with sprinkler system.
- Water spray on every equipment, vessel, column, air fin cooler, tanks, cable cellar and transformers shall have tappings from two sides of main header. (But network design shall be done assuming only one tapping as operational.)
- Water curtain shall be provided between heater and flow pass control valve and as per process licensor's recommendations.
- While providing water spray on equipments/ vessels, special care shall be taken to provide water spray on flanges of nozzle connected to equipments/ vessels.

TABLE 1

Rate of Water Application & Mode of Operation of Water Spray & Foam System

Facilities	Mode of Operation	Rate of application
Hydrocarbon Storage tanks	Manual	As per TAC, OISD & MRPL EDB whichever is more
Process unit handling hydrocarbon		
- On pumps	Manual	As per TAC, OISD & MRPL EDB whichever is more
-On compressors	Auto (Deluge system)	As per TAC, OISD & MRPL EDB whichever is more
- Other equipments as per licensor	Manual	As per TAC, OISD & MRPL EDB whichever is more
- Tall column	Manual	As per TAC, OISD & MRPL EDB whichever is more
- Air Fin Coolers	Manual	As per TAC, OISD & MRPL EDB whichever is more
Transformers	Auto (Deluge system)	As per TAC, OISD & MRPL EDB whichever is more
Cable Cellar	Auto (Deluge system)	As per TAC, OISD & MRPL EDB whichever is more

NOTE: In case process licensor recommends for automatic deluge system, manual system shall be changed accordingly.

- **Material of Construction**

Pipes, fittings	CS for mains and MS-GI(HVY) flanged joints for spray system
Valves and flanges	CS.
Spray nozzles	Cu Alloy
Deluge valves	CS
Detector piping	GI.

3.3.3 Foam System On Hydrocarbon Storage Tanks

- Type of foam -Low and medium expansion foam Aqueous Film Forming Foam (AFFF)
- Operation -Manual
- System type -Semi fixed
- Application time -As per TAC
- Foam Solution -3% foam

Foam solution application rate

- 5 lpm/m^2 of liquid surface - for fixed roof and cone cum floating roof tank
- 12 lpm/m^2 of vapour seal area i.e. foam dam area for floating roof tanks.
- 8.1 lpm/m^2 for roof collapse case for floating roof tanks.

Foam Compound Storage

- Foam compound requirement shall be considered to meet requirement of foam fire protection system.

In addition to above for Hydro carbon storage tanks automatic actuated by Linear Heat Detection Rim Seal Foam Protection System designed to detect and extinguish the floating roof Rim seal fire at its incipient stage shall also be provided as laid down in OISD – 116. (The system is installed at the roof of tank and consist of long foam line laid along the tank perimeter. The foam aspirating nozzles are mounted on the line at an interval of 2.5 M. The premix foam is contained in a vessel which is kept charged with nitrogen through a nitrogen cylinder. The system is designed for minimum foam application rate of 18 LPM / M^2 of rim seal area.)

3.3.4 CO_2 Fire Extinguishing System

- The system shall be as per NFPA-12.

3.3.5 Clean Agent Fire Extinguishing System for control room

Clean agent fire extinguisher system shall be provided in control rooms as per NFPA 2001. The system shall be automatic and detection and actuation shall also meet the requirement of NFPA 2001. Initial approval shall be taken from client before proceeding with design and detailing.

3.3.6 First Aid Fire Fighting Equipments

This shall be provided as per TAC.

3.3.7 Mobile Fire Fighting Equipments

Existing Refinery infrastructure shall be used Any additional requirements shall be reviewed based on the project requirement.

3.3.8 Fire Fighting Appliances

Rubber line type B Hoses with hand controlled water cum foam(Jet and Fog) nozzle & Hose boxes with accessories shall be provided as per TAC and MRPL EDB requirements.

3.3.9 Fire Station

New fire station if envisaged shall be located at safe location Codes & Standards

a. Fire Protection Manual (Internal appliances, fire engines, trailer pumps, and hydrant systems) (By Tariff Advisory Committee)
b. I.S. Codes For Fire Fighting Equipments.
c. Rules for water Spray system (For spray system design)
d. NFPA 10 (Portable Fire Extinguisher)
e. NFPA 12 (CO2 Fire Extinguishing system).
f. NFPA 2001 (Clean Agent Fire Extinguishing System)
g. OISD standards
h. NFPA-11 Std. For Low Expansion Foam
i. NFPA-13 Std. For Installation of Sprinkler System
j. NFPA-17 Std. For DCP
k. Process licensor's standards and recommended HSE Policy/ codes.

3.4 APPROVAL OF FIRE PROTECTION SYSTEM

TAC Manuals describe procedure of submitting documents elaborating the details of documents, drawings, scale of drawings, minimum contents in the drawings. Based on their guidelines, documents / drawings shall be prepared. *Approval from TAC accredited agency shall be taken.*

3.5 FIRE PROOFING

Fire proofing using vermiculite shall be provided for steel structures and equipment supports that could collapse under fire condition and contribute to the intensity of the fire shall be provided to meet the requirements of OISD Standard 164 (Fire Proofing in Oil and Gas Industry).

4.0 FIRE DETECTION / ALARM SYSTEM

Refer OISD Standards.

5.0 COMMUNICATION

Refer Electrical Specifications for details.

6.0 SPARES

Spares recommended by vendor shall be supplied for Remote Operated Long

Range monitors, fire hydrants, Hose reels, Deluge system, Rim seal protection, sprinkler system, foam pourer system Etc. and as recommended in MRPL spares EDB.

C-2	ENGINEERING DESIGN BASIS
C-2.10	INFORMATION SYSTEM

MRPL Marketing Terminal Project at Devangonthi, Bangalore

PROJECT : **Marketing Infrastructure Projects, MRPL**

OWNER : **MANGALORE REFINERY AND PETROCHEMICALS LTD**

PMC : **Nauvata.**

JOB NO. : **JBG20005**

Rev No.	Date	Purpose	Prepared by	Checked by	Approved by
0	19-02-2021	Issued for BID	SP	ASN	ASN

Contents

1.0 GENERAL

This design basis covers the general requirements for Information Systems design and installation strategy. The principal goals in design are flexibility and scalability, which involve site location, building selection, floor layout, network cabling, electrical system design, mechanical design and modularity. Individual specifications shall be referred for more detailed information.

This document is not intended to be a complete and detailed engineering guide for Local Area Network or Server Room/Data centre design. Rather, it is intended to be an overview of the various components of the network, their impact on network performance, and the issues to be considered when contemplating LAN installations or upgrades.

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**

1.1 Purpose:

The purpose of this document is to describe the minimum requirements for designing, installing, securing, monitoring, maintaining, protecting, and decommissioning of IT facility at MRPL.

1.2 Applies to:

All site locations of MRPL including its branch offices at different geographical locations where there is need of setting up of IT Infrastructure like Data Centre /Server rooms, Network rooms, Network Cabling etc.

2.0 REFERRED STANDARDS

Design and terminology shall comply, as a minimum, with the latest edition prior to the date of purchaser's enquiry with following codes, standard practices and publications:

- TIA –TELECOMMUNICATION INDUSTRY ASSOCIATION STANDARDS
- EIA - ELECTRONIC INDUSTRIES ALLIANCE STANDARDS
- ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
- IEEE - STD 802.3 STANDARD FOR ETHERNET

3.0 NETWORKING DESIGN

The term “structured cabling” refers, in general, to a planned, modular approach to laying out and wiring a copper- or fibre-based network. The object of structured cabling is to ensure that the network can handle the expected volume of traffic and be expanded as needed. From an engineering perspective, the main feature of structured cabling is adherence to industry standards in planning, installing, and expanding the network.

Structured cabling design and installation is governed by a set of standards that specify wiring data centres and campus buildings for data or voice communications using various kinds of cable, most commonly category 6 (CAT6), and fibre optic cabling and modular connectors.

3.1 WORK AREA

A work area corresponds to a typical office space with a phone and a computer.

Each work station must minimally have:

- An outlet with two network connectors, typically one for a computer and one for any other network device. These outlets must be either T568A RJ45 or T568B RJ 45.
- Cables to link the work area devices to the outlet connectors. Work area cables are limited to 3 meters (9.8 feet) or less in length as shown in figure below.

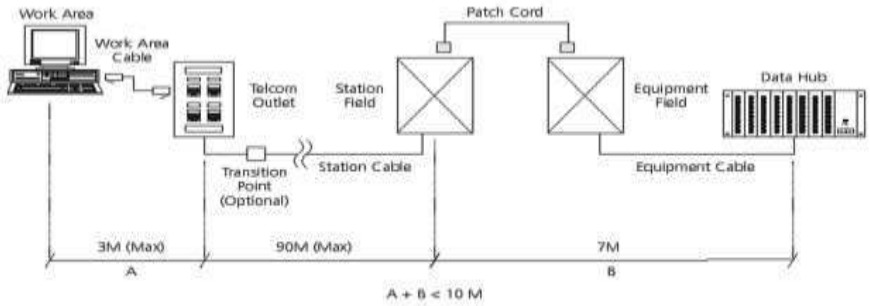


Figure 11. Work Area and Horizontal Cabling

- All Ethernet cables and ports must support 1Gbps connectivity.
- All copper Ethernet cabling must be Category 6 cable or better.
- Each work station should be provided with 3 numbers of 230 V power sockets, provisioning to connect a Desktop, Laptop, Printer, Scanner etc.
- Provision to install a separate rack for keeping network equipments in common area/main halls.
- Provision for high speed 802.11n wireless Access Points.
- Network conduits should be sized as if the tables were to be wired with current standards of two drops per seat.

Apart from the above requirements, common halls and cabin work areas will require additional provisions as mentioned below.

Conference Rooms:

- All conference rooms are designed with common multimedia AV presentation systems
- AV designs that accommodate an ADA compliant multimedia podium with space for presenter to use their laptop that is wired with electricity, Ethernet, visual presenter, sound system, and LCD projector.
- Need to be pre-wired to accommodate web casting and videoconferencing.
- Equipped with individual high speed 802.11n wireless Access Points.

Cabins:

- Each office should have minimum one location with two network drops. Offices larger than 10x10 (usually Department Heads) will probably require two locations, opposite of each other.
- Provision for AV presentation systems with additional network point for AV system.

3.2 NETWORK CABLING

Indoor Cabling:

1. Ethernet ports, SFPs, SFP+ and switch interconnecting cables required for connectivity on the switch shall satisfy the LAN point's requirements.

2. For interconnecting 2 or more floor switches, proper interconnecting cables shall be used to provide the maximum available bandwidth (minimum 1Gbps required) between switches using a single port. Link aggregation shall not be used to achieve higher bandwidth.

3. UTP CAT6 cabling shall support 1Gbps connectivity.

4. UTP CAT6 LAN Cabling shall be able to carry power for PoE devices.

5. LAN / fibre cabling shall support all types of traffic (data, voice or video).

6. Shall use cabling standards and follow the structured cabling industry practices.

7. Fibre termination on LIUs shall be of SC type with proper interfaces.

8. The network racks power supplies cables shall be suitable for Indian power specifications of voltage, frequency, and phasing, and match the power requirements.

9. All the cable interfaces, connectors, etc. are included in scope of supply. This shall include fixing of LIU, connecters, cables, and components to make the circuit operational.

10. Each network room shall have redundant fiber connectivity to the Server room (Admin).

11. Uplink ports from each network room shall be on fibre and shall terminate on Core Switch at main server room.

12. Each LAN point should be properly tagged and labelled with colour coding.

Outdoor Cabling:

For routing cables between campuses, buildings, structures etc. These cabling consist of the backbone fibre cables, splices, terminations, and patch cords or jumpers used for backbone to backbone interconnections.

1. Single Mode 12F armoured cable should be used.
2. Cables should be terminated with connectors of the same category.

3. Length of conduit shall not exceed 183m (600 ft.) between pulling points.
4. Back-to-back 90° degree bends shall be avoided.
5. Cable trays should be used to the maximum extent possible.
6. For underground cabling, HDPE/GI pipes should be used with a minimum excavation of 2 feet.
7. Installation of painted and engraved cement cable route markers at a distance of 25 meters.

4.0 GENERAL CONSIDERATIONS FOR IT SPACE

- Network points with power sockets to be provided at common places for installation of network printers, scanners etc.
- Network points with power sockets at the entrance of buildings for Access Control and Bio Metric devices
- A separate space/room for servers/network racks in each building or floors as applicable with network points and power sockets.

C-2	ENGINEERING DESIGN BASIS
C-2.11	SURFACE PREPARATION AND PROTECTIVE COATING

MRPL Marketing Terminal Project at Devangonthi, Bangalore

PROJECT : **Marketing Infrastructure Projects, MRPL**

OWNER : **MANGALORE REFINERY AND PETROCHEMICALS LTD**

PMC : **Nauvata.**

JOB NO. : **JBG20005**

Rev No.	Date	Purpose	Prepared by	Checked by	Approved by
0	19-02-2021	Issued for BID	SP	ASN	ASN

Abbreviations:

AS	Alloy Steel
CS	Carbon Steel
DFT	Dry Film Thickness
DM	De-mineralized
GI	Galvanized Iron
ID	Internal Diameter
IRN	Inspection Release Note
LTCS	Low Temperature Carbon Steel
MS	Mild Steel
NB	Nominal Bore
OD	Outside Diameter
RCC	Reinforced Cement Concrete
SS	Stainless Steel
TSAC	Thermally Sprayed Aluminium Coating
WFT	Wet Film Thickness

CONTENTS

1.0 GENERAL

1.1 This technical specifications shall be applicable for the work covered by the contract, and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that contractor shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

1.3 This specification covers the requirement for protective coating for new construction.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to the following.

2.1.1 This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services and chimneys if any. The items listed in the heading of tables of paint systems is indicative only, however, the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

2.2 Extent of Work

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

- All uninsulated Carbon Steel & Alloy Steel equipments like vessels, Columns, Storage Tanks, Exchangers if any, parts of boilers etc.

- All uninsulated carbon steel and low alloy plant and related piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.

- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping and if any other insulated items present.
- All items contained in a package unit as necessary.
- All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.

- Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining. (If present)
- Identification of color bands on all piping as required including insulated aluminum clad, galvanized, SS and nonferrous piping.
- Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminum clad, galvanized, SS and non-ferrous piping.
- Marking Me identification signs on painted surfaces of equipment/piping including hazardous service.
- Supply of all primers, paints and all other materials required for painting (other than Owner supplied materials)
- Over insulation surface of equipments and pipes wherever required.
- Painting under insulation for carbon steel, alloy steel and stainless steel as specified.
- Painting of pre-erection/fabrication and Shop primer.
- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.
- All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in ETP plant.
- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating) **along with the Involvement of Paint Manufacturer.**

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the owner, the same shall be painted as per the relevant specifications:

a. Uninsulated austenitic stainless steel.
b. Plastic and/or plastic coated materials
c. Non-ferrous materials like aluminum, Cu-Ni alloy, galvanized steel.

2.3 Documents

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for execution of work.

a. Bill of quantities for piping, equipment, machinery and structures etc

b. Piping Line List.

2.4 Unless otherwise instructed, final paint coating (i.e., application of field primer, wherever required, intermediate and top coats) on pre-erection/ shop primed equipments shall be applied at site, only after all welding, testing on systems are completed as well as after completion of steam purging wherever required.

2.5 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to MRPL for deviation permit.

3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered by this contract.

IS-5	Color coding
RALDUTCH	International Standard for color shade (Dutch Standard)
IS-101	Methods of test for ready mixed paints and enamels
IS-2379	Indian Standard for Pipe line identification-color code
IS0-12944	Corrosion Protection of steel Structures by Protective Paint System
ASTM-Vol6.01&6.03	American standard test methods for Paints and Coatings.
ANSI A 13.l	Scheme for identification of piping systems: American National Standards Institution
SSPC	Steel Structures Painting Council

3.2 Surface Preparation Standards

The latest editions of any of the following standards shall be followed for surface preparation:

3.2.1 ISO 8501-1/SIS-0559 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

3.2.2 Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC-SP).

