KUWAIT OIL COMPANY (K.S.C.)

A subsidiary of Kuwait Petroleum Corporation

إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation

PRODUCTION & PROJECTS (GAS) GROUP

GAS PROJECTS TEAM-II

Mutriba Remote Boosting Facility (MRBF) at North Kuwait

Appendix-13

Piping Technical Specification

(Doc. # MRBF-TS-M-001)

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1 INTRODUCTION

As a part of developing Mutriba Fields, Kuwait Oil Company intends to install Mutriba Remote Boosting Facility (MRBF) at North West area of Kuwait for Reservoir performance assessment, well testing, processing, treating and handling of wet and high sour as well as sweet hydrocarbon well fluids. Mutriba Remote Boosting Facility (MRBF) has also been referred as "Facility" in this document.

2 SCOPE

This specification describes the basis for the overall design of process / utility piping, the requirements governing the arrangement of equipment and piping for "MUTRIBA REMOTE BOOSTING FACILITY (MRBF).

3 PURPOSE

This document along with the codes & standards mentioned herein covers the minimum requirements for design of piping systems associated with the project. This document also defines the specifications, codes and standards to be used during the detailed design phase of the Project.

4 REFERENCE DOCUMENTS

The latest editions and revisions of the following codes, standards, documents, specifications, drawings and statutory local laws and regulations available at the time of award of contract shall be applicable. In the event of conflicts between this specification and the latest edition of standards / codes referred herein, the most stringent requirement shall apply. Contractor shall notify such mismatch at the earliest to the Client. Compliance with this specification shall not relieve the Contractor of its responsibility to design and install the piping system suited to meet the specified service conditions and applicable regulations.

4.1 PRIMARY CODE

The primary Code for requirements of materials and components, design, fabrication, assembly, erection, examination, inspection and testing of piping systems and associated works shall be ASME B 31.3 latest edition as per the jurisdiction outlined below.

The piping system within fenced areas shall be designed as per ASME B31.3 (Latest edition) with the exception of portion covered under Pipeline, where respective pipeline codes shall apply.

All process and utility piping systems within the battery limits including piping within the equipment skid limit shall be designed in accordance with the requirements of ASME B31.3 and the Project Piping Specifications. All the plant piping shall be designed for service life of 20 years.

4.2 INTERNATIONAL STANDARDS

Applicable international Standards are listed in Appendix No. 8C to technical Specification.

4.3 COMPANY STANDARDS

Applicable Company standards are listed in Appendix No. 8A to technical Specification.

5 ABBREVIATIONS

ABBREIVIATION	DESCRIPTION
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BS	British Standards
ISO	International Organization for Standardization
KOC	Kuwait Oil Company (K.S.C)
MSS-SP	Manufacturers Standardization Society of the Valves and Fittings Industry
NACE	National Association of Corrosion Engineers
NDE	Non Destructive Examination
NFPA	National Fire Protection Association
P&ID	Piping and Instrumentation Diagram

6 DEFINITIONS

NOMENCLATURE	DESCRIPTION
Company	Kuwait Oil Company (KOC)
Project	Mutriba Remote Boosting Facility
Vendor	Supplier of Equipment / Package

7 BASIS OF DESIGN

7.1 DESIGN CONDITIONS

7.1.1 DESIGN PRESSURE AND TEMPERATURE

The design pressure and temperature of piping systems shall be determined according to Section 301 of ASME B31.3. In situations where different design conditions exist in one piping system, different piping classes may be used. These "spec. breaks" shall be located so that the more severe design condition can never occur in the part of the system with the lower piping class.

7.1.2 OTHER DESIGN CONDITIONS

The following conditions shall be included in the strength calculations for piping systems:

- Temperature conditions (installation temperature, heating due to heat tracer or solar radiation, freezing or cooling due to adiabatic expansion, and low temperatures)
- Dynamic load (impact force, wind load, seismic load, vibration, water hammer effect, or reaction force caused by differential pressure through pressure safety valves, control valves, etc.)

- Load due to abrupt change in flow velocity or pressure of the internal fluid resulting from sudden stoppage of pump or operation of valve
- Piping load (dead load and live load)
- Testing Load
- Thermal expansion and contraction (reaction forces, friction forces, temperature gradient due to rapid temperature changes)
- Changes in pipe support conditions (movement or settlement of piping or supports)
- Cyclical loads (Cycling frequency of pressure and temperature)

7.1.3 RED ZONE ACCESS REQUIREMENTS

The specific access requirements for equipment and process structures located within a Red Zone, as determined by the QRA and associated H2S zoning layout drawings shall be as follows:

- Access to equipment in Red Zones shall be by using stairs and not ladders.
- For access around equipment in a Red Zone a minimum distance of 1.2 meter shall be provided.
- All Instrument tapping isolation valves, diaphragm seal flanges including associated flushing ring valving and line mounted instruments shall be accessible from grade or platform as applicable.
- For access to drain vessels in pits within the Red Zone one staircase shall be provided. Each such case shall be reviewed and subject to Company approval.

The purpose for these additional special requirements is to facilitate access and egress for personnel who are required by procedure to wear breathing apparatus when entering a Red Zone.

These requirements also facilitate emergency response and rescue in high risk areas. The above requirements shall be read in conjunction with paragraph 10.2, “ACCESSIBILITY AND CLEARANCES”

8 PIPING SERVICE CLASSES

Contractor shall develop project specific Piping Material Specification based on KOC-MP-010 & its Addendum and project material selection report. The piping and valve material inside skid limit shall also confirm to Project specific piping material specification.

9 EQUIPMENT LAYOUT

9.1 BASIS OF EQUIPMENT LAYOUT

Equipment layout shall be developed based on the following data:

1. P& IDs / PFDs / vendor/package data
2. Indicative equipment Layout from process / licensor / Client.
3. Process / Equipment Data Sheets.
4. Wind Direction.
5. Overall Plot Plan.

9.2 DEVELOPMENT OF EQUIPMENT LAYOUT

The piping design and layout shall fulfil the requirements as a minimum of the KOC Recommended Practice for Plant Layout (including spacing charts), KOC-L-028 and this document. The layout shall

meet all the project requirements and comply with the applicable Codes & Standards, KOC Standards / Documents / Specifications / Drawings, Project Specifications.
Preferred layout is attached with the contract. Contractor may use the same or develop the new layout during detail engineering.
The following aspects shall be considered during the development of equipment layout:

- Process Requirement- i.e. proper flow sequence between equipment as per P&IDs to achieve the intended process parameters.
- Economy of Piping material.
- Erection & Construction requirement:
    a) Erection scheme and delivery schedule of all equipment must be considered during equipment layout to facilitate smooth erection
- The primary consideration in the arrangement of plant and equipment should be to provide:
    a) A safe operating facility that shall be economically designed and easy to operate and maintain.
    b) For spacing between various equipment and items refer to KOC-L-028.
- The equipment layout shall consider provision of appropriate space for future needs and expansion of plant.
- Equipment shall be located and orientated with due consideration to the effect of noise in the immediate vicinity of the equipment and on the general plant areas.
- Control/Maintenance buildings shall be located to allow unobstructed emergency escape. The orientation and layout of the building shall be considered in view of prevailing wind direction.
- Stacking of equipment should be avoided unless they are in the same basic service and process flow path such as a contractor, reflux accumulator etc. When stacking of equipment, the layout shall facilitate the maintenance of individual items including removal and inspections.
- Safety Requirements
    a) The Equipment layout should meet all the applicable Kuwait EPA Regulations and shall conform to the relevant KOC HSE Guidelines with a view to protecting personnel and surrounding environment.
    b) Access to equipment in Red Zones as determined by the QRA shall be by using stairs and not ladders.
- Operation and Maintenance Requirements.
    a) Drop out areas shall be provided for Columns and Towers.
    b) Overhead and side clearances for exchangers and pumps.
    c) Horizontal & overhead clearances for easy movement of working personnel.
    d) Provision of EOT for the maintenance of heavy equipment
    e) Crane approaches for air coolers /fired heaters.
    f) Similar equipment grouping – pumps etc. should be grouped together (in separate groups for similar equipment) for convenience of maintenance and safety wherever feasible.
- U/G piping corridors for main headers should be considered in equipment layout for all underground piping.
- Groups of equipment, which can be isolated from adjacent equipment for maintenance purposes, while the plant is still operating, shall be separated by a minimum of 15 m.
- Process equipment shall be located a minimum of 15-m from substations.
- Process equipment shall be at a minimum distance of 30 m from Control buildings.

- Dyke/curb walls shall be provided around process equipment to collect the spillages, if required.