3.2.3 National Association of Corrosion Engineers, U.S.A., (NACE).

3.2.4 Various International Standards equivalent to Swedish Standard for surface preparations are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

3.4 The paint manufacturer's instructions shall be followed as far as practicable at all times for best results. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparation prior to painting shall be followed as per Table 8.0 to 16.0 of this standard shall be followed.

c. Mixing and thinning.

d. Application of paints and recommended limit on time intervals in between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipments, scaffolding materials, shot & grit blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity. The manufacturer's test certificates I data sheets for all the above items shall be reviewed by Engineer-in-charge at site before start of work.

4.2 Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

5.0 SURFACE PREPARATION, SHOP PRIMER COATING APPLICATION & REPAIR AND DOCUMENTATION

5.1 General

5. 1.1 In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by Engineer-In-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

a. Abrasive blast cleaning

b. Mechanical or power tool cleaning

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification. The minimum acceptable standard, in case of thermally sprayed metal coatings, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent. In case of blast cleaning it shall be Sa 2-1/2 as per Swedish Standard SIS-055900 (latest edition) or SSPC-SP or ISO 8501-01.Blast cleaning shall be Sa 3 as per Swedish Standard in case thermally sprayed metal coatings.

Before surface preparation by blast cleaning, the surface shall be degreased by aromatic solvent to remove all grease, oil etc.

5.1.3 Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%. In case of internal coating of storage tanks, dehumidifier shall be used, to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3°C below the metal substrate temperature during centre period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on substrate.

Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by contractor for the given site conditions before starting operation of dehumidifier to ensure that desired values of dew point, moisture content in enclosed scope is achieved.

Dehumidification to be maintained round the clock for surface preparation and painting till the total coating application is over.

Dehumidifier shall not be stopped under any condition till the entire blasted surface is primed to the satisfaction of the technical representative of the paint manufacturer interested with quality assurance for the work. In case the dehumidifier breaks down in middle of the job, the same shall be replaced at the risk and the cost of the contractor and the entire unfinished work shall be repeated.

5.1.4 The Engineer in-charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances the contractor shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the owner.

5.1.5 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray if recommended by the paint manufacturer on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re• cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.6 The external surface of R.C.C. Chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCL solution for about 15 minutes shall be carried and surface must be thoroughly washed with water to remove acid & loose particles and then dried completely before application of paint.

5.2 Procedure for Surface Preparation

5.2.1 Air Blast cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives like angular chilled cast iron or steel grit, copper slag or Nickel slag, A1203 particles at pressure of 7kg/cm2 at an appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron or steel shall be in the form of shot or grit of size in the range of G 16 - G42 conforming to SSPC AB 1 and 8250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak. For all other abrasives, size shall be in the range of G 16 - G24. The combination of steel grits and shots shall be normally in the ratio of 3: 1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB 1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venture style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to: Y..." On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer/first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to SO microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.2 Mechanical or Power Tool Cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and /or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

5.3 Non-Compatible Shop Coat Primer

For equipments on which application of total protective coating (Primer + Intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipments (coated with Primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per Table 7 .2 of paint systems depending upon compatibility of paint.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before application of selected paint system for particular environment.

5.6 For Package units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipments, structures, piping, etc, shall be carried out only after its erection and all welding, testing, steam purging (wherever carried out) have been completed.

5.7 Coating Procedure and Application

All paint coatings shall be applied by airless spray excepting at the following special cases where application can be carried out by brush subject to suitability of the application of the paint product by brush.

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application.

Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than 5°F above dew point when the relative humidity is greater than 85% or when the temperature is below 40°F and when the ambient/substrate temp is below the paint manufacturer's recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20km per hour.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter coat interval.

5.7.5 When the successive coat of the same color have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Airless spray application shall be in accordance with the following procedure: as per steel structure paint Manual Vol.1 & Vol.2 by SSPC, USA, Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor issued to operate a pump to produce pressures of 1000 to 6000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun; a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of in built strainer. Usually very small quantity of thinning is required before spray. In case of high build epoxy coating (two packs). 30:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8" ID and not longer than 50 ft to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

5.7.7 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint.

b. Round or oval brushes are most suitable for rivets, bolts, irregular surface, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paint shall be applied into all comers.
d. Any runs or sags shall be brushed out.
e. There shall be a minimum of brush marks left in the applied paint.

f. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskin.

5.7.8 For each coat the painter should know the WFT corresponding to the specified OFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of Coated Surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or maxing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

5.9 Spot Repair of Damaged Primer

5.9.1 Where pre erection shop primer has been damaged at isolated localized spots during handling and transportation, or after erection I welding, the repair of damaged coating of pre-erection I pre-fabrication or shop primer shall be done as given below and as per the Table 7.2 of this specification.

5.9.2 Repair of damaged inorganic zinc silicate pre-erection I pre-fabrication or shop primer (F9) after erection I welding in the design temperature of -90°C to 400°C and damaged silicone aluminum (F-12) pre-erection I pre-fabrication or shop primer after erection I welding for design temperature range of 401 - 550 °C.

Surface Preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal.

Blasts clean the surface, if possible. Feather the primed surface over the intact adjacent surface surrounding the damaged area by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damage was observed on pre• erection I pre fabrication or shop primer of inorganic zinc silicate coating (F-9). Similarly one coat of F-12 shall be applied wherever damage observed on pre-erection I pre• fabrication shop primer of silicone aluminum (F-12).

5.9.3 Wherever if damaged areas are found extensive and spread over large areas, then entire pre-erection I pre-fabrication or shop primer shall be removed by blasting to achieve SSPC-SP-10 then entire blasted surface shall be primed again with F-9 or F-12 as applicable for the intended design temp. (See note under table 7.2).

5.10 Paint Application

5.10.1 Shop priming/pre-erection priming with F9 or F 12 shall be done only on blasted Surface (SSPC-SP-10)

5.10.2 Shop priming I pre-erection priming with F9 or F12 shall be done only with airless spray.

5.10.3 Assessment of Painting Requirement

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the environment from area classification details and chose the appropriate table.
- Identify the design temperature from the technical documents
- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.
- Identify the shop priming requirement from Table 7.1 based on compatibility of the above paint system.
- Identify the need of repair of shop primer and execute as per Table 7 .2.

5.11 Documentation and Records

5.11.1 A written quality plan with procedure for qualification trials and for the Actual work including test and inspection plan & procedure for approval before start of work.

5.11.2 Daily progress report with details of weather conditions, particu1ar of Applications, no of coats and type of materials applied, anomalies, progress of

Work versus program.

5.11.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

5.11.4 Particulars of surface preparation and paint application during trials and during the work.

5.11.5 Details of non-compliance, rejects and repairs.

5.11.6 Type of testing equipments and calibration.

5.11.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 5.11.2 – 5.11.7 above as well as the approved procedure of work (5.11.1 above). The job record consisting of information as required in accordance to 5.11.2 - 5.11.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

After completion of the job, along with the final documentation, contractor shall submit the document for the total quantum of job carried out, quantity of paint used area wise / equipment wise. Test certificates, stage wise inspection reports, manufacturer's guarantee certificate, stage wise inspection / witness certificate from paint manufacturer.

TABLE-1 (FOR CLAUSE 5.0)
SURFACE PREPARATION STANDARDS

SI. No.	DESCRIPTION	VARIO US INTERNATIONAL ST AND ARDS (EQUIV ALE NT)			REMARKS
		ISO 8501-1/ SIS-OS 59 00	SSPC-SP, USA	NACE, USA	
1.	Manual or hand tool cleaning	ST.2	SSPC-SP-2	--	

	Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen				This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting
2.	Mechanical or power tool cleaning Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	ST.3	SSPC-SP-3	--	
3.	Dry abrasive Blast cleaning There are four common zrades of blast cleaning				
3.1	White metal Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	SA3	SSPC-SP-5	NACE #l	Where extremely clean surface can be expected for prolong life of paint system.
3·2	Near white metal Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is free of all visible residues with desired surface profile	SA 2\12	SSPC-SP-10	NACE #2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	Commercial Blast Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	SA2	SSPC-SP-6	N0.3	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint svstems.
3.4	Brush-off Blast Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so imnortant	SA 1	SSPC-SP-7	N0.4	

6.0 PAINT MATERIALS

Paint manufacturers shall furnish the characteristics of all paints materials on original printed literature, along with the test certificate for all specified characteristics given in this specification. All the paint materials shall be of first quality and conform to the following general characteristics as per the tables 6.1, 6.2, 6.3 and 6.4.

PAINT MATERIALS
TABLE NO.6.1 PRIMERS

SI. No.	DESCRIPTION	P-2	P-4	P-6	P-7
1	Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/ wash primer	Epoxy zinc phosphate primer	ZINGA, LOCKTITE or ZRC cold zalvanizine
2	Type and composition	Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticizer, pigmented with zinc phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack Synthetic Resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.
3	Volume Solids %	40±3	10±1	50±1	37%
4	DFT (Dry Film thickness) per coat in microns	40-45	8-10	40-50	40-50µ
5	Theoritical covering capacity in M2/coat/ litre	8-10	8-10	8-10	4m2/kg
6	Weight per litre in kgs/litre	1.3±0.05	1.2±0.05	1.4±0.05	2.67 kg at 15°C
7	Touch dry at 30°C (minimum)	30 minutes	2 hrs.	After 30 min.	10 minutes
8	Hard dry at 30°C (maximum.)	8 hrs.	24 hrs.	8 hrs	24 hrs.
9	Overcoating interval	Min.: 8 hrs	Min: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
10	Pot life at 30°C for two component paints	Not Annlicable	Not applicable	6 - 8 hrs.	Unlimited

11	Temperature (Resistance (minimum)	60°C Drv service	NA Drv service	80°C Drv service	50°C Drv service

PAINT MATERIALS
TABLE No. 6.2 FINISH PAINTS

Sl. No.	DESCRIPTION	F-2	F-3	F-6A/B	F-6C	F-7
1	Technical Name	Acrylic Polyurethane Finish paint	Chlorinated rubber based finish paint	Epoxy -High Build coating	Solvent less epoxy coating	High build coal tar epoxy coating
2	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two-pack Aromatic amine cured epoxy resin medium suitably pigmented. F-6B : polyamide cured epoxy resin medium suitably pigmented	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
3	Volume Solids%	40±3	38±2	60±3	99±1	65±3
4	DFT (Dry Film thickness) per coat in microns	30-40µ	30-40	100-125µ	200-500	100-125µ
5	Theoritical covering capacity in M2/coat/litre	11-15	11-15	5-6	2-3	5.2-6.5
6	Weight per liter in kags/litre	1.15±0.03	l.15±0.03	1.42±0.03	1.40±0.03	1.40±0.03
7	Touch drv at 30°C	30 minutes	30 minutes.	3 hrs.	3 hrs.	4 hrs.
8	Hard dry at 30°C Full cure at 30°C (for immersion/ high	8 hrs	8 hrs	16 Hrs 5 days	16 hrs	48 hrs 5 days
9	Over-coating interval at 30ºC	30 minutes	30 minutes	3 hrs.	3 hrs.	4 hrs.
10	Pot life (approx.) at 30ºC for two component paints	6-8 hrs.	Not applicable	4-6 hrs	30 minutes	4-6 hrs.
11	Temperature Resistance (minimum)	80ºC Dry service min	60ºC Immersion service	80ºC Dry service	120ºC (Dry service), 50ºC (Immersio n service)	125ºC Immersion service

PAINT MATERIALS
TABLE No.6.3 FINISH PAINTS

Sl. No.	DESCRIPTION	F-8	F-9	F-11	F-12
1	Technical name	Self priming type surface tolerant high build epoxy coating (complete rust control coating)	Inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250ºC dry temp	Heat resistant silicone Aluminium paint suitable upto 500ºC dry temp
2	Type & composition	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating	A two pack air drying self curing solvent based inorganic zinc silicate coating with minimum 80% zine content on dry film. The final cure of the dry film shall pass the MEK rub test	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250ºC	Single pack silicone resin based medium with Aluminium flakes
3	Volume Solids	78+3	60+3	38+0.03	20+2
4	DFT (Dry Film thickness) per coat in microns	100-125	65-75	15-20	15-20
5	Theoretical covering capacity in M^2/coat/litre	6.0-7.2	8-9	10-12	8-10
6	Weight per liter in kgs/litre	1.41+0.03	2.3+0.03	0.95+0.03	1.00+0.03
7	Touch dry at 30ºC (maximum)	3 hrs.	30 minutes	3 hrs.	30 minutes
8	Hard dry at 30ºC (maximum) Full cure 30ºC (for immersion/high temperature service)	24 hrs 5 days	12 NA	12 NA	24 hrs NA

9	Over-coating interval	Min. : 10 hrs	Min. : 12 hrs. at 20ºC & 50% RH	Min. 24 hrs	Min.:24 hrs
10	Pot life at 30ºC for two component paints	90 minutes	4-6 hrs.	Not applicable	Not applicable
11	Temperature Resistance (minimum)	80ºC Dry service	400ºC Dry service	250ºC Dry service	500ºC Dry service

PAINT MATERIALS
TABLE No.6.4 FINISH PAINTS

Sl. No.	DESCRIPTION	F-14	F-15	F-16	F-17
1	Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint)	Ambient temperature curing Poly Siloxane coating/High build cold applied inorganic copolymer based aluminium coating suitable for under insulation coating of CS and SS piping for high temperature service	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
2	Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS/SS piping	Amercoat 738 from PPG Protective & Marine Coatings or Intertherm 751 CSA of International (Akzo Nobel). Note : 6	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
3	Volume Solids %	70+3	70+3	60+2	98-100
4	DFT (Dry Film thickness) per coat in microns	100-125	75-100	75-100	125-150

5	Theoretical covering capacity in M^2/coat/litre	5-8	4-5	7.0-9.0	6.5-8
6	Weight per liter in kgs/litre (mix paint)	1.45+0.03	1.65+0.03	1.3	1.7
7	Touch dry at 30ºC (maximum)	4 hrs.	3 hrs	1 hr	2 hrs
8	Hard dry at 30ºC (maximum) Full cure 30ºC (for immersion/high temperature service)	24 hrs 168 hrs (7 days)	24 hrs 168 hrs (7 days)	16 hrs	24 hrs 168 hrs (7 days)
9	Over-coating interval	Min. : 6 hrs Max. 5 days	Min. : 36 hrs. Max. 21 days	Min. 16 hrs Max. Not applicable	Min.: 16 hrs Max. : 21 days
10	Pot life at 30ºC for two component paints	4 hrs	4-6 hrs.	1 hr	1 hr
11	Temperature Resistance	-45ºC to 125ºC under insulation and immersion	-45ºC to 150ºC under insulation & immersion (Note : 5)	a) upto 400ºC for C. Steel & S. Steel for Intertherm 751 CSA b) upto 480ºC for C. Steel & upto 600ºC for S. Steel for Amercoat 738	-45ºC to 150ºC for immersion service

NOTES (for tables 6.1 to 6.4):

1. Covering capacity and DFT depends on method of application. Covering capacity specified above is theoretical. Allowing the losses during application, min specified OFT should be maintained.

2. All primers and finish coats should be cold cured and air drying unless otherwise specified.

3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. In case of conflict between this specification and manufacturer's recommendation, the same shall be clarified through EIL SMMS department.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

5. F-15: Two-component Epoxy phenolic coating cured with Polyamine adduct hardener system (primer + intermediate coat + finish paint) suitable up to 225°C (Intertherm 228 from M/s Akzo Nobel Coatings India Pvt Ltd. Bangalore). For all other companies, the temperature resistance shall be a maximum of l 50°C.

6. F- 16: Ambient temperature curing epoxy poly siloxane Coating or high build cold applied inorganic co-polymer based aluminum coating.

   Amercoat 738 from PPG Protective & Marine coatings. Mumbai, is suitable up to 480°C for CS surfaces and 600°C for SS surfaces.

   Intertherm 751 from Akzo Nobel Coatings India Pvt Ltd. Bangalore, Inorganic co-polymer cold applied Aluminum spray coating is suitable up to 400°C of CS & SS surfaces

7.0 COATING SYSTEMS

The coating system should be selected based on the Plant location as given below:

Classification based on Plant Location:

a. Plant located in Inland area (more than 50 km from coast);
Environment Classification - Industrial

- For offsite areas: Table 9.0 to be followed
- For all unit areas including DM.CPP and Cooling Tower: Table 10.0 to be followed

b. Plant located on sea coast or within 50 km from sea coast;
Environment classification- Industrial marine

- For offsite area, as well as all unit area including DM, CPP, Cooling Tower: Table 10.0 to be followed

c. For external surface of above ground tanks, table 12.0 to be followed for all locations (Inland or coastal)

NOTES:

1. Coating systems (Primers, Finish Paints etc.) based on

Area classification/environments/Applications are tabulated in Table 8.0 to Table 17.0

2. Primers & Finish paints covered in Tables 8.0 to 17.0 are listed in Table 7.1.

3. Repair of Pre-Erection/Pre-Fabrication & Shop priming after erection/ welding shall be done as per Table 7.2.

TABLE 7.1 : LIST OF PRIMERS & FINISH COATS COVERED IN TABLE NOS. 8 TO 18.0

PRIMERS	
P-2	Chlorinated rubber zinc Phosphate Primer
P-4	Etch Primer/Wash Primer
P-6	Two component Epoxy Zinc Phosphate Primer cured with polyamine hardner
P-7	Single pack, cold galvanizing compounds containing minimum 92% electrolytie zinc in dry film. Make ZINGA, LOCKTITE (of HENKEL) or ZRC
FINISH COATS / PAINTS	
F-2	Two component Acrylic – Polyurethane finish paint
F-3	Chlorinated Rubber finish paint
F-6A	High Build Epoxy finish coating cured with polyamine hardener
F-6B	High Build Epoxy finish coating cured with polyamine hardener
F-6C	Solvent less Epoxy Coating cured with poly amine hardener
F-7	High build Coal Tar epoxy coating cured with polyamine hardener
F-8	Self priming surface Tolerant High Build epoxy coating, cured with polyamine hardener
F-9	Two component Inorganic Zinc Silicate coating
F-11	Heat resistant synthetic medium based Aluminium paint
F-12	Two component Heat resistant Silicone Aluminium paint
F-14	Specially formulated coal tar epoxy coating, cured with polyamine hardener
F-15	Two component Epoxy phenolic coating cured with Polyamine adduct hardener system

F-16	Engineered Epoxy poly Siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating
F-17	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardener system

TABLE 7.2 REPAIR OF PRE-ERECTON/PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION/WELDING

For all un-insulated CS, LTCS & low allow steel items in all Environments

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
7.2.1	-90 to 400	SSPC-Sp-3	1 coat of F-9	65-75	See note below and clause 5.9.3

NOTES:

1. The application and repair of pre-erection/pre-fabrication or Shop Primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area. entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-9 or F-12 as applicable.

TABLE 8.0 COATING SYSTEMS FOR GRATINGS, ROLLING & STATIONERY LADDERS, SPIRAL STAIRWAYS AND HAND RAILS IN ALL LOCATION

Sl. No.	Design Temp. in °C	Coating System	Total DFT in Microns (min.)
8.1	Up to 60	Hot Dip Galvanizing to 80-85 microns (600-610 gm/m2) as per IS 4759, 2629, 4736, 2633 + 1 coat of P-6 @ 40 DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	80 microns of finish coat (excluding the thickness of galvanizing)

NOTES:

1. No galvanized specimen shall have thickness less than 80 microns.
2. Repair of the damaged area of galvanized coatings due to welding during erection shall be carried out as per recommended practice IS 11759 using cold galvanizing spray process. Organic Paint systems are not acceptable for repair.
3. After repair of damaged galvanized coating by Cold Galvanized, the repaired area shall be top coated with paint system as given in Table 8.0 above (i.e., 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @40µ OFT/coat).
4. Approved Cold Galvanizing manufacturers are ZINGA, LOCKTITE or Z.R.C.

TABLE 9.0 COATING SYSTEMS FOR OFFSITE AREA (INLAND PLANTS)

For external surfaces of Un-insulated & above ground (atmospheric exposure) Structures, Piping, Vessels, Equipments, Pumps, etc. (Note-1); (For Carbon Steel, LTCS & Low Alloy Steel). See Note Below*

Sl. No.	Design Temp in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection/Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
9.1	-90 to -15	SSPC-Sp-10; 1 coat of F-9 @ 65-75 DFT/coat	None	None	65-75	No over-coating to be done on F-9 as it will lead to mud cracking.
9.2	-14 to 60	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	1coat of F-2 @ 40 DFT/coat	105.115	
9.3	61 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	1 coat of F-2 @ 40 DFT/coat	105-115	
9.4	81 to 250	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	2 coats of F-11 @ 20 DFT/coat; (2x20=40)	105	
9.5	251-400	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat (2x20=40)	105.115	
9.6	401 to 550	SSPC-SP-10: 1 coat of F-12 @ 20 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat (2x20=40)	60	F-12 shall be ambient temperature curing type.

* Flare line within unit or offsite areas shall be coated as per Clause 10.3 of Table 10.0, but having finish coat of 2 coats of F-12.

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre• fabrication/pre-erection primer, if required, shall be done as per Table 7.2.

3. In case of Paint systems as per SL Nos. 9.5 and 9.6, the color bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping given in Clause 19.0.

4. All coating system including surface preparation, primer, and finish coat for piping hall is done at field only.

TABLE 10.0 COATING SYSTEM FOR UNIT AREAS AS WELL AS DM, CPP, COOLING TOWER OF INLAND PLANTS AND FOR ALL AREAS (UNIT, OFFSITE, DM, CPP, ete.) OF COASTAL PLANTS

Sl. No.	Design Temp in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection/Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
10.1	-90 to -15	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	None	65-75	a) No over-coating to be done on F-9 as it will lead to mud cracking. b) F-12 shall be ambient temperature curing type c) Finish coat including primer compatible with finish coat (i.e. field primer) shall be applied at site only. Finish coating is not permitted at equipment manufacture shop.
10.2	-14 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	1 coat of P-6 @ 4 DFT/coat	2 coats of F-6A @ 100 DFT/coat + 1 coat of F-2 @ 40 DFT/coat; (2x100+40=240)	345-355	
10.3	81 to 400	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat 2x20=40	105-115	
10.4	401 to 550	SSPC-SP-10; 1 coat of F-12 @ 20 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat (2x20=40)	60	

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication& Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre- fabrication/pre-erection primer, if required, shall be done as per Table 7 .2.

3. For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system as per 10.3 above shall be followed.

4. For external surface of RCC Chimney, 2 coats of F-6 @ 100µ DFT/coat to obtain total DFT of 200 µ shall be applied after proper surface preparation as per guidelines in 5.1.6.

5. In case of paint systems as per SL Nos. 10.3 and 10.4, the color bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping given in Clause 19.0.

6. All coating system including surface preparation, primer, and finish coat for piping shall be done at site/field only.

TABLE 11.0 COATING SYSTEMS FOR EFFLUENT TREATMENT PLANT (ETP)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
11.1	For Internal Surfaces of CS/MS Items: Bio-sludge sump, Filter feed sump, Process sump, Sanitary sump, Transfer sump, Sludge, Slop oil tank, scrapping mechanism in Clarifier					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75 DFT/coat	2 coats of F-6A @ 100 DFT/coat of F-2 @ 40 DFT/coat; (2x100+40+240)	305-315	
11.2	For Internal Surfaces of CS/MS Items: Bio-sludge sump, Filter feed sump, Process sump, Sanitary sump, Transfer sump, Sludge, Slop oil tank, scrapping mechanism in Clarifier					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75 DFT/coat	3 coats of F-6A @ 100 DFT/coat (3x100+300)	365-375	Note:1
11.3	All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc. in Process sump, TPI separator (Process and Oil), Aeration Tank and Transfer sump etc.					
	-14 to 80	Blast cleaning to SSPC-SP guide lines and Acid etching with 10-15% HCI acid followed by thorough water washing	Epoxy Screed lining		3mm	Epoxy screed lining shall be applied as per specific manufacturer and Engineer-in-Charge instructions
11.4	C.S/M.S Dual media filters (Internal), Chemical dosing tanks (internal) such as Di-Ammonium Phosphate (DAP) and Urea					
	Up to 60	SSPC-SP-10	Natural Rubber Lining (As per IS 4682, Part 1)		4.5mm	Natural Rubber lining shall

					be applied as per specific manufacturer and Engineer-in-Charge instructions

NOTES :

1. The paint /coating manufacturers shall provide their Quality control test certificate of coating materials (F-6A) for immersion service of the exposed effluent given in 11.2.

ONGC एमआरपीएल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

TABLE 12.0 EXTERNAL COATING SYSTEMS FOR UNINSULATED CARBON STEEL AND LOW ALLOY STEEL STORAGE TANKS (For all plant locations, coastal or inland)

All Process Units & Off-sites

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
12.1	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external and internal floating roof and associated external structural works					
12.1.1	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75 DFT/coat + 1 coat of P-6 @ 40 DFT/coat;	2 coats of F-6A @ 100 DFT/coat + 1 coat of F-2 @ 40 DFT/coat;	345-355	F-6 should be suitable for occasional water immersion
12.1.2	81 to 150	SSPS-SP-10	1 coat of F-15 primer @ 80 DFT/coat + 1 coat of F-15 intermediate coat @ 80 DFT/coat;	1 coat of F-15 finish coat @ 80 DFT/coat + 1 coat of F-2 @ 40 DFT/coat;	280	-
12.1.3	151 to 500	SSPC-SP-10	1 coat of F-9 @ 65-75 DFT/coat	2 coats of F-12 @ 20 DFT/coat Or 1 coat of F-16 @ 50 DFT/coat	105 or 115	-
12.2	External surfaces of bottom plate (soil side) for all storage tanks					
12.2.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75 DFT/coat	3 coats of F-7 @ 100 DFT/coat (3x100=300)	365-375	F-7 should be suitable for immersion service of the products given
12.2.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat + 1 coat of F-15 intermediate coat @ 80 DFT/coat ; (80+80=160)	1 coat of F-15 finish coat @ 80 DFT/coat	240	-

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›Èãñ‡ãñŠãä ½ã‡ãŠÊÔã ãäÊããä½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

12.2.3	151 to 550	SSPC-SP-10	1 coat of F-16 @ 125 DFT/coat	1 coat of F-16 @ 125 DFT/coat	250	-
12.3	For underside of the bottom plate (in case tank is not lifted during PWHT) (see Note 2c)					
12.3.1	-180 to 650	For CS SSPC SP-6 Commercial Blast For SS SSPC SP-1 with non-chloride solvent	1 coat of inert polymeric matrix coating @ 125	2 coats of inert polymeric matrix coating @ 125	350-400	Products form JOTUN or HI-TEMP coating or SK FORMULATIONS are recommended

NOTES:

1. All paint coating application including primer for tankage shall be carried out at field after erection and completion of all welding.

2. For underside of bottom plate:

a) Painting shall be carried out before laying of bottom plate for tanks with Non-Post Weld Heat Treatment (PWHT).
b) For tanks with PWHT, painting shall be carried out after PWHT.
c) In case tank is not lifted during PWHT then painting shall be applied before laying of bottom plate, clause no. 12.3.l shall be followed.

Caution: PWHT temperature shall not exceed 650°C.

TABLE 13.0 INTERNAL COATING SYSTEMS FOR CARBON STEEL AND LOW ALLOY STORAGE TANKS

All Process Units & Off-sites

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
13.1	CRUDE OIL, ATF, TURPENTINE OIL, LUBRICATING OIL AND VEGETABLE OIL					
13.1.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1 coat of F-15 finish coat @ 80 DFT/coat;	240-300	-

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

13.2	PETROLEUM PRODUCTS & INTERMEDIATES like LDO, HSD, GAS OIL, FEEDS of FCC-PC, FCC-LCO, VGO-HDT, ISOM, DHDT, REFORMATE, DCU, NHT & GASOLINE, NAPHTHA, ISOMERATE AND KEROSENE. Underside of Floating roofs, internal surface of cone roof, inside of bottom plate, internal surfaces of Bare shell for full height, underside of floating roof, oil side surfaces of pontoons, support structures and ladders etc.					
13.2.1	-14 to 45	SSPC-SP-10	1 coat of F-9 @ 75 DFT/coat	-	75	Note-2
13.2.2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1 coat of F-15 finish coat @ 80 DFT/coat;	240-300	-
13.3	POTABLE AND FIRE WATER All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.3.1	-14 to 45	SSPC-SP-10	1 coat of P-6 @ 100 DFT/coat	2 coats of F-6A @ 100 DFT/Coat; (2x100=200)	300-350	Note-4
13.4	DE-MINERALIZED (DM) WATER All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.4.1	-14 to 60	SSPC-SP-10	1 coat of P-6 @ 100 DFT/coat	2 coats of F-6C @ 200 DFT/coat; (2x200=400)	400-450	-
13.4.2	61 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1 coat of F-15 finish coat @ 80 DFT/coat; (80+80=160)	240-300	-
13.5	HYDROCHLORIC ACID (HCI) 10% All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.5.1	-14 to 60	SSPC-SP-10	None	Natural Rubber Lining	4.5 mm	-
13.6	AGGRESSIVE SOLVENTS LIKE HEXANE, HEXENE, BENZENE, XYLENE AND TOLUENE All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

13.6.1	-14 to 65	SSPC-SP-10	1 coat of F-9 @ 75 DFT/coat	-	75	-
13.7	ETHYLENE CLYCOL (EG) TANKS Internal shell-full height, bottom plate, underside of roof and all accessories					
13.7.1	All	SSPC-SP-10	None	3 coats of vinyl chloride co-polymer AMERCOAT 23 @ 75/coat; (3x75+225)	225	-
13.8						
13.8.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1 coat of F-15 finish coat @ 80 DFT/coat; (80+80=160)	240	-
13.10	VACUUM RESIDUE, FUEL OIL, DRY SLOP, BITUMEN AND OTHER HIGH TEMPERATURE HYDROCARBON LIQUIDS Underside of floating roof, internal surface of cone roof, bottom plate, inside of bare shell – including wetted and non wetted surfaces, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structure, structural steel and ladders					
13.10.1	Up to 150ºC	SSPC-SP-10	1 coat of F-17 primer @ 125 DFT/coat	1 coat of F-17 intermediate coat @ 125 DFT/coat + 1 coat of F-17 finish coat @ 125 DFT/coat; (125+125=250)	375	Note:3
13.11	ALKALIS UP TO 505 CONCENTRATION All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.11.1	Up to 60 ºC	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	2 Coats of F-6 A @ 100 DFT/coat; (2x100=200)	280-100	-

NOTES:

1. All paint coating application including primer shall be carried out after erection and completion of all welding work at site.

2. F-6A should be suitable and resistant for immersion service for the respective Hydrocarbons.

3. This system can be used where maximum operating temperature is below 150°C and design temperature is up to 200°C. Cases of operating temperature > 150°C are not covered in this spec; such cases shall be covered in the job specifications.

4. F-6 A shall be suitable for drinking water service and should have competent authority certification.

TABLE 14.0 COATING SYSTEMS FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND UNDERGROUND VESSELS.