9.3 PUMPS

- Process pumps should be located at or near grade level and under a shelter. All pumps should be accessible for operation & maintenance and suitable lifting arrangement shall be provided for their maintenance.
- Pumps should be located and specified so that an acceptable NPSH can be obtained without undue elevation of suction vessels or columns. Pumps in flammable or toxic service shall not be located in pits to meet or satisfy NPSH requirements.
- Pumps shall be grouped together for ease of operation, provided process requirements are satisfied.
- Suction lines shall be kept as short as possible and shall have no pockets.
- Eccentric reducer shall be used with flat side up in pump suction line to avoid cavitation.
- Pumps handling flammable liquids shall not be located under overhead equipment, pipe rack or structure. A minimum horizontal clearance of 10 meters shall be maintained between pump and overhead equipment, pipe rack or structure etc.
- The pump vent and drain lines should be piped to proper containment facilities.
- Adequately ventilated shelters shall be provided for large machines requiring in-situ maintenance. Adequate space for lifting and handling facilities shall be provided. A bridge or gantry crane should be provided to help replacement of parts and components of pump for maintenance.

9.4 AIR-COOLED HEAT EXCHANGERS

- Air-cooled exchangers shall be located to provide safe and practical access for operation and maintenance. They may be located at grade or over pipe ways. Crane access shall be provided for tube bundle removal.
- The location of air-cooled exchangers shall consider the effect of air movement on increased fire spread and the possibility of tube failure adding fuel to the fire.
- Air-cooled exchangers shall be located so that the hot air emitted shall not cause hazard or an inconvenience to personnel, and does not impair the operation of adjacent equipment.
- Air coolers shall not be located above pumps or compressors handling flammable materials.

9.5 TOWERS AND VERTICAL VESSELS

- Tower and vertical vessels shall be arranged in a row with common center line, decided by the largest vessels, placing O.D. of the equipment minimum 4.0m away from the pipe rack. The gap between the vertical vessels shall be such that the platform of adjacent towers do not overlap. To handle heavy items a davit or monorail is required. The davit shall be on the side of the vessel/column away from the rack. The area at the grade shall be kept clear for a drop out.

9.6 FLARE STACK

- The location, spacing, orientation and height of flare stack shall be determined by a full assessment of the factors involved and appropriate calculation for the heat radiation.

- Flares are a possible source of ignition; and shall generally be located remote from process facilities, storage areas, utility areas, and office / service areas but well inside the property line. They should be well away from public occupied areas (present or future) located adjacent to the site boundaries.
- Flares should also be considered a source of vapour release, as it is possible that the flame could be extinguished.
- The flare should be located either on side wind location or upwind location from the process facilities and sources of a major release of flammable vapour.
- Flares should be located as close as practicable to the process units served. However this spacing should be computed based on risk assessment and calculations for heat radiation.
- Flares shall be spaced from each other to allow maintenance work to be carried out in a safe radiation zone from an adjacent flare.
- Sloping and no pockets requirement shall be ensured from relieving /depressurizing sources to flare side. Flare header, pipe rack and KOD elevations shall be finalized accordingly.
- Flares shall be located with respect to the plant and prevailing winds such that:
  a) Gas releases from the plant are not blown into flare zones.
  b) Smoke from flares does not drift over operating areas of the plant.

10 PIPING LAYOUT

10.1 PIPING ROUTES

10.1.1 GENERAL

- Piping layouts shall have the shortest practicable route with the minimum number of horizontal and vertical bends.
- Where practical, piping entering and leaving a plot area or a processing unit shall be grouped together.
- Valves and field-mounted instruments installed in piping shall be easily accessible for operation, maintenance, and monitoring.
- The piping route shall meet the process requirements specified on the P&ID.
- Change in the pipe class ("spec. break") in a line shall be made at flanged joints rather than welded joints, unless otherwise specifically requested.
- All change in the pipe class ("spec. break") and isolation kit which is required for dissimilar Material joint & interface flange joint between underground to aboveground shall be marked in the respective P&IDs.
- Flange bolt holes to straddle the Centre lines.
- Flexibility shall be provided for RTJ type Flanges / blinds for easy removal of gasket/ blinds.
- Dead end and low pockets in lines shall be avoided.

10.1.2 PIPING ON RACKS

- Pipe Racks shall be designed to the give the piping shortest possible run and to provide clear headroom over main walkways and secondary walkways.
- Preferably all process lines shall be kept at lower tier and utility & hot process lines on upper tier.

- Overhead piping shall be routed at different elevations in the Pipe Rack. Exceptions may be made in certain cases to avoid unnecessary changes in elevation at changes of direction or where essential to avoid pockets in the piping system.
- Avoid flat turns in pipe routing in pipe rack.
- Large heavy lines shall be run near structural columns supporting the pipe rack.
- Cold lines and hot lines shall be routed on opposite sides of the pipe rack to simplify locating the expansion loops.
- Flange joints on pipe racks for process lines shall be minimized.
- Flare headers shall be placed at the top of pipe rack and provided with 1:500 slope towards Knock Out Drum.
- Pipe racks shall be sized to allow 25% clear space (throughout) for future expansion

10.1.3 PIPING IN TRENCHES

- Trench piping shall be minimized.
- A minimum 75 mm clearance shall be provided between the bottom of the pipe or its insulation and the trench bottom.
- When flanged joints are used, a minimum of 100 mm clearance shall be provided between flange top and cover plate or grating and between the flange side and trench wall.
- For drain piping, a minimum of 150 mm clearance should be provided between the bottom of a drain valve and the trench bottom.

10.1.4 UNDERGROUND PIPING

- All valves in underground piping shall be installed inside valve pits to facilitate operation, inspection and maintenance.
- The clearance requirement for buried pipelines, cables, buried underground structures etc. and minimum soil cover is as per KOC-L-002.
- The sleeve pipe design & thickness shall be as per KOC Std. DWG. No- 55-04-77.
- Minimum clearance between buried piping operating at ambient temperature and electrical and instrumentation cables shall be 300 mm.
- Underground piping shall be externally protected as per KOC std. Refer Clause 23 for details.
- Buried metallic sections of piping & pipelines shall be provided with CP system as per KOC-L-015.
- Underground lines exiting the battery limit shall be identified by route markers from battery limit till the destination at intervals of 50 m. One markers also shall also be provided inside the facility at the battery limit.
- Drain line header shall be sloped towards drain vessels.
- Non-metallic piping (RTRP) shall not be used in the project.

10.1.5 SLEEPER PIPING

- The bottom of piping supported by sleepers shall not be less than 600 mm above local high point of paving.
- Where the piping requires flat expansion loops, lines shall be routed on the edge of the sleeper.

- High alloys and stainless steel pipes shall not directly rest on carbon steel insert plates. 3 mm thin plates equivalent to the pipe material shall be welded onto insert plates at the contact region.

10.1.6 PIPE SPACING

- The minimum spacing between pipes shall be based on staggered flanges with at least 50 mm clearance for pipe sizes 18" and smaller and 15% of the nominal diameter for sizes 20" and larger , between the outside of bare pipe or outside of insulation and outside of bare flange or outside of flange insulation on adjacent line. Piping without flanges shall have 100 mm minimum vertical or horizontal clearance between bare pipes or between insulation.

10.1.7 SPECTACLE BLINDS AND SPACERS

- Spectacle blind, spades and spacers shall be provided as shown on P&IDs.
- For spectacle blinds weighing more than 50 kg, spade and spacer shall be supplied separately with handles with hole for lifting.
- On each handle, the pressure rating and size shall be clearly marked.
- For identification when installed inline, spades shall be marked in capital letters as "SPADE" and "SPACER" for spacers on the respective handles.
- Jack screw shall be provided at blind or spacer locations as follows.
    - 150LB and 300LB flanges: 6 in and larger
    - 600LB,900LB and 1500LB flanges: 2 in and larger

10.2 ACCESSIBILITY & CLEARANCES

10.2.1 General Access Requirements

- Stairways shall be provided as the primary means of access / escape to main operating or service levels of process structures and buildings. Ladders are acceptable as a secondary access / escape, except in red toxic zones. Unless specifically approved by the Company. Ladders shall not be used in the red zone.
- Platforms with stair access shall be provided at points which must be serviced once or more per shift and at platforms servicing mechanical equipment. Points which require operating access less frequently than once per shift may be provided with ladder access.
- The walking distance from any point on an operating platform to an exit shall not be greater than 20 m horizontally.
- Fixed ladders for access / escape purposes are acceptable for access platforms less than 8 m long, towers or small storage tanks outside the red zone.
- Access from ladder to platform shall be side entry.
- The maximum straight run of ladder without rest platform shall be 6.0m. Straight run up to 9.0m may be permitted subject to Company's approval.
- The maximum vertical rise of a single flight of stairs is 3 m.
- Landing width shall be at least as wide as the stairway.
- Manways shall not obstruct access ways such as landing areas for stairs or ladders. 800 mm clearance is required in front of manways.
- Manway covers opening shall be indicated and modelled in the 3D Model to 180 degrees.
- Handrails shall be provided for safety around edges of all platforms and walkways which are 500 mm or more above ground or any operating level. Handrails shall be provided for stairways and all landings.