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
14.1	**Underground carbon steel plant piping**					
14.1.1	25 to 35	-	SSPC-SP-10; 1 coat of synthetic fast drying primer 25 @ DFT/coat	1 layer of coaltar tape coating @ 2mm + 1 coat of synthetic fast drying primer 25 @ DFT/coat + 1 layer of coal tar tape coating @ 2mm/layer as per EIL Standard Specification No.6-79-0011	4 mm	The primer DFT is not measurable Reconciliation primer shall be done by coverage of maximum to sq.m/litre
14.2.1	66 to 150	-	SSPC-SP-10; 1 coat of F-17 primer @ 125 DFT/coat	1 coat of F-17 intermediate coat @ 125 DFT/coat + 1 coat of F-17 finish coat @ 125 DFT/coat	375	-

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

14.2.2	151 to 400	-	SSPC-SP-10; 1 coat of F-16 primer @ 125 DFT/coat	1 coat of F-16 finish coat @ 125 DFT/coat	250	-
14.3	**External side of un-insulated underground storage vessels**					
14.3.1	-40 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	-	3 coats of F-7 @ 100 DFT/coat	365-375	-
14.3.2	81-150	SSPC-SP-10; 1 coat of F-17 primer @ 125 DFT/coat	-	1 coat of F-17 intermediate coat @ 125 DFT/coat + 1 coat of F-17 finish coat @ 125 DFT/coat	375	-
14.3.3	151-400	SSPC-SP-10; 1 coat of F-16 primer @ 125 DFT/coat	-	1 coat of F-16 finish coat @ 125 DFT/coat	250	-

TABLE 15.0 COATING UNDER INSULATION (COASTAL OR INLAND PLANTS). ALL UNITS AREAS & OFF-SITES
For insulated Piping, Equipments, Storage vessels, tanks, Columns etc of Carbon Steel, LTCS, Low Alloy Steel & Stainless Steels.

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
15.1	**Carbon steel, LTCS and low Alloy steel Piping**					
15.1.1	-45 to 120	SSPC-SP-10; 1 coat of F-15 @ 75 DFT/coat	1 coat of F-15 @ 75 DFT/coat	2 coats of F-15 @ 75 DFT/coat; (2x75=150)	225-250	-
15.1.2	121-540	SSPC-SP-10;	None	2 coat of F-12 @ 20 DFT/coat;	60	-

ONGC एमआरपीएल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

		1 coat of F-12 @ 20 DFT/coat		(2x2=40)		
15.2	**Carbon steel, LTCS and low Alloy steel – Storage vessels, Reactors, Columns & Equipments**					
15.2.1	-45 to 120	SSPC-SP-10; 1 coat of F-15 @ 75 DFT/coat	1 coat of F-15 @ 75 DFT/coat	2 coats of F-15 @ 75 DFT/coat (2x75+150)	225-250	-
15.2.2	121 to 540	Temporary oil based varnish coatings to be provided for transport and storage	Thermally Sprayed Aluminium coating (TSAC) Refer ANNEXURE-I		-	-
15.3	**Stainless Steel (SS) including Alloy-20 piping (Note:2)**					
15.3.1	-180 to Zero	For CS SSPC SP-6 Commercial Blast	1 coat of inert polymeric matrix coating @ 125	2 coats of inert polymeric matrix coating @ 125	350-400	Products from JOTUN or HI-TEMP coatings or SK FORUMATIONS are recommended
15.3.2	0 to 125	SSPC-SP-10 (15-25 surface profile) 1 coat of F-15 @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat	1 coat of F-15 finish coat@80 DFT/coat;	240	If the piping & equipments are already erected then surface shall be prepared by cleaning with emery paper and wash/flush with chloride free DM water followed by wiping with organic solvent
15.3.3	126 to 400	SSPC-SP-10 1 coat of F-16 @ 125 DFT/coat	None	1 coat of F-16 @ 125 DFT/coat	250	Not recommended for operating temperature
15.3.4	401 to 600	SSPC-SP-10; 1 coat of Amercoat 738@ 125 DFT/coat	None	1 coat of Amercoat 738@125 DFT/coat	250	Between 60-120ºC
15.4	**Coating system for Cyclic Service of Carbon Steel, LTCS, Low Alloy Steel & Stainless Steel**					

ONGC एमआरपीएल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

15.4.1	-40 to 150	SSPC-SP-10 (15-25 surface profile) 1 coat of F-15 @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat	1 coat of F-15 finish coat @ 80 DFT/coat;	240	Apcothern EPN 200 of M/s Asian Paints Ltd OR Equivalent
15.4.2	- 180 to 650	For CS SSPC SP-6 Commercial Blast For SS SSPC-SP-1 with non-chloride solvent	1 coat of inert polymeric matrix coating @ 125	2 coats of inert polymeric matrix coating @ 125	350-400	Products from JOTUN or HI-TEMP coatings or SK FORMULATIONS are recommended
15.5	**No painting is required for insulated Monel, Incoloy and Nickel Lines**					

NOTES:

1. "Cyclic Service" is characterized by rapid temperature fluctuation.
2. The blast cleaning abrasives for SS and Alloy steel surfaces shall be Aluminum oxide grits/shots or garnet.
3. In case of overlapping of temperature ranges as mentioned in 15.4.l and 15.4.2, clause 15.4.1 shall be followed.

TABLE 16.0 COATING SYSTEM FOR CARBON STEEL COMPONENTS OF COOLERS I CONDENSERS (INTERNAL PROTECTION) FOR FRESH WATER SERVICE

Fresh Water boxes, channels, partition plates, end covers and tube sheets etc.

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection / Field)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
16.1	Up to 80 °C	SSPC-SP-10	1 coat of F-15 @ 80 microns	2 coats of F-15 @ 80 DFT/coat;	240	-
16.2	80 to 140	SSPC-SP-10	-	1 coat of Glass Fibre Reinforced Novolac epoxy of 1.5 mm DFT	1500	-

TABLE 17.0 COATING SYSTEM (INTERNAL PROTECTION) FOR GALVANIZED OR NON FERROUS OR STAINLESS STEEL/DUPLEX STAINLESS STEEL COMPONENTS OF COOLERS/ CONDENSERS FOR FRESH WATER SERVICE

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection / Field)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
17.1	Up to 80	Sweep Blasting	1 coat of F-15 @ 80 DFT/coat;	1 coat of F-15 @ 80 DFT/coat;	160	-
17.2	80 to 140	Sweep Blasting	-	1 coat of Glass Fibre Reinforced Novolac epoxy of 1.5 mm DFT	1500	-

18.0 STORAGE

18.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE - NO NAKED LIGHT - HIGHLY INFLAMABLE" shall be clearly displayed outside. Manufacturer's recommendation shall be followed for storage of paint materials.

19.0 COLOUR CODE

The following color coding system shall be followed. However alternate color coding may also be followed as per Owner's color coding practice/scheme.

19.1 IDENTIFICATION

The system of color coding consists of a ground color and secondary color bands superimposed over the ground color. The ground color identifies the basic nature of the service and secondary color band over the ground color distinguishes the particular service. The ground color shall be applied over the entire length of the un-insulated

pipes. For insulated lines ground color shall be provided as per specified length and interval to identify the basic nature of service and secondary color bands to be painted on these specified length to identify the particular service. Above color code is applicable for both unit and offsite pipelines.

COLOUR CODING

SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR COADE	
			BASE COLOUR	BAND COLOUR
HYDROCARBON LINES (UNINSULATED)				
1	CRUDE SOUR	Dark Admiralty grey with 1 orange band	7012	2011
2	CRUDE SWEET	Dark Admiralty grey with 1 red band	7012	3001
3	LUBE OILS	Dark Admiralty grey with 1 green band	7012	6010
4	FLARE LINES	Heat Resistant Aluminium	9006	
5	LPG	Orange with 1 oxide red band	2011	3009
6	PROPYLENE	Orange with 2 blue bands	2011	5013
7	NAPTHA	Orange with 1 green band	2011	6010
8	M.S.	Orange with 1 dark admiralty grey band	2011	7012
9	A.V. GASOLINE (96 RON)	Orange with 1 band each of green, white and red bands	2011 / 6010	9010 / 3001
10	GASOLINE (regular, leaded)	Orange with 1 black band	2011	9005
11	GASOLINE (premium, leaded)	Orange with 1 blue band	2011	5013
12	GASOLINE (white)	Orange with 1 white band	2011	9010
13	GASOLINE (Aviation 100/130)	Orange with 1 red band	2011	3001
14	GASOLINE (Aviation 115/145)	Orange with 1 purple band	2011	4006
15	N-PENTANE	Orange with 2 blue bands	2011	5013
16	DIESEL OIL (White)	Oxide red with 1 white band	3009	9010
17	DIESEL OIL (Black)	Oxide red with 1 yellow band	3009	1023
18	KEROSENE	Oxide red with 1 green band	3009	6010
19	HY. KEROSENE	Oxide red with 2 green bands	3009	6010
20	DISUFIDE OIL (EX-MEROX)	Oxide red with 1 black band	3009	9005

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊããä½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	**DESIGN BASIS FOR** **Surface Preparation and Protective Coating**	**DOCUMENT NO** **EDB-0014**

21	M.T.O.	Oxide red with 3 green bands	3009	6010
22	DHPPA	Oxide red with 2 white bands	3009	9010
23	FLUSHING OIL	Oxide red with 2 black bands	3009	9005
24	LAB FS	Oxide red with 2 dark admiralty grey bands	3009	7012
25	LAB RS	Oxide red with 3 dark admiralty grey bands	3009	7012
26	LAB (Off. Spec)	Oxide red with 1 light grey band	3009	7035
27	N-PARAFFIN	Oxide red with 1 blue band	3009	5013
28	HEAVY ALKYLATE	Oxide red with red band	3009	3001
29	BELOW DOWN. VAPOR LINE	Off white / Aluminum with 1-Brown band	9006	8004
30	BLOWDOWN	Off white /Aluminum with 2 brown bands	9006	8004
31	A.T.F.	Leaf brown with 1 white band	8003	9010
32	TOULENE	Leaf brown with 1 yellow band	8003	1023
33	BENZENE	Leaf brown with 1 green band	8003	6010
34	LAB PRODUCT	Leaf brown with 1 blue band	8003	5013
35	FUEL OIL	Black with 1 yellow band	9005	1023
36	FUEL OIL (Aromatic rich)	Black with 2 yellow bands	9005	1023
37	ASPHALT	Black with 1 white band	9005	9010
38	SLOP AND WASTE OILS	Black with 1 orange band	9005	2011
39	SLOP AROMATICS	Black with 2 orange bands	9005	2011
CHEMICAL LINES				
40	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	1012	5000
41	CAUSTIC SODA	Canary yellow with 1 black band	1012	9005
42	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
43	AMMONIA	Canary yellow with 1 blue band	1012	5013
44	CORROSION INHIBITOR	Canary yellow with 1 Aluminum band	1012	9006
45	HEMAMETA PHOSPHATE	Canary yellow with 2 black bands	1012	9005
46	ACID LINES	Golden Yellow with 1 red band	1012	3001
47	RICH AMINE	Canary yellow with 2 blue bands	1012	5013
48	LEAN AMINE	Canary yellow with 3 blue bands	1012	5013
49	SOLVENT	Canary yellow with 1 green band	1012	6010

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊããä½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	**DESIGN BASIS FOR** **Surface Preparation and Protective Coating**	**DOCUMENT NO** **EDB-0014**

50	LCS	Canary yellow with 1 smoke grey	1012	7031
WATER LINES				
51	RAW WATER	Sky blue with 1 black band	5015	9005
52	INDUSTRIAL WATER	Sky blue with 2 signal red band	5015	3001
53	TREATED WATER	Sky blue with 1 oxide red band	5015	3009
54	DRINKING WATER	Sky blue with 1 green band	5015	6010
55	COOLING WATER	Sky blue with 1 light brown band	5015	1011
56	SERVICE WATER	Sky blue with 1 signal red brown	5015	3001
57	TEMPERED WATER	Sky blue with 2 green bands	5015	6010
58	DM WATER	Sky blue with 1 aluminum band	5015	9006
59	DM WATER ABOVE 150° F	Sky blue with 2 black bands	5015	9005
60	SOUR WATER	Sky blue with 2 yellow bands	5015	1013
61	STRIPPED WATER	Sky blue with 2 blue bands	5015	5013
62	ETP TREATED WATER	Sky blue with 2 oxide red bands	5015	3009
FIRE PROTECTION SYSTEM (ABOVE GROUND)				
63	FIRE WATER FOAM & EXTINGUISHERS	Post office red	3002	
AIR & OTHER GAS LINES (UNINSULATED)				
64	SERVICE AIR	Sea green with 1 signal red band	6018	3001
65	INSTRUMENT AIR	Sea green with 1 black band	6018	9005
66	NITROGEN	Sea green with 1 orange band	6018	2011
67	FREON	Sea green with 1 yellow band	6018	1023
68	CHLORINE	Canary yellow with 1 oxide band	1012	3009
69	SO_2	Canary yellow with 2 white bands	1012	9010
70	H_2S	Orange with 2 red oxide bands	2011	3009
71	GAS (Fuel)	Orange with 1 aluminum band	2011	9006
72	GAS (Sour)	Orange with 2 aluminum bands	2011	9006
73	GAS (Sweet)	Orange with 2 signal red band	2011	3001
74	HYDROGEN	Orange with 1 light green band	2011	6021
STEAM AND CONDENSATE LINES (UNINSULATED)				
75	HP STEAM	Off white / Aluminum with 1 yellow band	9006	1023
76	MP STEAM	Off white / Aluminum with 1 red band	9006	3001
77	MLP STEAM	Off white / Aluminum with 1 orange band	9006	2011

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	**DESIGN BASIS FOR** **Surface Preparation and Protective Coating**	**DOCUMENT NO** **EDB-0014**

78	LP STEAM	Off white / Aluminum with 1 light green band	9006	6021
79	CONDENSATE	Sky blue with 1 white band	5015	9010
80	CONDENSATE ABOVE 150° F	Sky blue with 3 oxide red band	5015	3009
81	BFW	Sky blue with 2 red bands	5015	3001
Note : For all insulated steam lines, the colour coding shall be follow as given for un-insulated lines with the specified length of color bands.				
INSULATED HYDROCARBON PIPING				
82	IFO SUPPLY	1 Black ground colour with 1 yellow band in centre	9005	1023
83	IFO RETURN	Black ground colour with 1 green band in centre	9005	6010
84	HPS	Black ground colour with 1 red band in centre	9005	3001
85	BITUMEN	Black ground colour with 2 red bands in centre	9005	3001
86	CLO	Black ground colour with 1 brown band in centre	9005	8004
87	VB TAR	Black ground colour with 1 blue band in centre	9005	8004
88	VR AM (BITUMEN / VBU FEED)	1 Black ground colour with 2 blue bands in centre	9005	5013
89	VR BH	1 Black ground colour with 2 blue bands in centre	9005	5013
90	VAC. SLOP	1 Black ground colour with 1 white band in centre	9005	9010
91	SLOP	1 Black ground colour with 1 orange band in centre	9005	2011
92	CRUDE SWEET	1 Dark admiralty grey ground colour with 1 red band in centre	7012	3001
93	CRUDE OUR	1 Dark admiralty grey ground colour with 1 orange band in centre	7012	2011
94	VGO/ HCU	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
95	OHCU BOTOM / FCCU FEED	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
UNINSULATED EQUIPMENTS, TANKS AND STRUCTURES				
96	HEATER STRUCTURE	Steel grey	7011	
97	HEATER CASING	Heat resistant aluminium	9006	

98	VESSELS & COLUMNS	Aluminium	9006	
99	HYDROGEN BULLETS	Pink	3014	
100	LPG VESSELS	Oxide red	3009	
101	SO2 VESSEL	Canary yellow	1012	
102	HEAT EXCHANGER	Heat resistant aluminium	9006	
103	FO TANK AND HOT TANKS	Black	9005	
104	ALL OTHER TANKS	Aluminum / Off white	9006	
		Golden yellow	1004	
106	SOUR WATER	Sky Blue	5015	
107	OUTER SURFACE IN BOILER HOUSE	Heat resistant aluminum	9006	
108	COMPRESSORS AND BLOWERS	Dark admiralty grey	7012	
109	PUMPS	Navy blue	5014	
110	MOTORS & SWITCH GEAR	Bluish green	5024	
111	HAND RAILING	Signal red	3001	
112	STAIRCASE, LADDER AND WALKWAYS	Black	9005	
113	LOAD LIFTING EQUIPMENT AND MONORAILS ETC	Leaf brown	8003	
114	GENERAL STRUCTURE	Black	9005	
PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE				
115	IBR	Signal red	3001	
116	9Cr-1Mo	Verdigris green	6021	
117	5Cr-0.5Mo	Satin blue	5012	
118	2 ¼ Cr-1Mo	Aircraft yellow	1026	
119	1 ¼ Cr-Mo	Traffic Yellow	1023	
120	SS-304	Dark blue grey	5008	
121	SS-316	Dark violet	4005	
122	SS321	Navy blue	5014	
SAFETY COLOUR SCHEMES				
123	DANGEROUS OBSTRUCTION	Black and alert orange band	9005	2008

124	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	2008

Note: All LPG service PSVs shall be painted Deep Blue.

All drains & Vents shall be painted in Main line color.
The color code scheme is for identification of piping service group, It consists of a ground color and 1 / 2 color bands.

19.2 Ground Color

On uninsulated pipes, the entire pipe has to be painted in ground color., and on metal cladded insulated lines, minimum 2M long portion should be painted.

19.3 Color Bands

Location of color bands:

- At Battery Limits
- Intersection points & change of direction points in piping
- Midway of piping section, near valves, across culverts
- At 50 M interval on long stretch pipes
- At starting and termination points.

Minimum width:

NB	Width

3" and below	75mm
Above 3" to 6"	NB X 25MM
Above 6" to 12"	NBX 18MM
Above 12"	NBX 15 MM

!!! Note: For insulated pipes, NB indicatesOD of the insulation.

Sequence:
Color bands shall be arranged in sequence showing Table above and the sequence follows the direction of flow. The width of the 1•1 Band to 2nd band is 4:1,

!!! Note:
Wherever deemed required by Process Department or Safety, pipes handling hazardous substances will be given hazard marking of 30 mm wide diagonal stripes of Black and Golden Yell ow as per IS : 2379.

19.4 Special Camouflage Painting for Uninsulated Crude and Product Storage Tanks.

Paint specification shall be as per standards.

Camouflage painting scheme for Defense requirement in irregular patches will be applied with 3 colors

Dark Green	Light green	Medium Brown
5	3	2

The patches shall be irregular and asymmetrical and inclined at 30 to 60 Degrees.

Patches should be continuous at surface meeting lines *I* points.

Slits / holes shall be painted in dark green shade.

Width of patches shall be 1 to 2 meters.

19.5 Identification Markings on Equipment / Piping

Equipment tag Numbers shall be Stenciled *I* neatly painted using normal 'Arial' Lettering Style on all equipment and piping (Both insulated & uninsulated) after

completion of all paint works. Lettering colour shall be either BLACK or WHITE, depending upon the background, so as to obtain good contrast.

Operations Group shall specify location
Sizes shall be:

Columns, Vessels, Heaters:	150mm
Pumps and other M/c	50 mm
Piping	OD I 2 with Maximum l 00 MM
Storage Tanks	(As per Drawings)

19.6 Color Coding for Control Valve

a) Carbon Steel Body - Light grey

Alloy Steel Body - Canary yellow

Stainless Steel Body - Natural

b) The actuator of the Control valve shall be painted as :
Direct action (open on air failure) valves - Green
Reverse acting (close on air failure) valves - Red

The painting Status shall be comprehensively updated every 6 months for compliance.

19.7 Colour Coding for Structural & Others

Sl. No	Item	Color	Indicative
1	Pipe rack structurals	Dark Admiraltry Grey	
2	Chequered Plate (Both faces)	Black	
3	Grating	Black	
4	Ladder Rungs & Railing Vertical Posts	Black	
5	Hand Rail, Middle rail, Toe Plate	Signal Red	
6	Ladder Vertical Posts	Signal Red	
7	Building Structurals, Steel Columns, brackets, beams, bracings, roof trusses, purlings, side girts, louvers, stringers	Dark Admiratry Grey	

8	OverHead Monorail	Signal Red	
9	Gantry Girder & Monorail	Dark Green	
10	Monorail Stopper Plates	Signal Red	
11	Coke Cutting System	Signal Red	
12	EOT/HOT Cranes	Canary Yellow	
13	Transformers & Battery room structurals	Dark Admiraltry Grey	
14	Electrical Motors	Dark Blue	

20.0 IDENTIFICATION OF VESSELS, PIPING ETC

20.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipe lines of more than one location as directed by Engineer-In-Charge; Size of letter printed shall be as below:

Column & Vessels	150mm (high)
Pump, compressor & other machinery	50mm (high)
Piping	40-150 mm

20.2 Identification of Storage Tanks

The storage tanks shall be marked as detailed in the drawing.

22.0 QUALITY CONTROL, INSPECTION AND TESTING

22.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable (see section 24.0).

22.2 The contractor must produce Test Certificate from Pre Qualified Paint Manufacturer for various tests as detailed out in section 25.1 of this document, for each batch & for each category of product. The Engineer-in-Charge shall have the right to test wet samples of paint from each batch at random for verifying quality of paint supplied. Contractor shall arrange to have such tests, when called for by Engineer-in-Charge, performed at his cost any one of the independent laboratories listed in the 25.1 of this document.

Samples for the test will be drawn at random in presence Engineer-in-Charge or his representations. Following tests to be carried out if called for by Engineer-in-Charge:

Specific Gravity
% solids by weight (% zinc content in case of inorganic or organic zinc primer)
Drying time (touch dry & full curing)
Adhesion
Flexibility
Hardness
Storage stability (pot life)

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

22.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and

contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

(a) Surface preparation
(b) Primer application
c) Each coat of paint

During surface preparation, following tests are to be carried out:

- Test for absence oil & grease after degreasing before blasting as per procedure given in sec 6.7 of Annexure-I of this specification (specification for thermally sprayed Alwninium Coating).
- Tests for surface finish of blasted surface shall be done by visual inspection using SSPC- VIS 1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m2 of blasted surface and minimum of 3 checks per shift.
- Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m2 (2 mg/cm"), Checks shall be done on each component at least once per 200 m2 of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of IS 12944-4 (water cleaning). After cleaning surface shall be retested for salt after drying.
- Blast profile measurement +This shall be done as described in sec 6.2 of Annexure-I of this specification (Specification for thermally sprayed Aluminum).
- Test for blasting Media and Blasting air- this shall be done as described in sec 6.6 of Annexure-I of this specification (Specification for thermally sprayed Aluminum).

In addition to above, record should include type of shop primer already applied on equipment e.g., zinc silicate, or zinc rich epoxy, or zinc phosphate.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (OFT) shall be checked and recorded after application of

each coat and extra coat of paint should be applied to make- up the OFT specified without any extra cost to owner, the extra coat should have prior approval of Engineer-in-charge.

22.4 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge.

22.5 The shades of successive coats should be slightly different in color in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In• Charge before application of successive coats.

22.6 The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detector and protector whenever required for checking in case of immersion conditions.

22.7 Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on M.S.test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elkometer'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

22.8 At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

22.9 Final inspection of finished coating shall consist of measurement of:

1) Paint dry film thickness (DFT),
2) Adhesion, and,
3) Holiday detection check as well as for finish and workmanship.

1) Coating DFT measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. OFT gauge calibration, number of measurement shall be as per SSPC-DA 2. Measured OFT shall be within + 10% of the dry film thickness, specified in the specifications.

2) Adhesion of the primer to the steel substrate and intercoat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D 6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel coupon coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m2 (2000 ft2) of coated surface.

3) Holiday testing shall be conducted in accordance with NACE SP 0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure,10% of coated area which must include weld seams, comers and edges to be holiday tested. Voltage at which test is to be carried out will depend upon OFT of coating being tested and shall be as per NACE SP 0188. Any holiday is unacceptable and should be marked and repaired immediately.

22.10 The contractor shall arrange for spot checking of paint materials for Specific gravity, glow time (ford cup) and spreading rate.

22.11 Final Inspection of coating system

A final inspection shall be conducted prior to the acceptance of the work. The coating contractor and the facility owner shall both be present and they shall sign an agreed inspection report. Such reports shall include:
General

- Names of the coating contractor and the responsible personnel
- Dates when work was performed

Coating Materials

- Information on coating materials being applied
- Condition of coating materials received

Environmental Conditions

- Weather and ambient conditions
- Coating periods

Surface Preparation
- Condition of surface before preparation
- Tools and methods used to prepare surface
- Condition of surface after preparation

Coating Application
- Equipment used
- Mixing procedure prior to application
- Coating application techniques use

Testing
- Type and calibration of inspection instruments used
- Type of quality control tests performed, and results.

23.0 GUARANTEE

23.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

24.0 QUAIFICATION CRITERIA OF PAINTING CONTRACTOR / SUB CONTRACTOR

Painting contractor who is awarded any job for MRPL, Projects under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor mush have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

25.0 QUALIFICATION/ACCEPTANCE CRITERIA FOR PAINT COATING SYSTEM

25.1 Pre-Qualification of Paint Coating Manufacturer and his Products

Paint Coating manufacture meeting the following requirements shall be considered for supply of their products. Contractor is advised to select coating manufacturer. Only after obtaining prequalification from MRPL for the manufacturer based on following requirements. Even those manufacturers, whose names are appearing elsewhere in the tender document, under the list of MRPL Recommended or Approved Vendors", will also be required to meet the following prequalification requirements.

- Manufacturer should have been in continuous business of paint coating formulation and manufacturer for at least past *5* years.

- Manufacturer should posses past experience of supplying his products to hydrocarbon processing industry or offshore platforms in the past *5* years.

- Coating manufacturer should have supplied at least 10000 liter of an individual product to hydrocarbon processing industry or offshore platform.

- The manufacturer's manufacturing procedure & QA/QC system shall meet ISO 9001 requirements and preferably should posses ISO 14000 certificate.

- The Quality control set up should be manned by qualified paint technologists whose bio data should be sent along with quality control organization chart.

- Pre-Qualification Testing:
- Manufacturer should have got his products tested at least one time in last 3 years at a reputed independent laboratory for the following test items. Test certificates which are more than 3 years old will not be considered.

Test	**Test Method**
Specific gravity	ASTM D 1475
Dipping properties	ASTM D 823
Film characteristics	-
Solids content by weight	ASTM D 2369
Drying time	ASTM D 1640
Flexibility	ASTM D 1737/ D 522
Hardness	ASTM D 3363
Adhesion	ASTM D 2197
Abrasion resistance	ASTM D 968/ D 1044
DFT/coat	As per SSPC guidelines

Storage Stability	ASTM D 1849
Resistance to moisture vapour permeability for 2000 hrs	ASTM D 2247
Cyclic Test for the duration of 4200 h (25 cycles a 168 hours)	ISO 7253, ASTM G53
% Zn in Dry film for Inorganic Zinc Silicate primer	-
Chemical Resistance test - 10% & 40% NaOH (applicable only for F-6 & F-15) - 10% H_2SO_4 (applicable only for F-6 & F-15) - 10% Nitric Acid test (applicable only for F-6 & F-15) - Benzene / Toluene (applicable only for F-6 & F-15) - Kerosene (applicable only for F-6 & F-15) - Sea water (applicable only for F-6 & F-15) - MIBK test (applicable only for F-6 & F-15)	ASTM D 543
Resistance to water using water immersion (applicable only for F-6, F-7,F-8, F-14 & F-15)	ASTM D 870
Dry Heat Resistance test (applicable only for F-9, F-6A/B, F-2, F-15, F-16, polysiloxane, heat resistance Al silicone)	
Thermal shock resistance test (only for F-9, F-6, polysiloxane)	ASTM D2485 - 91

Each coating product to be qualified shall be identified by the following

1. An infrared scan (fingerprint), for Part A and B, each component as per ASTM D262
2. Specific gravity of Base and curing agent (Ref. ISO 2811)
3. Ash content (ASTM D1650), volatile and non-volatile matters (ISO 3251) of Each component

The identification shall be carried out on the batch, which is used for the Pre• qualification testing. Pre-qualification of the products shall be carried out at an independent laboratory.

Test shall be carried out at any one of the following laboratories and tests to be witnessed & certified by third party inspection agency (TUV, BY, DNV).

IICT, Hyderabad
HBTI, Kanpur
DMSRDE, Kanpur

BIS Laboratories
UICT, Matunga, Mumbai
RITES, Kolkata
PDIL, Sindri
NTH, Kolkata

Contractor shall furnish to MRPL for approval/ acceptance of all necessary documents/information including test certificates to prove that the paint manufacturers, from whom he intends to procure paint products, meet the various requirements for fulfilling the pre-qualification criteria as given under section 25.l above. The paint manufacturer shall be qualified and approved for supply after review/assessment of the submission made by the contractor.

25.2 Information to be furnished during delivery of coating system:

Contractor along with delivery of paint material has to furnish following information from paint manufacturer to MRPL for acceptance/approval of products.

a) Batch test certificates (Batch Testing)

Along with delivery to site of the paint products from pre-qualified coating manufacturer. Contractor has to produce test certificate from paint manufacturer for each batch and for each category of product for the following test items. Test to be witnessed & certified by third party inspection agency. All test results must mention clearly the batch no. and category of product tested. Tests to be conducted for following properties:

- Infrared scan for Part A and B, each component
- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)

b) Product information sheet/ technical data sheet for each category of product.

26.0 METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING
(Pre-Qualification tests (sec. 25.1), Batch testing (sec. 25.2) and Inspection testing (sec. 22.0))

26.1 Samples of coating materials should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory. The sampling shall be certified and sealed by a certifying agency.

26.2 All test panels should be prepared by Govt. testing agency colored photographs of test panels should be taken before and after the test and should be enclosed along with test report.

Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code.

26.3 Manufacturers should intimate the company, details of sample submitted for testing, name of Govt. testing agency, date, contact personnel of the govt. testing agency. At the end of the test the manufacturer should submit the test reports to the company for approval.

26.4 Coating systems for panel test shall be decided after discussion with MRPL.

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

ANNEXURE-I

SPECIFICATION FOR THERMALLY SPRAYED ALUMINIUM (TSA) COATING

1.0 SCOPE

The following sections outlines the requirement of supply, application and testing of thermally sprayed aluminum coatings (TSAC) for corrosion protection of insulated carbon steel piping and equipments with design temperature not exceeding 540 ° C.

2.0 ITEMS TO BE THERMALLY SPRAYED

Steel Structures/equipments to be protected by TSAC shall be as per Tables 15.0 of this standard specification. Structures, components thermally sprayed shall not have any uncoated area or shall not be in mechanically connected by flanges etc to any uncoated bare steel work. Such adjacent areas to TSA coated areas, if not coated by TSA shall have suitable paint coating system as per the standard specification.

3.0 TSAC REQUIREMENTS

3.1 Surface Preparation

All the parts to be sprayed shall be degreased according to SSPC-SP 1. The absence of oil and grease after degreasing shall be tested by method given elsewhere in the specification (Refer Sec. 6.7). Thereafter the surface to be abrasive blasted to white metal finish as per NACE l/SSPC-SP *5* for marine and immersion service. Using SSPC VIS I, it is to be visually assessed that the blast cleaned surface meets requirement of SSPC-SP 5. Thereafter clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on the blasted surface. Finally blasted surface shall be tested for presence of soluble salts as per method ISO 8502-9. Maximum allowable salt content shall be considered 50mg/m2. (5 micrograms/cm2). In case salt content exceeds specified limit. The contaminated surface shall be cleaned by method as per Annex C of IS 12944-4 (Water Cleaning). After cleaning the surface shall be retested for salt content after drying. Testing shall be carried out at least on each component, once per 200 m2 and a min of 3 times per shift during progress of work.