- Maximum reach to all operable and maintainable equipment shall be 500 mm or less.
- The minimum clearance in front of valves and other operable equipment shall be 800 mm.

Access space shall take into account of normal, abnormal and emergency operations as well as Maintenance activities, including the use of cranes etc. Where several pieces of equipment have to be stacked, consideration shall take into account of the frequency of maintenance.

The design shall also include provisions for temporary access points for operational access, maintenance access to equipment, piping, instrumentation and fire protection equipment, which shall be established on the criticality of the equipment or instrumentation and the frequency of the maintenance activity.

10.2.2 Operational Access

- Access shall be provided to equipment, valves and instruments from grade or permanent ladders/ platforms.
- All valves and instruments requiring operation and/or inspection during each operational shift, or that have an emergency shutdown function shall be provided with permanent access.
- Valves shall be located such that operator does not have to stand on pipe work, cables trays, handrails, other equipment, or any object not intended as a standing surface. Valves shall be oriented and positioned such that spindles, hand wheels or handles do not protrude into the designated access ways. Valves that are operated and maintained from elevated access platforms should be accessible within the confines of the platform (i.e. not requiring personnel to reach outside the platform).
- Sufficient space shall be preserved around valve and actuators to allow maintenance work be carried out, including the use of tools. Minimum 100 mm hand clearance shall be provided around all valve hand wheels and levers over full range of available travel.
- Operable elements in auxiliary piping (e.g. sight glasses, instruments, valves) shall be accessible.
- Sampling points should be located such that the valves are easy to operate, and taking the sample will not impair safety of personnel or plant or cause environmental impact.
- Adequate space around sampling points shall be provided to allow operators to perform sampling safely while using anticipated Personal Protective Equipment, including the use of respiratory protection.

10.2.3 Maintenance Access

- Equipment and piping shall be arranged to permit planned maintenance by either fixed or mobile facilities.
- Permanent Platforms and ladder access do not need to be provided where access is only required for maintenance at elevations 2 m or less above grade, provided access at grade is available for temporary scaffolding/ crane approach.
- Pipe flanges that require disconnection for routine maintenance shall be located at an elevation of 600 mm to 1400 mm from standing surface. If this is not feasible, permanent or moveable platforms should be considered to provide access.
- Necessary space for tools and bolts withdrawal shall be allowed to pipes, tubes, fittings, etc. Generally, a distance of 250 mm minimum is required for “bolt to obstruction”.
  Special attention shall be given to the design of removable spools to allow easy removal and without causing over-stressing of piping once disconnected. Removable spools shall be

minimum length.

- Flanges shall be avoided in overhead piping routed above access ways.
- Spades and spectacle blinds should be installed in a horizontal run of a line. However, blinds can be installed in vertical for equipment with a vertical nozzle.
- Clear access and viewing space shall be provided to safely remove and install rotors with precision control. Ease of alignment shall be considered for re-installation during maintenance and necessary special alignment tools shall be provided.
- Sufficient space shall be provided at floor level for dismantling of compressor, its drives and auxiliary equipment.
- Elevated platforms 3 m or more above grade servicing three or more vessels or greater than 5.5 m length shall be provided with two access ways.

10.2.4 Access to Equipment, Piping, Valves and Instruments

Accessibility to various equipment, instruments and valves for operation, maintenance and inspection during operation shall be provided in the manner as listed below.
From grade or permanent platforms:

- Actuated valves (e.g. control valves, shutdown valves, and motor operated valves).
- Pressure relief valves (except thermal relief valves).
- Flow meters (except orifice type)
- All Instrument tapping isolation valves.
- Diaphragm seal flanges including associated flushing ring valving.
- Line mounted instruments.
- Battery limit valves.
- Operating valves 3" and over.
- Manholes higher than 4.5 m above grade.
- Sample collection points.

Note: Requirement for maintenance access shall be based on frequency and not only height. If the frequency is high, such as monthly or six monthly, then a fixed platform shall be provided.

By permanent ladder:

- Operating valves 2” and smaller.
- Level gauges on towers & vessels.
- Dial gauges of pressure/temperature instrument.
- Sensing elements (mechanical or non-electronic) of pressure/temperature instruments.
- Preference is for all Instrument tapping isolation valves, diaphragm seal flanges including associated flushing ring valving and line mounted instruments shall also be accessible from grade or platform, where not then ladder is acceptable except in Red Zone Areas.

By portable / temporary devices (no permanent access):

- Orifice types flow meters.
- Restriction orifice.
- Check valves.
- High point vent valves and low point drain valves.
- Header block valves in pipe racks (except at battery limits).
- Utility branch isolation valves on pipe racks.
- Non-operating valves, like tie-in valves.
- Manholes at 4.5 m or lower above grade.
- Spectacle blinds/spacers & blinds at 4.5 m or lower above grade or permanent platform.

Note: Red Zone requirements for access are stated in paragraph 7.1.3 "Red Zone access requirements."
Accessibility for corrosion Monitoring shall be as follows:

- For any station installed at 6 o'clock position on an above ground piping and the clearance between the piping bottom and the ground is less than 1.8 m, water proof concrete pit shall be constructed to allow a clearance of 1.80 m between the piping bottom and the pit bottom.

- For any station installed at 12 o'clock position on an above ground piping and the clearance between the piping bottom and the ground is more than 800 mm, a permanent access platform shall be installed to access the monitoring station from the top of the line.

10.2.5 Clearances

The minimum vertical clearance from grade to the bottom of pipe, supports, insulation, flanges, valves or hand wheels shall conform to the following restrictions:

- Clearance over plant roads/main facility road/primary road/secondary road for vehicular movement for major mobile equipment- 6.5 m.
- Clearance for access by forklift truck- 2.7 m.
- Clearance for passageway for personnel (headroom) - 2.1 m.
- The minimum gap between a handrail and any obstacles shall be 100 mm minimum. This clearance shall be maintained for the full distance. Impingements shall be avoided.
- Clearance below pipes on sleepers- 0.6 m.
- Clearance below blinded/ plugged end of drain valves- 100 mm.
- CC and CP retrieval - As per KOC STD.

The minimum horizontal clearances in front of equipment, pipe, insulation, flanges, valves, instruments or hand wheels shall conform to the following:

- Clearance on platforms in front of manholes, valves- 0.8 m.
- Clearance on platforms in front of instruments - 0.8 m (or as required for element removal).
- Maintenance access around equipment - 0.9 m.
- Clearance from Building walls or solid structures & handrails where it is not a through route - 0.3 m.

The minimum widths of roads and access ways shall conform to the following:

- Main access ways within plant areas providing major crane access- 6 m.
- Width of secondary plant roads- 6 m.
- Width of aisle for forklift truck – 2.1 m.
- Width of staircase, passageways and elevated walkways- 1.2 m.
- Width of stairways on tanks - 0.75 m.
- Width of designated Escape way- 1.2 m.

10.3 3D MODELLING OF PIPING

All the equipment and piping shall be modelled using PDMS, PDS, SP3D, AVEVAE3D or equivalent software.

- Package and skid mounted 3D models provided by vendors shall be integrated with the piping 3D Model to model the entire plant.
- All the deliverables like piping general arrangements, support arrangement drawings and isometrics for all lines shall be extracted from the 3D Model.

- Contractor shall carry out 3D modelling reviews of the Facility along vendor's representatives at 30 % 60 % and 90% stages.
- Company reserves the right to review and provide the comments, if deemed necessary.

11 PIPING AROUND PROCESS EQUIPMENT

11.1 PIPING AROUND AIR-COOLED EXCHANGERS

- Piping shall not be arranged to cross above the air-cooled heat exchanger.
- The piping connected to the inlet and outlet connections of air cooled heat exchangers shall have a minimum number of bends, provided the piping is flexible enough and the reaction forces and moments imposed on the air cooled heat exchanger nozzles are within the allowable limits guaranteed by the manufacturers.

11.2 PIPING AROUND PUMPS

- Suction piping should be as short as possible
- When the line size reduces at a pump nozzle, the reducer shall be located as close to the pump nozzle as possible. No elbows shall be installed after the reducer. Reducers in horizontal suction lines shall be eccentric with the flat portion on top.
- Double suction pumps shall have 5 diameters of straight pipe immediately before the suction nozzle, irrespective of suction piping configuration. These diameters being equivalent to the nominal bore of the suction nozzle. This straight run should be free of any obstruction, with the exception of a top flat reducer positioned at the nozzle.
- Suction and discharge piping for reciprocating pumps shall be supported so that pulsating resonance is prevented throughout the entire system. Any pulsation dampener that is required shall be properly supported.
- Suction and discharge piping shall not be routed over the pump and motor to facility the removal for maintenance.
- The inlet piping to pumps needs to be arranged and supported such that the strainer can be removed for cleaning without disturbing the piping connection at the pump suction nozzle.

11.3 TANK PIPING

- The storage tank piping shall be sufficiently flexible to absorb the reaction forces and moments imposed by thermal expansion of the tank and piping, settlement of the tank foundation and bulging of the tank shell due to the pressure of the contained fluid.
- Level gauges, thermometers and other transmitters mounted on storage tanks shall be accessible from grade, roof, stairs or ladders, or the tank foundation.
- Piping connected to storage tanks with cathodic protection attached to the tank bottom plate shall be equipped with insulation flanges.
- Only piping associated with the tank shall be located inside the bund wall.
- External corrosion protection shall be applied to portions of piping passing through bund walls. A carrier sleeve is required where pipes pass through concrete bund walls.
- The annular space between the carrier sleeve and pipe shall be completely sealed at each end by a rubber end seal.

11.4 UTILITY HOSE STATIONS

- Utility stations with plant air, service water and nitrogen shall be provided at grade or on elevated platforms so that all equipment items can be covered using a 15 m length hose.

11.5 PIPING AROUND VESSEL AND COLUMNS

- Piping around vessels and columns shall be located radially around towards the Pipe rack side; man ways and platforms shall be located on the access side.
- The connection of flare header to KOD shall be with two symmetrical inlet and one outlet. All the inlet and outlet nozzles shall be top of KOD. KOD shall be located aboveground.
- The Access shall be provided to all flanged nozzles for temporary blinding during maintenance, and the piping shall be supported so that a blind may be readily installed.
- Maximum continuous ladder run shall be 6 m. Where the height exceeds 6 m, rest landings shall be provided.
- Starting at 2.5 m from the base of the ladder, all ladders shall be provided with safety cages. The safety cages shall extend 1 meter above the top of the ladder.
- Platforms shall be positioned so that the manhole centerline is not less than 0.6 meter above the platform. The bottom of the manhole entry shall not be more than 1 meter above the platform.

11.6 UTILITY PIPING

Water Piping

- Potable water piping shall be laid above ground. However Potable water piping to remote area such as to workshop buildings etc. may be buried. Safety showers shall have a chilling arrangement suitable to maintain the temperature of potable water to 25-28 deg C at all times.

Air and Nitrogen Piping

- Branch line of plant air, instrument air and nitrogen shall be taken from top of the run pipe.
- Additional tapping points with valves shall be provided for future requirement or plant maintenance activities. This should be apart from the utility stations.

11.7 PIPING FOR SAFETY AND RELIEF VALVES

- KOC standard KOC-MP-027 Part-1 & 2 can be referred for PSV design. The pressure loss through the safety valve inlet piping shall not exceed 3% of the set pressure according to API RP 520 based on orifice size, regardless of the types of valve. Connecting piping shall be of minimum length, with a minimum number of bends and, if necessary, the pipe size shall be increased to compensate for excessive pressure loss.
- Sufficient supports shall be provided adjacent to all safety valves to prevent excessive local stress in the piping, and vibration of the valves, due to impact and thrust forces during fluid discharge.
- Safety valves shall be located higher than the flare header, and the discharge piping connected to the flare header without any pockets.
- Relief lines shall enter flare or blowdown headers at an angle of 45 degrees in the direction of flow of the header. In all cases, discharge piping shall enter in the top or side of the header.

- Reinforcing pad shall be provided for all 45 degree branch connections of flare / blowdown header. The pad shall be of the same material & thickness as that of flare header with pad width equal to half the diameter of branch pipe as a minimum.

11.8 PIPING FOR INSTRUMENTS

Piping for Flow Meters

- Orifices or venturi tubes shall normally be installed in horizontal pipe runs. If this is impractical, they can be installed in vertical pipe runs in an upward flow.
- The minimum straight pipe run required either side of the orifice plate shall comply with Standards.

Piping For Pressure Instruments and Temperature Gauges

- Wherever possible the pressure tapping shall be located either horizontally or on top of the pipe.
- Height of tapping points for pressure gauges, pressure transmitters etc. shall be kept at a minimum especially on lines which are susceptible to vibration
- Piping scope terminates at the provision of isolation valve for all instruments except for temperature elements like RTD where the scope ends at flange welded to the main line.
- For line class of 600 lb and higher two isolation valves will be provided.
- Minimum flange size and rating for instruments shall be 1 ½" NPS and 300 lb respectively.

Piping For Instruments with Temperature Elements

- Flange standoff height shall be suitable to ensure adequate insertion length of thermowell.
- Sufficient space shall be provided for thermowell insertion and removal.

Piping for Control Valves

- The piping around control valves shall be sufficient to lift and remove the valve.
- Control valves shall be installed in horizontal lines with vertical actuators with sufficient clearance above the actuator and the bottom flange to allow the control valve to be dismantled without removing the valve body from the pipe.
- Sufficient space shall be provided around the control valve to permit access for operation and maintenance.
- Upstream & Downstream straight pipe run requirements shall be provided for the flow instruments as per the vendor recommendation

11.9 VENTS AND DRAINS

- Vent and drains shall be provided as shown on P&ID's for operation and maintenance purpose. Hydro Test drain and vents shall be provided at all high points and low points of piping. Post hydrotest these valves shall be removed and blinded unless they are required for operation and maintenance purpose. Vents and drains shall be as short as possible.
- Sizes of drains and vents shall be as below:

Vent and Drain Sizes

PIPE SIZE	VENT SIZE (NPS)	DRAIN SIZE (NPS)
Pipe sizes up to 8" NPS	¾ "	¾ "
Pipe sizes between 8" to 14"	¾ "	1"
Pipe sizes above 16"	¾ "	1 ½"

- Drains shall be located so that there is sufficient free space underneath to install temporary facilities to discharge the drained liquid.

11.10 THREADED PIPING

- Where threaded piping is used, break flanges and /or unions shall be adequately provided for maintenance purpose. Galvanizing (where specified) to be carried out after threading of the pipe.

11.11 VENDOR SUPPLIED SKID PIPING

- Pipe routing, supporting, testing & inspection of piping inside skid area shall be under vendor scope.
- Piping shall be sufficiently flexible to absorb the reaction forces and moments imposed by thermal expansion of the piping inside the skid.
- Sufficient supports shall be provided to prevent excessive local stress in the piping, and vibration of the valves.

11.12 INTERCONNECTING PIPING

Design of piping also includes the following tie-ins from / to the Facility to well flow lines & pipelines laid under other projects by the Company:

- Well flow lines/trunklines from Mutriba to the inlet inlet manifold.
- Fuel gas inlet line to the Facility.
- Brackish water inlet lines from Source Wells.
- Sour fluid transfer pipeline from the Facility.
- Drain line from Trunk lines to the Facility Closed Drain system
- Drain line from transfer area to the Facility Closed Drain system
- Blow down line from Fuel Gas pig launcher receiver area to the Flare system

12 VALVES

12.1 GENERAL

- All valves shall comply to relevant KOC standards KOC-MP-013, KOC-MP-014, KOC-MP-015, KOC-MP-016, KOC-MP-033 Part-1 as specified under Reference Codes, Standards and specifications. The Contractor shall supply all new valves as shown in the P&ID. The valve pressure ratings / valve identification shall be as indicated in the P&ID. As a minimum, all new valves shall follow the material specifications as per Company Piping Material Standard KOC-MP-010 and its Addendum. Valve datasheets for Ball, Gate, Globe, Check, Plug, PRV,

Control Valve, MOV's, SDV, ESDV, EDBV etc shall be submitted for company's information.