The blasting media shall be either chilled iron or angular steel grit as per SSPC-AB-3 of mesh size G-16 to G-40. Copper, Nickel slag, Garnet or Aluminum Oxide as abrasives will also be suitable having mesh size in the range of Gl6 to G24 (10-30 mesh), conforming to SSPC-AB-1. Mesh size shall be required as appropriate to the anchor tooth depth profile requirement and blasting equipment used. The blasted

surface should be having angular profile depth not less than 65 microns with sharp angular shape but shall not exceed 85 microns. The profile depth shall be measured according to NACE standard RP 0287 (Replica Tape) or ASTM D 4417 method B (Profile depth gauge).

For manual blasting one profile depth measurement shall be taken every 10-20 m2 of blasted surface.

Surface preparation shall be completed in one abrasive blast cleaning operation wherever possible.

If rust bloom (visual appearance of rust) appears on the blast cleaned surface before thermal spraying, the affected area shall be reblasted to achieve specified degree of cleanliness after which only thermal spraying shall commence.

Air blasting pressure at nozzle shall be normally maintained at 100 psi. Air pressure and media size should be reduced and adjusted to preclude damage/distortion to thin gauge materials. Blasting time on work piece should be adjusted to only clean the surface and cut required anchor tooth with minimum loss of metal. Blast angle should be as close to perpendicular as possible but in no case greater than ± 30 ° from perpendicular to work surface. Blasting media must be free of debris, excessive fines, and contaminants such as NaCl and sulfur salts (Ref. SEC 6.0 of this Spec). Blast cleaning shall not be performed when the surfaces to be blasted are wet or less than 5°C above dew point temperature or when the relative humidity in the vicinity of the work is greater than 90%.

3.1. l Blasting Equipment

The TSAC applicator shall use mechanical (centrifugal wheel) or pressure pot blast cleaning equipment and procedures. Suction blasting equipment shall not be used. Sec 6.6.2 shall be used to validate clean and dry air.

3.1.2 Feed Stock

The feed stock shall be in the form of wire. The feed stock shall be 99.5% aluminum of commercial purity grade, its composition shall be in accordance with requirement of BS 1475 or ASTM B833 or ISO 209-1 type Al (wrought aluminum and aluminum alloys, wire). Wire shall be supplied in protective wrapping indicating batch number and other details.

3.1.3 Thickness Requirement

The nominal thickness of finished TSAC shall be 250 microns having minimum value-of225 microns at low thickness areas (valleys) and not more than 275 microns at peak areas.

The finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge (Magnetic Gauge).

3.1.4 Coating Bond Strength Requirement

The TSAC coating shall have a minimum individual tensile-bond strength value of 1000 psi for flame sprayed and 1500 psi for arc sprayed coating with an average of 2000 psi for arc sprayed coatings. Minimum tensile bond strength should be achieved by proper anchor tooth profile of blasted surface, laying down the TSA thickness in multiple passes and carrying out TSA application under controlled environment

3.1.5 Porosity

All thermally sprayed metallic coatings will have porosity. For thermally sprayed aluminum coatings porosity shall not exceed 15% of total surface area for flame sprayed coating and 8% for arc spray coating.

4.0 THERMAL SPRAYAPPLICATIONPROCEDURE

Items in the atmospheric zone to be coated by TSA shall be applied by either Flame spray or Arc spray method only. For coating under insulation, application shall be by arc wire method.

4.1 Equipment Set Up

4.1.1 Thermal spray equipment shall be set up calibrated, operated (1) according to manufacturer instructions/technical manuals and also TSAC applicators refinement thereto and (2) as validated by Procedure Qualification (Sec 7 .0 of this specification).

4.1.2 Spray Parameters

Spray parameters (see 4. I .3 below) and thickness of each crossing pass shall be set and shall be validated with bend test (See 6.5 of this Spec).

4.1.3 Spray Parameters

Spray Parameters	Method of Application	
Arc voltage	Arc wire Spray	Flame Wire Spray

	27 V	-
Air pressure	80 psi	80 psi
Steel surface cleanliness	NACE-1 white metal	NACE-1 white metal / or Near white metal
Steel surface profile	75 microns (minimum)	75 microns (min.)
Arc current	250-280A	-
Coating thickness	225 microns (nominal)	225 microns (Nominal)
Coating adhesion	>1500 psi (Total coating), see 3.1.4	>1000 psi
Coating porosity	Less than 80%	Less than 15%
Spray distance (spray Gun work piece)	6-8”	5-7”
Spray Pass width	40 mm	20 mm

The above parameters to be validated with a bend test by the contractor before start of work (for details of bend test see Sec 6.5 of this Spec).

4.2 Post Blasting Substrate Condition and Thermal Spraying Period.

4.2.1 The steel surface temperature shall be at least 5°C above dew point of ambient air temperature.

Steel substrate surface temperature shall be recorded by with a contact pyrometer. Thermal spraying should commence within 15 minutes from the time of completion of blasting

4.2.2 Holding Period

Time between the completion of final anchor tooth blasting and completion of thermal spraying of blasted surface should be no more than four hours. If within this period rust bloom appears Sec 4.4. l of this specification will apply.

4.3 Pre-Heating

For flame spraying, the initial starting area of 1-2 square feet to be preheated to approx.120°C to prevent condensation of moisture in the flame on the substrate. For arc spraying the preheating is not required.

4.4 Thermal Spraying

Spraying should commence only after validation of equipment set up by procedure qualification test and spray parameter validation tests described in Sec 7.0 and 6.5 respectively. Thermal spraying must commence within 15 minutes from the time of completion of blast cleaning

The specified coating thickness shall be applied in several crossing passes. The coating bond strength is greater when the spray passes are kept thin. Laying down an excessively thick spray pass increases the internal stresses in TSAC and decreases the bond strength of total TSAC. The suitable thickness for crossing passes shall be determined by procedure qualification test described in Sec 7.0 of this specification.

For manual spraying, spraying to be done in perpendicular crossing passes to minimize thin spots in coating. Approx. 75-100 microns of TSAC shall be laid down in each pass.

The surface geometry of the item or area to be sprayed should be inspected before application. The spraying pass and sequence shall be planned according to following.

- Maintain Gun as close to perpendicular as possible and within ± 30° from perpendicular to the substrate.
- Maintain nominal standoff distance and spray pass width as given below:

Spray method	Standoff (Inches)	Spray pass width
Arc Wire	6-8	1 ½ (40mm)
Flame Wire	5-7	¾ (20mm)

4.4.1 Rust Bloom (Visual appearance of rust or Discoloration)

If Rust bloom appears on the blasted surface before thermal spraying, the affected area shall be reblasted to achieve the specified level of cleanliness.

If Rust bloom in form of discoloration, or any blistering or a degraded coating appears at any time during application of TSAC, then spraying shall be stopped and acceptable sprayed area shall be marked off. The unsatisfactory areas shall be repaired to the required degree of surface cleanliness and profile.

Blast the edges of the TSAC to provide for 2-3" feathered area overlap of the new work into existing TSAC.

Then apply TSAC to the newly prepared surfaces and overlap the existing TSAC to the extent of feathered edge so that overlap is a consistent thickness.

4.4.2 Masking

Masking all those parts and surfaces which are not required to be thermally sprayed as instructed by purchaser should be inspected by applicator to ensure that they are properly marked and covered by purchaser.

Complex geometries (flanges, valve manifolds, intersections) shall be masked by applicator to minimize overspray i.e. TSAC applied outside spray parameters (primarily gun to substrate distance and spray angle).

4.4.3TSAC Finish

The deposited TSAC shall be uniform without blisters, cracks, loose particles, or exposed steel as examined with 10 X magnification.

5.0 SEALER

Sealant shall be applied after satisfactory application of TSAC and completion of all testing and measurements of the finished TSAC as per Sec 6.0 of this specification.

For shop work Sealer shall be applied immediately after thermal spraying and for field work sealer shall be applied within 8 hours. The sealcoat shall be thin enough to penetrate into the body of TSAC.

The sealant shall be Silicone Alkyd Aluminum paint having OFT not more than *3540* micron. Typically seal coat shall be applied at a spreading rate resulting in theoretical 38 microns OFT. The seal coat shall be applied in accordance with SSPC-PA 1 and the paint manufacturer instruction for sealing.

6.0 TESTING AND MEASUREMENT SCHEDULE

6.1 Surface Finish

That the blasted cleaned surface meets the required criteria (NACE 1/SSPC-SP 5) shall be visually inspected using SSPC-VIS 1. The clear cellophane-tape test as per ISO 8502-3 shall be used to confirm absence of dust or foreign debris on the cleaned surface. Checks shall be done on each component at least once per 200 m2 of blasted surface and minimum of 3 checks per shift.

6.2 **Blast Profile Measurement**: (In-Process testing during actual production before application of TSA coating)

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM 0 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m2 of blasted surface. At each spot three measurements shall be taken over an area of 10 cm2 and average of measurements to be recorded and reported.
If profile is <65 microns blasting shall continue till greater than 65 microns depth profile is achieved.

6.3 TSAC Thickness (In-Process Testing For finished coating during regular production)

6.3.1 TSAC finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge.

6.3.2 For flat surfaces, measurements shall be taken along a straight measurement line, one measurement line for every 15 m2 of applied TSAC shall be selected along which 5 measurements to be taken at 25 mm internal and average to be reported.

6.3.3 For curved surface or complex geometry, 5 measurements shall be taken at a spot measuring 10 cm2 in area. One spot to be taken for every 15 m2 of applied TSAC area.

6.3.4 The TSAC thickness in surface changes or contour changes, welds and attachments shall be also measured and reported.

6.3.5 If TSAC is less than specified minimum thickness, apply additional TSAC until specified thickness range is achieved.

6.3.6 All locations and values of TSAC thickness measurements shall be recorded in Job Record (JR).

6.4 Tensile Bond Testing (In-Process testing for finished coating during regular production)

- Tensile Bond strength of the TSAC finish coat shall be determined according to ASTM D 4541 using a self-aligning adhesion tester.

- One measurement shall be made every 50 m2• If tensile bond at any individual spot is less than 1 000 psi for flame sprayed coating and 1500 psi for arc sprayed coating the degraded TSAC shall completely removed and reapplied.

- The tensile bond portable test instrument to be calibrated according to ASTM C 633

6.5 Bend Tests

Bend test shall be carried out at beginning of each work shift. Bend tests shall also be conducted on sample coupons before start of thermal spraying work to qualify the following as mentioned earlier in this specification.

- To qualify spray parameters and thickness of each crossing pass.

6.5.1 Test Procedure

a) Five corrosion control steel coupons each of dimension 50 mm x 150 mm x 1.3 mm thk. to be prepared.

b) Surface shall be prepared by dry abrasive blast cleaning as per this specification.

c) TSAC shall be applied as per specified thickness range. TSAC should be sprayed in crossing passes lying down approx. 75-100 microns in each pass.

d) TSAC applied coupons shall be bent 180 ° around a 13 mm diameter mandrel.

e) Bend test shall be considered passed if on bend radius there is

- No cracking or spalling or lifting by a knife blade from the substrate
- Only minor cracking that cannot be lifted from substrate with a knife blade.

f) Bend test fails if coating cracks with lifting from substrate.

6.6 Tests for blasting media, blasting air

6.6.1 Blasting Media (For every fresh batch of media and one random test during blasting)

Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

a. Inspection for the absence of oil contamination shall be conducted using following procedure:

- Fill a small clean 200 ml bottle half full of abrasive.

- Fill the bottle with potable water, cap and shake the bottle.

- Inspect water for oil film/slick. If present, the blasting media is not to be used.

b. Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

c. Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

6.6.2 Test for Blasting Air (Once Daily before start of blasting and once at random during blasting)

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

6.7 Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP I shall be tested as per following procedure to validate absence of oil and grease contamination.

a) Visual inspection - Continue degreasing until all visible signs of contamination are removed.
b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free trichloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.
Continue degreasing and inspection till test is passed.

7.0 TSAC APPLICATOR QUALIFICATION

Following tests to be carried out as part of procedure qualification test for the applicator.

- Thickness measurement
- Coating bond strength
- Porosity test
- Bend strength

TSAC applicator's surface finishing and application process and equipment set up, calibration and operation shall be qualified by application of TSA on a reference sample which shall be used as a comparator to evaluate the suitability of application process. Only that applicator will be permitted to carry out the work when test specimens coated by the applicator meets the desired requirements as cited below.

The sample shall be made of a steel plate measuring approx. 18"x 18" x *W'* thick. If the actual work is less than *W'* thick then the sample to be made from material of representative thickness.

The surface preparation, TSAC application shall be made with actual field equipments and process/spray parameters and procedures as per the specification. The depth profile of blasted surface, TSAC coating thickness for each cross pass and total thickness range shall be as per specification.

The surface preparation and thermal spraying shall be carried out in representative environmental conditions spraying with makeshift enclosure.

7.1 After application of coating, thickness and tensile bond measurements shall be made in following manner.

- Divide the sample piece into four quadrants.
- Measure thickness along the diagonal line of each quadrant.
- Four each quadrant five in-line thickness measurements at I" interval shall be done using SSPC-J>A 2 type 2 fixed probe gauge. Thus a total of four...five in line" thickness measurements to be done for the whole sample.
- One tensile bond measurement using ASTM D 4541 type III or IV portable self aligning test instrument to be done at centre of each quadrant. Total of 4 measurements for the sample.
- One porosity evaluation test by Metallographic examination shall be conducted to demonstrate the achievement of porosity within the limits specified. Sample shall be prepared for Metallographic examination as per ASTM E- 3.
- The procedure shall be considered qualified if thickness and tensile-bond strength and porosity values meet the specification requirement.

7.2 Bend test: Bend test shall be carried out as detailed at sec. 6.5 of this specification.

Applicators thermal spray equipment set-up, operation and procedure of application including in-process QC checkpoints adopted during procedure qualification as described above should be always subsequently followed during entire duration of work.

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

8.0 DOCUMENTATION

The following information shall be provided by TSAC applicator before award of work.

- TSAC application process consisting of equipment capabilities and their technical parameters, feed stock material and source of procurement.
- Detailed application procedure and in-process quality control check points for (a) surface preparation (b) thermal spraying (c) seal coats.
- Type and specification of instruments to be deployed for measurement of blast profile depth, TSAC thickness and tensile bond.
- Paint manufacturer data sheet for the selected sealing coat to be applied.

9.0 RECORDS

The TSAC applicator shall maintain job record to record production and QC information. All the results of the tests and quality control checks shall be entered in the record for each component/part thermally sprayed. All the result of tests (thickness, tensile bond, bend tests) and other validation tests (e.g. Procedure qualification test, test for surface cleanliness after abrasive blasting, test for cleanliness of abrasives and air) shall also be recorded and duly signed by owner.

All the information mentioned in Sec 8.0 above should also form part of the Job record.

Any modification affected after procedure qualification in the procedure, QC, spray parameter, equipment spec to the original information (submitted before award of the work) must also form part of Job record.

10.0 WARRANTY

The TSAC applicator shall warrant the quality of material used by providing the purchaser with a certificate of materials used to include

a. Spray feed stock: Alloy type/designation, Lot Number, wire diameter, chemical analysis, name of supplier, manufacturer.

b. Sealant: Name of manufacturer, application data sheet.