- For materials of valves, refer clause 15.2.
- Valve seat rings shall be removable type for future maintenance to do weld overlay / hard facing.
- Unless otherwise specified, all Butterfly valves with soft seating shall be of fire safe design and certified as per API 607.
- Valves in horizontal pipes shall be positioned with their stem on or above the horizontal, except as follows:
    a) Butterfly valves shall be positioned with the stem horizontal in services where fouling substances could collect in the lower shaft bearing;
    b) Gate valves should be positioned with the stem horizontal in services where fouling substances could collect in the bottom cavity;
    c) Valves shall be positioned with the stem horizontal in systems where a component failure (e.g. wedge pin) could cause closure of the valve and lead to unsafe situations (e.g. flare systems).
- Double block and Bleed isolation shall be provided for the following
    a) All Equipment / Piping handling toxic fluids (≥500ppm (vol) for H2S for toxic vapour and ≥ 500 ppm (wt.) for toxic liquid)
    b) High pressure (600# and above)
    c) High temperature (>250 C)
    d) Facility battery limits

12.2 ERGONOMIC ASPECT OF VALVES

- The minimum distance between hand wheels and any obstruction shall be 75 mm.
- The location of valve hand wheels and/or stems shall not obstruct walkways or platforms.
- The preferred height to centerline of hand wheel for all valves shall be 1200 mm above grade or platform.
- Operating platforms shall be provided for valve hand wheels located above 1500 mm.
- Wrench movement of ball, plug or butterfly valves shall at no point be higher than 1600 mm.
- Valves should not be located in overhead pipe racks.

12.3 VALVE OPERATION

- Flow line interconnection valve to headers shall be MOVs with remote operation in order to reduce the manual intervention due to high H2S.

12.3.1 Gear Operated Valves

- In general, requirement of Gear operated valves shall be as shown in below mentioned table:

Gear Operated Valves

RATING	BALL VALVES	GATE VALVES	GLOBE VALVES	PLUG VALVE
150 #	6" and above	14" and above	12" and above	8" and above
300#	6" and above	12" and above	10" and above	8" and above

600#	6" and above	6" and above	6" and above	6" and above
900#	4" and above	4" and above	4" and above	6" and above
1500#	4" and above	4" and above	4" and above	4" and above
2500#	4" and above	4" and above	4" and above	4" and above

- All butterfly valves 8" and larger shall be provided with gear operators.

12.3.2 MOVS

- In general requirement of Motor operated valves shall be as shown in below mentioned table, however, if the project drawings are indicated with MOVs/ROVs, same shall be followed.

Motor Operated Valves

RATING	BALL VALVES
150#	20" and above
300#	16" and above
600#	14" and above
900#	12" and above
1500#	10" and above

12.4 VALVE TEST

- All Valves shall be subject to shell test, seat test, back-seat test and air seat test to KOC Std and API 598 / API 6D. There shall be no visible leakage under test pressure.
- In addition to pressure tests performed by manufacturer, the pressure tests of valves at site during construction stage after receipt of valves at site shall also performed to verify the degree of valve closure tightness and the structural adequacy. The testing of valves shall be performed only at company approved workshops in Kuwait. The extent of testing shall be as per following table:

VALVE TEST TABLE

<table>
<tr><th>Type</th><th>Body test and stem packing with water
Pressure: MWP x 1.5</th><th>Low pressure seat test with air
Pressure: 6 bar</th><th>High pressure seat test with water
Pressure: MWP x 1.1</th><th>Back-seat test with water
Pressure: MWP x 1.1</th></tr>
<tr><td>Control Valve globe/butterfly</td><td rowspan="7">5%</td><td>N/A</td><td>100%</td><td rowspan="3">N/A</td></tr>
<tr><td>Power operated ball ESDV,MOV,etc.</td><td>100%</td><td rowspan="5">5%</td></tr>
<tr><td>Manual Ball Valve</td><td rowspan="2">5%</td></tr>
<tr><td>Manual Gate Valve</td><td rowspan="3">5%</td></tr>
<tr><td>Manual Globe Valve</td><td rowspan="3">N/A</td></tr>
<tr><td>Manual Plug Valve</td><td rowspan="2">N/A</td></tr>
<tr><td>Manual Check Valve</td></tr>
<tr><td colspan="5">5% means per type/size/class/material/batch of the valves (min. one)
Valves to be installed at Tie-in points shall be 100% tested.
Valves of size 2" and below need not be tested. The percentage mentioned above is on valves above size 2".
The selection of the valves for testing shall be as per instruction of KOC.
High-pressure seat test is not required for floating ball valves.</td></tr>
</table>

- Acceptance criteria for valve test shall be as specified in valve specific standard applicable for specific valve / service. For each test failure, extent of sampling shall be increased by steps of at least 10% of the total valves number subject to spot checks upto 100%. In case test fails contractor is permitted to resubmit the same valve only once and only after it has been properly reworked and the reasons for failure thoroughly examined and explained by the contractor to the company. Should a given valve fails to pass a test second time, it shall be rejected and replaced by new one.
- Evidence of PSV testing & calibration shall be submitted to company for information prior to commissioning.

13 PIPING FLEXIBILITY

13.1 PIPING STRESS ANALYSIS

- Piping system shall be analyzed for expansion, contraction, differential settlement, relief valve reaction, and for effects due to weight, wind and other mechanical loadings if required.
- Forces and moments due to weight, thermal loads and other loads imposed on the equipment nozzle must not exceed the allowed loads for the equipment.
- The stress analysis of piping shall be carried out using Caesar II software (or any other Company approved Software) capable of performing stress calculations including pressure, dead weight, thermal expansion and occasional loads (wind, earthquake etc.). The analysis shall consider primary, Secondary and peak stresses of the piping system and the resulting stress levels shall be limited to the values specified in ASME B31.3. Contractor shall submit a summary report along with detailed computer printouts for company information.

  Forces and moments on equipment

- The allowable forces and moments on nozzle of equipment shall be as per manufacturer specifications.

  Critical line list

- Following lines shall be considered critical and shall mandatorily require formal analysis as a minimum. Other lines may also need analysis, if required.
  a) Lines with diameter from 4" and 6" with design temp. above 300°C
  b) Lines with diameter from 8" and 14" with design temp. above 150°C
  c) Lines of diameter 16" and above with design temp. above 80°C
  d) All lines connecting to strain sensitive equipment like high pressure reciprocating compressors, centrifugal pumps (hydrocarbon service), air-coolers etc.
  e) Dynamic analysis shall be carried out on critical lines where two phase or multiphase flow is expected.
  f) Lines (2" and above) requiring Tie in to the existing system.
  g) Lines related to blowdown system and flare.
  h) Buried lines (6" dia and above)
  i) Long run piping system with any straight portion longer than 200 m (anchor to anchor)
  j) Lines connecting to PSVs and bursting discs (2" dia and above).
  k) Lines connecting to storage tanks (3" dia and above)

- Special analysis methods shall be followed for lines involving pulsating flow such as those connected to reciprocating pumps and compressors.
- Stress analysis shall be carried out for buried firewater inlet lines and firewater ring mains and thrust blocks shall be designed and located at change in directions as necessary.
- Surge analysis shall be carried out for lines with ESDVs / HIPPS valves. Contractor shall ensure that surge pressure is below design pressure of piping. In case of conflict suitable reliving system shall be provided with prior approval from the company.

14 PIPING SUPPORTS

- Piping shall be supported, anchored or guided to prevent line deflection, vibration or expansion / contraction which could result in stresses in excess of those permitted by ASME B31.3 in the piping or connected equipment.
- Piping shall be adequately supported so that the total longitudinal stress caused by internal fluid pressure, the weight of fluid, thermal insulation, the weight of the piping and all components and attachments, etc. does not exceed the allowable stress.
- Design and spacing of pipe supports shall be such that the maximum pipe deflection between any two supports does not exceed 8 mm. In principle, vertical run piping shall be supported within a span of 1.5 times the span required for horizontal run piping.
- Special attention shall be given to locations with potentially high load concentrations, such as valves, strainers, in-line instruments, and equipment. The supports shall be suitable for these high loads and shall facilitate maintenance and exchange of the heavy valves/equipment.
- Supports shall be located as close as possible to changes in direction, but shall allow adequate flexibility to the line concerned.

- Piping around safety relief valve shall be supported to withstand the dead loads and the blow-off loads. Blow-off thrust design loads shall take into account the most severe case, such as possible flashing conditions and liquid entrainment in vapor flows.
- A sufficient number of permanent supports shall be provided at the following locations to prevent excessive forces and the deflection of piping when flanges are disconnected:
    a) The inlet and outlet of safety valves
    b) Spectacle blinds or blind plates and spacers
    c) Equipment nozzles
    d) Upstream and downstream of control valves
    e) Piping and components that must be disconnected or replaced during maintenance
    f) Small bore piping (less than 2" NB) may be supported from adjacent medium or large diameter piping provided that a large difference in thermal movement between the respective piping systems is not anticipated.
- Anchors or stoppers shall be provided at appropriate locations to:
    a) Restrict the thermal stresses and reaction forces and moments imposed on equipment nozzles.
    b) Restrict excessive axial movement of piping, in contact with adjacent piping or the shoes dislocating due to slug flow.
    c) Restrict the vibration of suction and discharge piping connected to reciprocating pumps and compressors, and piping handling fluids in a two-phase flow.
- Guides shall be installed at the following locations
    a) Both sides of the piping anchors.
    b) Both sides of expansion loops.
    c) Positions necessary to prevent skewing of linear piping on pipe racks, sleepers, or stanchions during construction and under operating conditions, including ambient temperature services.
    d) Points next to and on both sides of each expansion joint.
- Horizontal lines 2" and larger with heat insulation shall be run on 100 mm high pipe shoes.
- Appropriate types and sufficient numbers of pipe supports shall be arranged in effective positions around rotating equipment as follows:
    a) Pipe supports suspending piping loads: As close to the equipment nozzles as possible to minimize the transference of the weight to the nozzles.
    b) Pipe supports restricting thermal expansion and contraction forces, friction forces, and wind or seismic loads.
    c) Pipe supports with sliding pads, such as made of PTFE: Between the nozzle and restriction point, when the supports are bottom supporting types and the friction forces are significant.
- Spring supports shall be used where a relative displacement in vertical axis occurs between the piping and supports due to thermal expansion or contraction of the piping, settlement of equipment or pipe supports, or thermal movement of the equipment shell where a pipe support is installed.
- Gusseting shall be provided for small-bore branches of sizes less than 2" to prevent excessive stresses due to vibration / pulsation on high-pressure process lines associated with reciprocating compressors and pumps. Small-bore branch lengths shall be kept to a minimum during layout / routing.

- To reduce friction forces, sliding pads (e.g. PTFE) may be used on pipe racks, stanchions and sleepers for large and heavy piping.
- The range of structural shapes used for pipe supports shall be minimized. The smallest size of steel shape shall be selected wherever design permits.
- The materials of pipe supports which are directly welded to the pipe should be of the same material and wall thickness as of the supported pipe.

15 MATERIALS

Selection of the piping material including valves shall be in accordance with project specific Piping Material Specification which shall be developed by contractor in line with KOC-MP-010 and its Addendum. Any other use of alternate material will require the approval of the Company, provided the selected material meets all the design requirements as per applicable design codes and standards. This is applicable for the piping and valves inside the equipment skids / vendor packages also.

- All sour service piping materials shall comply with clause 8.0 of KOC-MP-010.
- The materials shall be intended to take care of H2S concentration & Chloride content levels.
- Hardness requirements for Carbon Steel forgings in sour service shall be 187 BHN. Hardness limit for Carbon Steel Castings shall be 235 HV10 or as required in applicable product specification or as applicable in NACEMR0175/ISO 15156 whichever is the lowest. The maximum hardness of parent plate material & weld joints shall not exceed 200 BHN.
- The inspection and testing requirements for seamless and welded sour service piping shall be as per KOC standard KOC-MP-002 Part 1. These requirements shall also apply to pipes that are used to make seamless and welded fittings for sour service.
- All duplex SS shall have PREN value > 40.
- Material certification of all pressure containing components shall be as per EN 10204-3.1 and that for structural components to 2.2
- The above requirements are also applicable for the piping and valves inside the equipment skids / Vendor packages.

15.1 PIPE

- Minimum pipe size of piping shall be 1/2".
- Pipe of 1-1/4", 2-1/2", 3-1/2", 4-1/2", 5", 7", 9" and 22" nominal pipe size shall not be used except for connections to equipment requiring these sizes. Such piping shall revert to a normal pipe size as soon as practical.
- Pipe shall be procured in double random length in general to avoid number of field joints at site.
- The required wall thickness of pipe and other components not having a specific pressure rating shall be determined using the piping design conditions and the formulas described in ASME B31.3.
- The wall thickness of nipples used for vents and drains shall be as per KOC-MP-010. The minimum wall thickness for 1 inch and smaller ferric nipples used for branch connection piping for vents and drains shall be extra strong (XS) for carbon steel and low / medium alloy steel piping material, and schedule 40S for austenitic stainless steel, super duplex stainless steel and nickel alloy piping material.
- The mill tolerances for pipe and pipe fittings shall comply with the values specified in the applicable material standards.

- Pipe Material in sour service shall conform to API 5 L PSL 2 in accordance with KOC Material Specification for Line Pipe for Sour Service KOC-MP-002 Part 1. ASTM A106 pipes may be used in plant piping, provided they meet all physical, chemical and NDT requirements specified in KOC-MP-002 Part 1, and on written approval of the Company.
- ERW pipes shall not be acceptable for use in sour service.

15.2 VALVES

- Unless otherwise specified, valve material shall be as per that specified in individual piping class of KOC-MP-010 and its addendum.
- Valve Trim materials (having direct exposure to sour fluids) shall be designed in accordance with KOC-MP-010 & NACE MR0175/ISO15156. However, the minimum metallurgy for the valve trim shall be as per pipe class specified on the Piping and Instrumentation Diagrams, details of which are available in KOC-MP-010 & its Addendum.
- Valve stem packing shall be of non-asbestos material that is fire safe and shall contain inhibitors to prevent valve stem pitting & shall comply to the following, as applicable:
  Bronze Valve: Packing shall be in accordance with the Manufacturer's standards.
  Carbon Steel & Stainless Steel Valves: Valve packing shall be non-asbestos material and fire safe. Packing shall be a five ring packing system consisting of three grafoil pre-compressed and die-formed packing rings with graphite fiber top and bottom stem wiper rings. The packing shall contain a corrosion inhibitor to prevent valve stem pitting.
- Bolts and nuts for stainless steel valves shall be of stainless steel material.
- Gasket materials for valves shall be as per manufacturer standards in so far as they shall be compatible with intended service.
- Strainer internal material such as strainer element, perforated, sheet fixing arrangement shall be similar to valve trim material of that service class.

15.3 WELDED FITTINGS

- Butt-welding fittings shall conform to ASME B 16.9.
- Butt-welding ends shall conform to ASME B 16.25.
- Long radius welding elbows: R = 1.5 D (D=nominal size) shall be used for all fabrication piping 2" and above, except where design requirements dictate the use of short radius elbows.
- Socket welding fittings shall conform to ASME B 16.11.
- Carbon Steel, Stainless Steel, SDSS and Inconel welded fittings shall be subjected to 100% radiography of welds.

15.4 FLANGES

- All flanges shall conform to B16.5 for size up to 24" NPS. Sizes above 24" NPS shall conform to B16.47 series A.
- Class 900 flanges and above shall be of ring joint type.
- If raised faced flanges are to be connected to the flat faced flanges, e.g. cast iron or bronze, the raised faced flange shall be modified to flat face.
- Flange insulation kits shall be provided to electrically isolate underground-buried lines, which are cathodically protected from above ground lines. This is to ensure efficient operation of CP system.

- Flange insulation kits shall be provided to electrically isolate mating flanges of dissimilar metals – Carbon steel – Stainless steel flanges, Carbon steel – Inconel 625 flanges etc. Isolation flanges shall be provided at all dissimilar metals locations and installed in line with requirements of KOC-L-015. Isolation Gasket kit shall have the properties as per KOC-L-012. Flange insulation kits shall be in accordance with pipeline/piping codes, KOC standard including KOC-MP-010, KOC-MP-031 part- 1&2, KOC-MP-001.
- The gasket contact surface on all raised face flanges shall have a machine finish in the range 3.2 to 6.4 micrometres (125 to 250 microinch) AARH (ASME B46.1), unless otherwise specified.

15.5 GASKET

- Unless otherwise specified, Gaskets shall be as per that specified in individual piping class. Gaskets shall comply with ASME B16.20 and B16.21 for non-metallic and metallic gaskets respectively.
- Any forms of asbestos materials in gaskets is prohibited.
- Ring joint (oval type) gaskets shall be utilized for all services above 600 lb rating.
- All gaskets shall match flanges to ASME B 16.5 for sizes up to and including 24” and flanges to ASME B16.47 Series A for sizes 26” and above, unless other specified.
- Full-face gaskets shall be used where flat face flanges are specified.

15.6 BOLTS AND NUTS

- Bolting shall conform to ASME B 18.2.1 or ASME B 18.2.2. All CS & low alloy steel Bolting shall be electro-zinc plated in accordance with ASTM B633.
- Bolt & Nuts shall be as per respective lines class of KOC-MP-010 and its Addendum.
- Jack screw shall be provided at blind or spacer locations
    - 150LB and 300LB flanges: 6 in and larger
    - 600LB,900LB and 1500LB flanges: 2 in and larger

15.7 PIPING SPECIAL ITEMS

- The list of Piping Special Items shall show all Piping Items outside the scope of the KOC-MP-010 “Piping Material Classes”. Items shall be described on “Piping Special Material Data Sheets” and receive a reference No. with the prefix “SP” which shall be identified on the P&ID’s”.