ONGC एम आर पी एल MRPL	½ãâØãÊãîÀ ãäÀ¹ãŠãƒ¶ãÀãè †¥¡ ¹ãñ›ÈãñŠãñŠãä ½ã‡ãŠÊÔã ãäÊãäã½ã›ñ¡ MANGALORE REFINERY & PETROCHEMICALS LTD.	DESIGN BASIS FOR Surface Preparation and Protective Coating	DOCUMENT NO EDB-0014

11.0 SAFETY

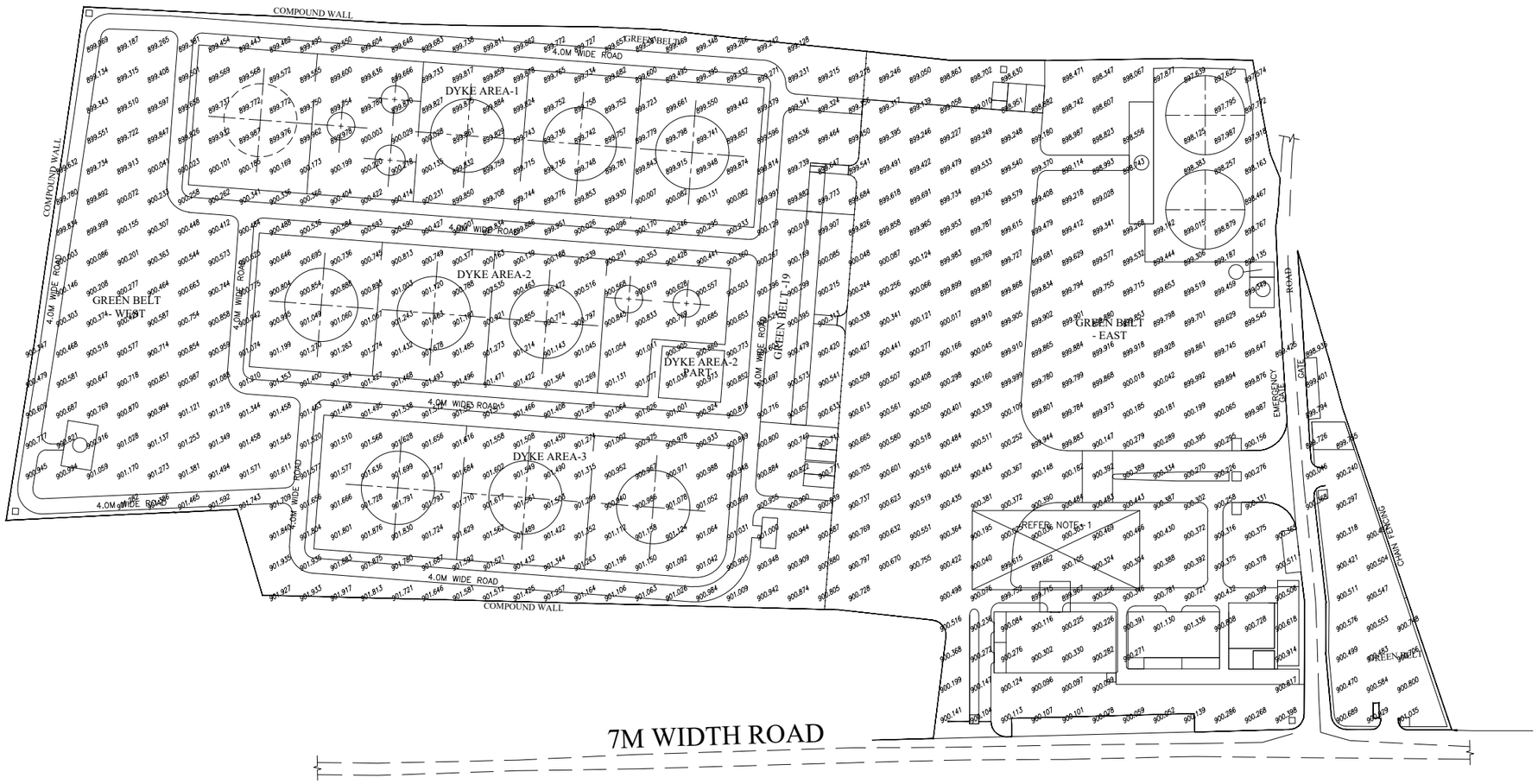
The TSAC applicator shall follow all safety procedures required by the purchaser/owner. Owner shall also give compliance requirement to be followed by applicator. The applicator shall follow all appropriate regulatory requirements.

12.0 CODES AND STANDARDS

This specification shall apply in case of conflict between specification and following applicable standards:

AWS C.2.17	Recommended Practice for Electric are Sprayu
ASTM C 633	Test Method for Adhesive/Cohesive Strength of Flame Sprayed Coatings
ASTM D 4285	Method for indicating Oil or Water in Compressed Air
ASTM D 4417	Test Method for Field Measurement of Surface Profile of Blasted Steel
BS 2569	Specification of Sprayed Metal Coating
NACE Standard RP 0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape
ASTM D 4541	Test method for Pull-Off Strength of Coating Using Portable Adhesion Testers
ANSI/A WS C2.18	Guide for the Protection of Steel with Thermal Spray Coatings of Aluminum, Zinc and their Alloys and Composites.
NACE No. 12/AWS C2.23M/SSPC-CS 23.00	Specification for the application of thermal spray coatings (Metallizing) of aluminum, zinc and their alloys and composites for the corrosion protection of steel.
SSPC Publication	The inspection of coatings and linings : A Handbook of Basic practice for Inspectors, Owners, and Specifiers
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-AB 3	Ferrus Metallic Abrasives
SSPC-PA 1	Shop, Field and Maintenance Painting of Steel
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
NACE No. 1/SSPC-SP 5	White Metal Blast Cleaning
NACE No. 2/SSPC-SP 10	Near – White Metal Blast Cleaning
SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces prepared by Dry Abrasive Blast Cleaning

DRAWING_NO:: 20005-GEN-S-DW-2328



GROUND ELEVATIONS	
AREA/ZONE MARKING	ASSUMED FGL
DYKE AREA-1	899.656
DYKE AREA-2	900.519
DYKE AREA-2 PART	900.75
DYKE AREA-3	901.189
GREEN BELT-19	900.15
GREEN BELT-EAST	900.15
GREEN BELT-WEST	900.150
ROAD - DYKE AREA-1	900.156
ROAD - DYKE AREA-2	901.019
ROAD - DYKE AREA-3	901.689

1

NOTES

1. DITCH AS MARKED IS OBSERVED AT SITE. LOCATION TO BE VERIFIED DURING SITE GRADING AND SUITABLY LEVELED.
2. AVERAGE ELEVATION OF PLOT IS ASSUMED AS 900.3m.
3. FORMATION LEVEL OF ROADS OTHER THAN DYKE AREAS ARE CONSIDERED TO BE SAME AS FGL IN RESPECTIVE AREAS.

SL.NO	DWG/DOC NO.	REV.	TITLE
1	20005-GEN-L-DW-3001	–	OVERALL PLOT PLAN

REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	DRWN	CHKD	APPRD	
			NAU			MRPL
1	16.03.2021	RE-ISSUED FOR BID	SKK	NR	ASN	
0	23.02.2021	ISSUED FOR BID	PB	NR	ASN	

CLIENT:

MANGALORE REFINERY AND PETROCHEMICALS LIMITED
(A subsidiary of Oil & Natural Gas Corpn. Ltd – ONGC)

PROJECT:

CONSTRUCTION OF MARKETING TERMINAL PROJECT AT DEVANGONTHI, BANGALORE.

PROJECT MANAGEMENT CONSULTANT:

NAUVATA ENGINEERING PVT. LTD.

DRAWING TITLE: AREA DEMARCATION FOR SITE GRADING AND EARTHWORK CALCULATION

CLIENT TENDER No:	DRAWING No:	SHT NO.	REV	SCALE:
	20005-GEN-S-DW-2328	1 OF 1	1	NTS

	MRPL Marketing Terminal Project at Devangonthi, Bangalore Marketing Infrastructure Projects, MRPL			
Part – -	INTERFACE MATRIX	Tender No :	3200000490	
Section – -		Document No:	-	
Subsection – -		Rev :	00	

Abbreviation	Nomenclature
PR	Primary Responsibility
P	Participation
S	Support

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
1	Design, supply, installation, testing and commissioning of 14" Feed Pipeline from PMHB unit to PLT Exchange Manifold, associated piping, OFC and inline instruments (MOVs).	PR		*S	*Procurement & supply of field instruments, OFC termination and data connectivity
2	Design, supply/fabrication, installation, testing and commissioning of Product storage tanks, UG Tanks and their Pumps and associated piping.	PR	S**	S*	*Provide inputs for instrument installation **UG pit for horizontal tanks, Equipment foundations
3	Design, supply, installation, testing and commissioning of firewater storage tanks, firewater pumps, jockey pumps, foam storage tanks, foam/firewater spray/sprinklers system, foam pumps, HVLR monitors package, fire hydrants, firewater/foam monitors, Remote operated HVLR water-foam monitors, complete firewater/foam networks, associated piping, instruments and controls.	PR	S**	S*	*Procure, supply and laying of Power cables up to junction box/motor terminal box. ** Design, supply, fabrication, installation of Fire Water Pump house, Foundation for Fire Water Pumps, Jockey pumps, Foam Tank, Foam Pumps.
4	Design, selection, supply, fabrication, installation and testing of fire hydrants system and portable firefighting equipment for all RCC buildings like Admin, Control room, Canteen, Lab, etc.	S*	PR	S	*LSTK-A shall lay firewater and utility piping/network leads to RCC buildings up to about 5.0 m outside the RCC buildings.

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
5	Design, supply, fabrication/construction, supporting, installation, painting, testing and commissioning of firewater system and utility piping within the RCC buildings.	S	PR	S	
6	Design, supply, installation and testing and commissioning of Clean Agent Flooding system for control room, UPS rooms, etc.		PR	S*	*integration to PLC/DCS.
7	Procurement, supply and laying of electrical cable for all product pumps, firewater/jockey pumps, utility pumps	S*	S*	PR	*Termination of cables at end users.
8	Design and Construction of Admin building, Control Room building, Laboratory room, etc.		PR	S*	*Input for control room size, Building instruments by LSTK-C
9	Design& construction of Product pump house, TLF gantries and firewater pump house.	S*	PR	S*	* Input for Pump house and gantries viz. piping, supports, Loading arm etc.
. 10	Design and construction of Electrical substation, Battery room and IMCC etc.		PR	S*	* LSTK-C shall provide input.
. 11	Design& construction of foundations for all pumps, UG tanks and other tanks (Except for Product tanks inside the Dyke and firewater storage tanks), Piping Support pedestals, Crossovers, Access platforms, Catwalks, Corrosion Inhibitor skid, Additive Injection skids, Instrument Air compressor and dryer package, Filters and Coalescer separator package, VRU package, Fast Flusher, Bulk Air eliminator, Diesel Generators, Truck Calibration Tank Fillers, and TT Recycle Pump.	S*	PR	S*	*Inputs like equipment size, dynamic and static load data shall be provided by LSTK-A &C

	MRPL Marketing Terminal Project at Devangonthi, Bangalore Marketing Infrastructure Projects, MRPL			
Part – -	INTERFACE MATRIX	Tender No :	3200000490	
Section – -		Document No:	-	
Subsection – -		Rev :	00	

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
. 12	Design & Construction of UG tanks pit - Excavation of sump pits, brick work & RCC foundation jobs inside pit, back filling and PCC top cover.	S*	PR	S	*Inputs like equipment size, installation of tank in the pit, supply of all hardware for tank installation.
. 13	Design, procure/supply, installation, testing and commissioning of Ethanol and Bio diesel unloading piping, storage tanks, pumps and associated inline Instruments and piping up to tie-in points inside TLF bays as demarcated in the P&IDs.	PR		S*	*Supply of field instruments (except MOV & ROSOV,DBBV) and Provide tie-in points coordinates in TLF bays.
. 14	Design, supply/fabrication, installation, testing and commissioning of additive packages for MS and HSD products, instruments & controls and its associated piping up to tie-in point in TLF bays	PR		S*	* Provide tie-in points coordinates in TLF bays.
. 15	Design, procurement/supply, installation, testing and commissioning of complete Vapor recovery unit (VRU) package, instruments & controls and associated piping up to tie-in point with vapor recovery arms in TLF bays	PR		S*	*To Provide tie-in points coordinates.
. 16	Bulk air eliminators and its accessories.	PR		*S	*Loading arm air eliminators is in the scope of LSTK-C
. 17	Conduct HAZOP Study & incorporation of HAZOP recommendations in design and project execution.	PR	P*	P*	*Participation and incorporation of HAZOP recommendations.
. 18	Conduct SIL Study & incorporation of SIL study recommendations in design and project execution.	P*	P*	PR	*Participation and incorporation of SIL recommendations.

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
. 19	Preparation and submission of Disaster Management Plan	PR	S*	S*	*Provide inputs/supporting documents as applicable.
. 20	Design, supply, installation, calibration , testing and commissioning of Instrumentation system including DCS, T A S , TFMS, LRCS, SIL3 PLC, CCTV system, Field Instruments, etc.	S	S	PR	
. 21	Integration of ROSOVs, MOVs, DBBVs, firefighting system and package units instruments & controls supplied by LSTK-A & B with DCS, TFMS, TAS, PLCs, as applicable	S*	S*	PR	*Shall provide all the inputs necessary for procurement of cables and integration
. 22	Design and construction of foundations for DG (diesel Generator) sets, Transformers		PR	S*	*Inputs like equipment size, dynamic and static load data shall be provided by LSTK-C
. 23	Design, Procurement, supply, installation, testing, calibration and commissioning of electrical works as defined in the respective Tenders.	PR*	PR*	PR*	* P & S with other LSTK Contractors for Interface.
. 24	Design, Procurement, supply, installation, testing, calibration and commissioning of meter proving skid, truck calibration tanks and TT recycle pump.		S*	PR	*Foundation, Shed, Sump and support for truck calibration tank and TT recycle pump.
. 25	Design , procurement, supply, installation, testing and commissioning of HVAC systems		PR	S*	*Heat Dissipation input for Control Room, UPS room ,Battery Room, LAB, VFD Room to be provided to LSTK-B Contractor.
. 26	Piping from Bore wells with pumps to Raw water sump and firewater sump	PR		S*	*Procure & supply of field instruments and integration to DCS.