16 SAMPLING, CORROSION MONITORING & CHEMICAL INJECTION

- Supply and installation of all chemical injection points, hydrogen probe, corrosion & scale monitoring and sampling points including but not limited to access fittings, isolation valves, coupons, probes, data loggers and injection quills shall be in Contractor's scope.
- Minimum Requirements for design, material specifications, installation testing, & commissioning of internal corrosion monitoring equipment shall be as per KOC-MP-035. However distribution of the internal corrosion monitoring stations shall be based on internal corrosion & scale assessment studies, corrosion flow & prediction modeling which shall be carried out during detail engineering by contractor.
- Probes and coupons shall be installed and retrieved online without need of shutdown and depressurization of the system.

- For the internal corrosion monitoring stations installed on crude, gas and condensate piping inside the facilities, the monitoring points shall be at 6 o'clock position. Additionally, one internal corrosion monitoring point shall be installed at 12 o'clock on gas and condensate piping.
- Generic 2" online retrievable flare weld type fittings shall be used on bare carbon steel piping. Flanged retrievable type fittings shall be used on internally lined CS piping to avoid damage to the lining.
- The design and construction of Corrosion Monitoring Pits shall be as Standard Drawing 55-02-39.
- Internal corrosion monitoring stations shall be installed at the lowest elevation of the piping.
- Sampling points shall be as per Company's standard drawing 55-5-1 sheet 3.

17 FABRICATION AND ERECTION

- Shop fabrication is generally understood for lines 2" and larger. All "0-let", pipe stub and reinforcing pad branch connections, welded to the main pipe shall be shop fabricated / welded irrespective of size.
- Small-bore lines (1-1/2" and smaller) are normally field fabricated. If the option is taken to shop-fabricate these lines, then the fabricator for field adjustment shall provide extra lengths.
- For shipping purposes from remote or off-site facilities, shop-fabricated spool dimensions shall be limited to a maximum of 2440 mm (8 ft) wide by 2440 mm (8 ft) high and 12200 mm (40 ft) long.
- All pipe branches shall be as per the branch reinforcement tables provided at the end of each piping class in the Piping Material Specification KOC-MP-010 and its Addendum.
- All Relief lines shall enter flare or blowdown headers at an angle of 45 degrees in the direction of flow of the header. In all cases, discharge piping shall enter in the top or side of the header.
- Stub-in branch connections for flare lines shall be permitted. However all the branch connections on flare / blowdown header shall be provided with a Reinforcement Pad. They shall be welded to the parent pipe prior to hydro test. A 6 mm hole shall be provided on the reinforcement pad and after the welding, the joints shall be pneumatically tested at 100 KPa. The hole shall then sealed with grease.

18 WELDING

- Welding of piping shall conform to Standard Specification No. KOC-MW-001
- All piping fabrication / welding shall be in accordance with ASME B31.3 Welding Procedures and Welders and welding operator's qualification shall be as per ASME Sec. IX.
- In case of galvanised piping, pipe spools shall be galvanised after spool fabrication and welding.
- When socket-weld fittings or valves are used, the pipe face shall be spaced approximately 1.6 mm (1/16 in) clear from the root face of socket to avoid "bottoming," which could result in excessive weld stress.
- Piping class for each line specifies the type of pipe joint to be adopted. All pipe joints shall be as per applicable pipe class of KOC-MP-010.
- Threaded connections in cast or ductile iron, non-ferrous and galvanized materials, thermowells, instrument bodies, steam traps, or plugs or caps for process drain and process vent valves shall not be seal welded.

- Distance between welds shall not be less than 101.6 mm (4 in.) or 5 times the thickness of the thicker component whichever is more unless by end-to-end fitting dimensions of less than 101.6 mm (4 in.). Distance between two successive girth welds can be as close as 300 mm (12 in) or 1.5 times the pipe diameter, whichever is less.
- Attachment of non-pressure parts by welds such as hanger lugs, pipe shoes and brackets to be maintained at a distance of 2 x Pipe wall thickness or 40 mm whichever larger from the welded joints.
- Longitudinal seams in adjoining length of welded pipe is to be staggered and located to clear branch opening and external attachment.
- The longitudinal weld joint of pipe shall be preferably located at the top of spools. Adjacent longitudinal weld seams shall be staggered 30 deg. Or 100 mm circumferentially.
- Welding process for weld joints of 2" dia. and below shall be fully GTAW. Weld joints above 2" dia. shall be welded using GTAW process for root pass and hot pass and SMAW for subsequent passes.
- In all the cases where piping are to be internally lined with Epoxy paint, all root passes shall be done with GTAW process.

19 FIRE FIGHTING

- Contractor shall provide a comprehensive Firefighting system for the entire facility including but not limited to the following:

  a) Fire Water Ring Main with isolation valves, Fire Hydrants & Risers.

  b) Automatic & Manual Fire Suppression Equipment such as Deluge System, Foam System, and Sprinkler System as required.

  c) Fire Fighting Equipment Boxes.

  d) Trolley mounted Foam / Water Cannons, Mobile Water Monitors, Fixed Water / Foam Monitors as required.

  e) Portable/ Mobile Fire Extinguishers.

  f) Safety Shower, Eye Wash and Eye/Face Wash Units.

  g) Breathing Apparatus set including cylinder, face mask and connecting apparatus.

  h) First Aid Kit / Stretchers.

  i) Safety Signs & Notices in both Arabic & English.

- All the above Fire Fighting system requirements shall be designed, procured, installed, tested & commissioned as per the requirements specified in Company Standard KOC-L-009, (KOC Standard for Fire Protection Systems & Safety Equipment). The Fire Water Ring Main shall be laid underground and Fire Water piping including valves shall comply with Q35A piping class of KOC-MP-010. The Fire Water Ring main piping shall be internally lined with liquid epoxy as per KOC-P-005 and externally coated as per KOC-P-004 Part 8 & KOC-P-004 Part 7. Isolation Valves, Hydrants, Equipment Boxes, Risers etc. shall be provided as per the requirements specified in Company Standard KOC-L-009. Fire Hydrants shall not be spaced at a distance greater than 30 meters and Isolation Valves shall be provided at 100 meters spacing, all technical requirements shall be as per KOC-L-009. Fire hydrant valves shall be diaphragm type and firewater ring main isolation valves shall be of post indicator type installed in valve pit as shown in Appendix-6 of KOC-L-009.
- Deluge Systems shall be provided as per Mechanical design criteria / data sheet as per the

requirements specified in KOC-L-009. The Deluge Valve shall be UL Listed, system sizing & flow requirements shall be determined in accordance with hydraulic calculations as per NFPA 15. Sprinkler System shall be designed & installed in accordance with NFPA 13, KOC-L-009 & Fire Risk Assessment Studies. Water Mist System, if required as per risk assessment studies shall be provided as per NFPA 750.

All other Fire Fighting equipment as listed above and described in detail in KOC-L-009 shall be provided by the Contractor as per the requirements listed in the subject KOC Standard, Risk Assessment Studies & HSE Studies at no extra time & cost impact to the Company.

20 INSPECTION / EXAMINATION AND TESTING

- Non- destructive examination requirements shall be as per the relevant service / KOC piping class as mentioned in Appendix 1 of KOC-MP-010.
- All piping fabrication / welding including primary supports shall be in accordance with ASME B31.3 Welding Procedures and Welders and welding operator's qualification shall be as per ASME Sec. IX and KOC-MW-001. Welding Procedures and Welders and welding operators shall be qualified. The Contractor shall ensure that each welder shall identify positively his welds.
- NDT shall generally be carried out as per ASME Section V with acceptance criteria as per applicable code of construction.
- Radiography shall be carried out by Company approved Contractor. All radiographic inspection, material, equipment and personnel to carry out radiographic inspections shall be the Contractor's responsibility.
- Butt Welds greater than 50 mm wall thickness shall be subject to AUT (TOFD+PAUT) testing. Detailed procedure to be submitted for company review and approval.
- PWHT shall be performed for carbon steel pipes welds greater than ¾" thickness, in line with table 331.1.1 of ASME B31.3-2012. Moreover, new version of ASME B 31.3-2014 Table 331.1.3 requirements about exemption of PWHT for P1 materials with all group members for all thickness ranges is not acceptable.
- NDT shall be carried out after completion of PWHT.
- Hardness Survey for sour service piping shall be carried out. Extent of hardness survey shall be as per Appendix-1 Table-3 of KOC-MP-010.
- PMI testing for CRA material shall be carried out in accordance with KOC-Q-015.
- Primary support welding shall be subjected to DPI/MPI. Extent of testing shall be (5%).
- Baseline data collection shall be in accordance with Appendix-J of KOC-Q-014. Contractor shall submit "Baseline Data Preparation Procedure" well in advance of the start of the work for company approval. Contractor to provide inspection window for insulated piping to facilitate the access for baseline thickness measurement.

21 PRESSURE TESTING

- Test pressures shall be 1.5 times the design pressure (for hydrostatic test) and 1.1 times the design pressure (for Pneumatic test) of the system and shall not exceed a hoop stress equivalent to 90% of the Specified Minimum Yield Strength (SMYS), but not less than the minimum test pressure per ASME B31.3, except as specified otherwise. Testing shall be performed prior to installation of pressure relieving devices.

- Piping Hydrotest holding time shall be 2 hours.
- Internal coated piping shall be tested prior to painting and after site installation.
- Weld seams shall be kept unpainted during pressure testing.
- The following piping and equipment shall be excluded from the piping system pressure Test by isolating, blinding, or disconnecting:

a) Rotating machinery, such as pumps, turbines and compressors.
b) In-line items that cannot sustain the test pressure such as strainers, filters and/or the filtering element, orifice/restriction plates, expansion joints that cannot be secured against deformation during testing, and thermometers and thermal elements from thermo wells.
c) Pressure relieving devices, such as rupture disks and pressure relief valves.
d) Pressure sensitive instrumentation, such as gauges and transmitters, where the test pressure will exceed their scale range.
e) Piping which is normally open to the atmosphere, such as atmospheric discharge piping from pressure relieving devices, and drains and vents after their isolating valves.
f) Piping on the downstream side of instrument and sampling system block valves.
g) Equipment that cannot be drained.

- The Contractor shall prepare a 'Pressure test package' comprising the following:

a) P&ID with test limits clearly marked
b) Isometric drawings with weld mark up.
c) Weld summary with NDE details etc.
d) Line List
e) Water Analysis Report
f) Pressure gauge &PSV calibration reports.
g) Punch List.
h) Release for Hydro test form.
i) Reinstatement Check List

- The new piping shall be hydro-tested with inhibited brackish water, which shall be supplied by the Contractor. Transporting, filling the pipeline and dewatering after hydro testing shall be the responsibility of the Contractor. The brackish water shall be dosed by corrosion inhibitor/oxygen scavenger/biocide mixture supplied the Contractor supplied and approved by Company so that the water filling the line shall uniformly contain the chemical manufacturer's recommended concentrations by hydro testing. The piping system shall be free of any debris before the commencement of the hydro-test. Tanks, piping, all Labor, materials, dosing / testing pumps of sufficient pressure and capacity, valves, fittings and all other tools and equipment necessary for the hydrostatic testing shall be provided by the Contractor. After the hydro test, the pipe work shall be dewatered and inhibited prior to commissioning. The chemical dosing of brackish test water shall follow the requirements of KOC Standard KOC-G-011. The Contractor shall also provide temporary drainage pipe for the test water after the hydro-testing. The draining of the test water shall be carried out to a location specified by the Superintendent's Representative or to a temporary lined HDPE drain pit which shall be done by the Contractor as per the instructions of Company.

- When the pressure tests are completed and accepted by company and the system has been drained, all temporary spool pieces, blanks and test blinds shall be removed. All control valves, instrumentation, orifice plates, restriction orifices, expansion joints, strainers, filter elements, and other components removed for the test shall be reinstated in accordance with their relevant specification. Flanged connections which were adjacent to temporary spool pieces shall be reinstated with new gaskets. New bolts and nuts shall be provided if test bolting is not of correct grade for the line service. Temporary test valves, valves at low point test drains and high point test vents shall be removed and blinded. Temporary supports shall be removed.

22 DRAINING DRYING & PURGING

- The Contractor shall ensure that immediately after a satisfactory completion of the pressure test the piping systems are properly dewatered and drained. All vent valves are to be opened and high point vent plugs removed before draining of the test fluid is started to ensure against damage by vacuum to any apparatus or piping. For buried lines where draining may not be possible, the hydro test water shall be driven out using oil free compressed air through a drain located on an outlet riser.
- All lines after draining shall be dried by blowing with oil free compressed air until the openings are clear of moisture.

23 EXTERNAL AND INTERNAL COATING / PAINTING

- All above ground piping shall be externally painted in accordance with KOC-P-001 (KOC standard for painting and coating of external metal surfaces) with appropriate color code & service / line / flow direction identification in accordance with KOC-P-017. Selection of external coating system as per KOC-P-001, shall be based on maximum operating temperature. Final color shade of all external uninsulated aboveground CS equipments and piping's shall be Aluminium –Leafing Grade-(RAL-9006). Final color shade of all aboveground CS fire water piping shall be signal red (RAL 3001).
- Coating Selection and application for internal portion of underground CS piping shall be as per KOC-MP-10 and KOC-P-005.
- Buried fire water rings shall be internally lined with liquid epoxy in accordance with KOC-P-005.
- Underground piping within the facility shall be externally coated either with High Build Epoxy as per KOC Standard KOC-P-004 Part-8 or with High Build Polyurethane as per KOC Standard KOC-P-004 Part-9.
- All buried field girth weld joint and buried flanges shall be externally coated as per KOC-P-004 Part 7 and all buried flanges shall be externally wrapped as per KOC-P-004 Part 7.
- Sleeve (Casing) Pipes for all Metallic carrier pipes shall be bare (both external and internal) as per KOC Standard KOC-L-015 (KOC Standard for External Cathodic Protection of underground steel pipelines and piping networks). However the vent pipes which is connected to the sleeve (casing) pipes shall be externally coated either with High Build Polyurethane as per KOC standard KOC-P-004, Part 9 or with High Build Epoxy as per KOC standard KOC-P-004 Part 8. Sleeve (casing) pipes (including welded vent pipes) for all Non-Metallic carrier pipes shall be externally coated either with High Build Polyurethane as per KOC standard

KOC-P-004, Part 9 or with High Build Epoxy as per KOC standard KOC-P-004 Part 8. The aboveground portion of vent pipe shall be externally coated as per KOC-P-001 and final color shade shall be Leafy Aluminium (RAL 9006).

- Application of FBE coating shall be carried out only by KOC approved FBE applicator.
- All Personals (applicators, blasters, foreman, supervisor and Inspectors) involved in the coating job within Kuwait shall be qualified as per KOC-P-006.
- All painting materials shall be selected from KOC approved Vendor list.
- Pickling and passivation shall be carried out for welds of stainless steel and super duplex piping.

24 PIPING AND EQUIPMENT INSULATION

- The insulation for all the piping based on the requirements like personnel protection, thermal insulation will be indicated on the respective P&IDs and shall comply with KOC standard KOC-G-006.
- Extent of insulation shall be as per P&ID, Line list, General Arrangement drawing, isometrics and Vessel & equipment data sheets.
- This consists of insulation for heat conservation, process stabilization, temperature maintenance, and insulation for steam-traced lines, insulation for electrical traced lines, and insulation for fire protection for operating temperatures above ambient temperature for all sizes of lines.
- Wherever insulation for personnel protection (PP) is mentioned, the same shall be provided judiciously as per insulation specifications.
- All insulation work shall commence only after successful completion of hydro testing of piping and equipment including steam-tracing systems.
- Surfaces to be insulated shall be thoroughly cleaned, dried and made free from loose scale, oil or grease. Painting under insulation shall be applied to carbon steel, low alloy steel.
- To ensure perfect waterproofing, all cladding joints shall be packed with sealing materials, which may either be in the form of an elastomeric sealing compound or fiber based bituminous felt strips.
- The following items under hot insulation shall not be insulated unless otherwise specifically asked:
    a) Pumps with operating temperature below 200C.
    b) Fans, compressors, blowers, or other rotating or reciprocating equipment.
    c) Internally insulated or refractory lined equipment.
    d) Turbine seal caps, shaft-bearing housing, throttle valves, governors and supports.
    e) Exchanger channel and covers, shell and channel flanges and expansion joints.
    f) Nozzles, manholes and handholds, and flanges of equipment.
    g) Surfaces of coolers and condensers.
    h) Thermowell bases and pressure tapping.

25 ANNEXURES

ANNEXURE 1	ADDENDUM TO KOC STD FOR PIPING MATERIAL CLASSES KOC-MP-010