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
. 27	Design, supply, installation, testing and commissioning of Raw water sump pumps, motors, associated instruments and piping up to water treatment plant battery limit, to firewater sump and to firewater storage tanks.	PR		S*	*Integration with DCS, as applicable.
. 28	Design, supply, installation, testing and commissioning of Firewater sump Pumps, motors, associated instruments and piping up to firewater storage tanks	PR		S*	*Procure & supply of field instruments and integration with DCS, as applicable
. 29	Design, supply, installation, testing and commissioning of Potable water pumps, motors, associated instruments and piping up to TT calibration shed and overhead tanks as demarcated in P&IDs.	PR		S*	*Procure & supply of field instruments and integration with DCS, as applicable
. 30	Design and construction of RCC Valve pits for OWS/CRWS drains	S*	PR		*valve pits size and depth shall be provided by LSTK-A
. 31	Design, supply, installation, testing and commissioning of OWS piping from various sources to inlet of OWS treatment unit and recovered oil piping from OWS unit to Slop tank as demarcated in the P&IDs	PR	S*		*To provide tie-in coordinates
. 32	Design, supply, construction, installation, testing and commissioning STP (Sewage Treatment plant) unit		PR	*S	Analyzer for pH suspended solid, COD and BOD is in the scope of LSTK-C contractor.
. 33	Design, supply, installation, testing and commissioning of domestic sewage Piping and valves from sources to inlet of sewage treatment plant (STP)	PR	S*		*To provide tie-in coordinates

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
. 34	Design & construction of foundations for pipe sleepers, other pipe supports, rack/bridges, culverts & road crossovers for underground piping, etc.	S*	PR		*Inputs like sleeper width, load data shall be provided by LSTK-A
. 35	Design, supply, installation, testing and commissioning of Instrument Air compressors with dryers, instrument Air receiver and associated instruments and distribution piping up to each tank farms and instrument air tubing for all ROSOVs.	PR	S*	S**	*Design & construction of Foundations for Air compressors and air receiver **Integration of air compressor package to PLC/ DCS.
. 36	3-D modelling for complete terminal using E3D software, Overall integration of 3-D models received from Other contractors,	PR	S*	S*	*Develop 3-D modeling for their respective scope, give inputs to PMC, participation in review, implementation in their scope after recommendations.
. 37	Conduct Model review at 30%, 60% and 90% stage	PR	P*	P*	*Participation and Tag/comments close
. 38	Carrying out Material Handling Study and procurement/ supply of material handling equipment.	PR*	PR*	PR*	*In their respective area/ section/ system.
. 39	Design, supply and Installation of fixed material handling system (monorail beams, EOT/ HOT beams (if any), pad eyes etc.) along with supports inside pump houses, TLF Gantry, RCC Building etc.	S*	PR	S*	*Necessary Inputs like SWL to be provided to LSTK-B for installation of fixed material handling system

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
. 40	Selection, sizing, procurement/ supply, installation, testing and commissioning of all products loading/ unloading pumps, associated piping and inline instruments like MOVs, ROSOVs, and DBBVs. (Except the inline instruments in TLF bays/Loading arms)	PR		*S	*Supply & laying of power and instrument Cables by LSTK-C
. 41	Selection, sizing, procurement/ supply, installation, cable termination, testing and commissioning of instruments for package units instruments and inline instruments like MOVs, ROSOVs, and DBBVs supplied by LSTK-A	PR		S*	*Cable procurement, supply, laying and integration with PLC/DCS
. 42	Any other item, systems, activities necessary for completion of jobs/ Statutory requirements, if any.	PR*	PR*	PR*	*In their respective area/section/system
. 43	Development of commissioning Procedures and Operating manual/ procedure.	PR*	PR*	PR*	*In their respective area/section/system
. 44	Training of plant Operating and maintenance personnel.	PR*	PR*	PR*	*In their respective area/section/system
. 45	Hydraulic Guarantee for the Terminal operation.	PR	P*	P*	shall Participate and provide technical supports (including supply of experiences technical experts/Engineers)
. 46	Performance guarantee for TLF loading batch accuracy.	P*	P*	PR	shall Participate and provide technical supports (including supply of experiences technical experts/Engineers)

	MRPL Marketing Terminal Project at Devangonthi, Bangalore Marketing Infrastructure Projects, MRPL			
Part – -	INTERFACE MATRIX	Tender No :	3200000490	
Section – -		Document No:	-	
Subsection – -		Rev :	00	

	SCOPE/ACTIVITY	LSTK-A	LSTK-B	LSTK-C	REMARKS
. 47	Commissioning of complete terminal.	PR	P*	PR	*shall Participate and provide technical supports (including supply of experiences technical experts/Engineers)
48	P&ID, Overall Plot Plan, hazardous area classification, HAZOP,	PR	P/S	P/S	

Note:

1. For any scope or activity which is not mentioned above, the interface is mentioned in the bidding document and shall be clarified during execution of contract. Bidder to follow the same.
2. Bidder to refer the respective tender document for scope, activity and the interfaces.

ಫ್ಯಾಕ್ಸ್ / Fax : 080-25586321
ಈಮೇಲ್ / Email : ho@kspcb.gov.in
ವೆಬ್‌ಸೈಟ್ / Website : http://kspcb.gov.in

ದೂರವಾಣಿ / Tel : 080-25589112
080-25589113, 25589114

ಕರ್ನಾಟಕ ರಾಜ್ಯ ಮಾಲಿನ್ಯ ನಿಯಂತ್ರಣ ಮಂಡಳಿ
Karnataka State Pollution Control Board

"ಪರಿಸರ ಭವನ", 1 ರಿಂದ 5ನೇ ಮಹಡಿಗಳು, ನಂ. 49, ಚರ್ಚ್ ಸ್ಟ್ರೀಟ್, ಬೆಂಗಳೂರು - 560 001, ಕರ್ನಾಟಕ ರಾಜ್ಯ, ಭಾರತ
"Parisara Bhavan", 1st to 5th Floor, # 49, Church Street, Bangalore - 560 001, Karnataka State, India

No.KSPCB/SEO-INFRA/STP-GUIDELINES/2020-21/ 5446 Date: 01 MAR 2021

OFFICE MEMORANDUM ON STPs

Sub: Guidelines for Design and location of Sewage Treatment Plants (STPs)- Reg

Ref: 1. Proceedings of the Technical Committee meeting held on 19/09/2020.
2. IISc letter dated 12/10/2020
3. The Government of Karnataka Notification No FEE 316 EPC 2015 on STPs dt. 19/01/2016

^^^^^^^

The Responsibility prescribed under the Section 24 and Section 25 of Water (Prevention and Control of Pollution) Act, 1974, indicates the wholesomeness water to be maintained in all the water bodies like River, Well, Lake, etc. Therefore, regulatory agency viz. Karnataka State Pollution Control Board (KSPCB), in exercise of its power has specified the mandatory condition to provide the Sewage Treatment Plants (STP) for a) Apartments with 20 Units and above or having a total built up area of 2,000 square meter including basement, b) Commercial constructions Projects (Commercials Complexes, office, IT related activities etc.) with total built up area of 2000 Square meter and above, c) Educational Institutions with or without Hostel facility having total built up area of 5.000 square meter and above and d) Townships and Area Development Projects with an area of 10 acres and above shall install STP.

The location of these STPs is equally important besides its Operation & Maintenance. It is observed that majority of STP'smainly of the Residential apartments are either not provided in the proper location leading to the frequent complaints by the residents about noise and odor nuisance. Also in many cases, the unit operations are not properly designed and the treatment technology is not properly adopted leading to non conformity to the standards prescribed by the Board. The Plant operators may not be aware of the functioning of various unit operations and this may result in discharge of untreated sewage which ultimately joins the water bodies and may also lead to seepage of water from the tanks thereby contaminating the ground water.

K.S.P.C.B. Karnataka State Pollution Control Board

The violations observed in many instances indicated improper location leading to Noise, Smell, unapproachable passage entry etc. and attracted neighboring complaints, spillages/ illegal Cross connection of such sewage entering intothe Groundwater.

In view of the above, general guidelines are framed considering various Environmental aspects and field conditions and are enclosed as Annexure-1. However, it is to be made clear that the guidelines are general in nature & may require certain modifications/ stringent practices to be adopted depending on the specific field conditions.

Hence ROs are hereby directed to advice the Project Proponents and also insist for best appropriate available technologies for implementation.

I. Sewage Treatment Plant Technologies

The approved Technologies are:

A) Activated Sludge Process(ASP) only in the case where the Sewage generated is 500 KL and above.
B) Sequential Batch Reactor(SBR)
C) Membrane Bio Reactor (MBR)
D) Moving Bed Bio Reactor (MBBR) / Fluidized Aerobic Bed rector (FAB)

Note: As and when new technologies are brought to the notice of the Board, the Technical committee review and decide if it can be adopted.

K.S.P.C.B.

II. Unit operation details for the above Technologies

No.	Unit	Activated Sludge Process(ASP)	Sequential Batch Reactor(SBR)	Membrane Bio Reactor (MBR)	Moving Bed Bio Reactor (MBBR) / Fluidized Aerobic Bed rector (FAB)
1	Equalization Tank	Shall have a Minimum Holding Period of 8 hours	Shall have a Minimum Holding Period of 8 hours	Shall have a Minimum Holding Period of 8 hours	Shall have a Minimum Holding Period of 8 hours
2	Anoxic Tank - To Achieve De-Nitrification	Return Activated sludge shall be pumped into the Anoxic Tank to achieve De-Nitrification	Sludge Recirculation Not required, however if the same is done by pumping the contents of the SBR Reactor back to the Pre-Aeration Tank, a better control on De-Nitrification can be achieved	Return Activated sludge shall be pumped into the Anoxic Tank to achieve De-Nitrification	Return Activated sludge shall be pumped into the Anoxic Tank to achieve De-Nitrification
3	Aeration Tank	Adequate care to be taken to ensure that higher DO is maintained in the Aeration Tank in excess of 4 mg/L	Adequate care to be taken to ensure that higher DO is maintained in the Aeration Tank in excess of 4 mg/L	Adequate care to be taken to ensure that higher DO is maintained in the Aeration Tank in excess of 4 mg/L	Adequate care to be taken to ensure that higher DO is maintained in the Aeration Tank in excess of 4 mg/L
4	Membrane Tank	Not Required	Not Required	The Membranes shall be replaced periodically as per the Manufacturers specifications	Not Required
5	Sludge Holding Tank	This tank shall be mandatorily provided, to hold the excess sludge prior to dewatering			
6	Final Treated Water Holding Tank	A minimum of 2 days capacity (Design Capacity of STP) shall be provided to store and use the water in case of rainy seasons.			
7	Sludge Drying	The sludge drying beds and filter press shall not be used due to the operational issues. Horizontal centrifuge system shall be used for the STP of more than 500 KLD and Vertical centrifuge / Belt Press / Screw Press system shall be used for the STP of less than 500 KLD			

III) Mechanical EquipmentSpecifications Guidelines(These equipment / Units shall be part of the STP)

No.	Unit	Activated Sludge Process(ASP)	Sequential Batch Reactor(SBR)	Membrane Bio Reactor (MBR)	Moving Bed Bio Reactor (MBBR) / Fluidized Aerobic Bed rector (FAB)
1	Bar Screen Chamber	To screen the incoming sewage of rags and floating solids			
2	Fine Screen	To screen the incoming sewage of fine particles. The filtration diameter shall be < 5mm			
3	Oil and Grease Trap	To trap and remove the oils from the sewage.			
	Pumps	Raw sewage pumps shall be submersible type with CI body and CI impeller. Other pumps like sludge transfer and filter feed pumps shall be Centrifugal surface mounted pumps /submersiblewith CI body and CI impeller			
4	Air Blowers	These form the heart of the treatment. Adequate air volume to compensate for the pipelines losses etc to be taken care off. Recommended to have 2.5 kg of oxygen per kg of BOD of removal			
5	Noise Control from Air Blower	Acoustic Enclosures shall be provided to ensure the noise from the Air Blower should be less than the permissible limits, a below			
		Area	**Day**		**Night**
		Industrial	75 dB		70 dB
		Commercial	65 dB		55 dB
		Residential	55 dB		45 dB
6	Ultra filtration System	Shall mandatorily be provided for the treated sewage reuse for toilet flush and also to avoid recontamination at the final holding tank		Not Required for MBR	Shall mandatorily be provided for the treated sewage reuse for toilet flush and also to avoid recontamination at the final holding tank
7	Membranes	The filtration efficiency of the membrane shall be to filter out virus and bacteria also in the range of ten to the power of minus 6 log reduction, The system shall be fully PLC based automatic plant for both filtration and backwash cycles. The membrane life shall be guaranteed for a period of 5 years of operation			
8	Faecal Coliform Control	A dual approach of having UV Stabilizer to disinfect the treated sewage followed by chlorinator to maintain a residual chlorine level of 2ppm in the treated sewage shall be adopted to achieve Faecal Coliform < 100 MPN / 100ml. Ozonation may also be considered with ozone dosage at 4 ~ 5 ppm.			

III (A) Mechanical Equipment's

1. Bar Screen Chamber and Oil & Grease Chamber shall have clear and easy access.
2. To avoid sound and vibration issues, as far as possible the equipment shall be submersible type with provision of easy removal when maintenance is required without the need to empty the tanks.
3. Air Blowers should be away from residential units to mitigate its effect of vibration and noise. Air blowers shall be provided with anti- Vibration mounts and acoustic Enclosures

IV. Location of the STP

- STP shall be located, preferably under drive way, clubhouses, play area and as far as away from apartment complexes.
- Never locate the STP in the basement of any flats of apartment towers.
- The access from the lowestbasement is not permitted for the reason of flooding of rain water, smell and sound nuisance.
- The access to the STP should be from the ground level / Upper Basement, all tanks should be open, and access shall be through well designed walkways and head room
- Mechanical Ventilation shall be provided to ensure adequate ventilation with a minimum of 25 air changes per hour shall be provided inline of para(1) along with the guidelines of NBC, in case if the STP is in the basement.
- The exhaust should be terminated at the terrace level. All ducting running inside the shaft shall be provided with acoustic insulation. This ducting and routing shall not be along with flats and shall be along the common utilities.
- STP Shall never is fully closed.
- Activated Sludge Process shall be avoided for all decentralized STPs less than 500 KLD.
- Preferably go for Sequential Batch Reactor (SBR) with Ultrafiltration Or Membrane Bio Reactor (MBR) or Moving Bed Bio Reactor (MBBR) with Ultrafiltration.

V)Treated Sewage Standards: The final treated sewage shall confirm to the following standards

No.	Parameter	Limits
1.	pH	6.5-8.5
2.	BOD(5^{th} day)	<10mg/l
3.	COD	<50 mg/l
4.	Suspended Solids	<10mg/l
5.	Ammonical Nitrogen	<5 mg/l
6.	Total Nitrogen	<10 mg/l
7.	Faecal Coliform	<100 MPN/100 ml

V.Installation of Sensors:

The Sensors are made mandatory for all the STPs,(Including BWSSB, Municipalities, ULBs, Residential, Commercial, IT, Educational Institutions, Railway Stations, Airports etc.,) for the parameters listed below:

The online monitoring shall be strictly comply with the specifications by CPCB. The brief Guidelines are as shown below:

No	Parameter	Type of Measurement	Type of Sensor	Communication Protocol
1.	pH	Inline	Ion selective glass electrodes	RS 485 communication with Modbus
2.	Total Suspended Solids	Inline	Turbidity to TSS correlation with nephelometric technique	RS 485 communication with Modbus
3	BOD	Inline	UV-Vis Spectrophotometry & combustion(Double beam with entire spectrum scanning	RS 485 communication with Modbus
4	COD	Inline	UV-Vis Spectrophotometry & combustion(Double beam with entire spectrum scanning	RS 485 communication with Modbus
5.	Flow	Inline	Electromagnetic flow measurement	RS 485 communication with Modbus

1. The Concerned Regional Officers shall properly indicate the above Technical status in their Inspection Report at the time of CFE for all the new applicants and shall follow strictly during the CFO to ensure full compliance.

2. RSEOs shall monitor on the aspects during the Monitoring/ Inspection of these units and report the action proposed suitably.

This Circular shall come into effect for newly proposed STP's or modifications or upgradations to the existing STPs from the date of issue of this memorandum and all other Circulars/Office Memorandums/any directions issued in respect of STPs will become null and void.

VI. Usage of Treated Sewage: 1) Mandatorily the treated sewage shall be used for the toilet flushing with dual plumbing system.

2) For gardening, lawn maintenance and land scape including vertical garden. The usage is considered at 5 Lt per every Square Meter of landscape area.

3) The treated water shall be used for the construction activity other than for the load bearing structures like curing, dust suppression, road consolidation, brick work etc., where the treated water does not come in contact with the steel either directly or indirectly (Until the Final study report from IISc obtained).

VII.Caution Board At STPs:

1) The STP owner shall provide '**DANGER**' sign board near the STP to maintain safety of the operational personnel and shall maintain operational safety protocol. Proper signages shall be displayed in both Kannada and English at the taps where treated sewage is flowing as "not fit for drinking".

2) Whenever there is a maintenance and staff get into STP, especially in the basements a display Board "Caution – Danger" shall be put up. The gases generated might choke & create breathlessness and may be fatal. During such activities the person entering shall do so with all protective equipment's including the Oxygen portable cylinder with a mask. Two more persons shall be watching from outside and shall immediately evacuate the person inside if such a situation arises. A minimum of two sets of such protective gear shall always be kept available in a working condition.

VIII. Adoption of Modular Based approach: It is found that in many large projects especially the layouts, the occupancy is minimal in the initial stages. The adequate quantities of sewage is not generated at the time of occupancy for the effective operation of STPs. Hence, the design and execution shall be on a modular basis so that the STP can be made operational during the lean occupancy also.

IX. Plan Sanctions: The approved Plan sanction shall include the location of the STP as per the guidelines of KSPCB.

MEMBER SECRETARY

To

1) All CEOs,/SEOs/ZSEOs/ROs for information and to strictly follow above.
2) Website of KSPCB
3) Mobile App
4) Office Master file

K.S.P.C.B.