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-18 to Technical Specification (Civil, Structural & Architectural Work)

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

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18.1 INTRODUCTION

18.1.1 This part of the technical specification outlines the minimum scope of Civil, Structural, Architectural and associated miscellaneous works to be carried out by the Contractor for Mutriba Remote Boosting Facility (MRBF) and an overview of materials and workmanship required to execute these works as per Company/National/International Standards and Procedures (latest editions at the time of bid submission).

18.1.2 Mutriba Remote Boosting Facility (MRBF) is an Onshore Surface boosting station / facility. The main function of the facility to boost the pressure of hydrocarbon from the Wells and route it to existing facilities for further assessment and processing. The MRBF mainly consists of Inlet header, Sour fluid heating section, Sour fluid transfer and metering section, Utility & Supporting systems, Facility infrastructures like buildings and roads, facility integration with existing Company systems.

18.1.3 This Technical Specification shall be read in conjunction with KOC Standards, KOC Recommended Practices, National/International Standards/code of practices, other Technical Specifications described under this Contract, Company supplied Project reference Drawings and Standard Drawings.

18.1.4 The design, detailed engineering, manufacture, procurement, supply, fabrication, construction, installation, inspection and quality tests for all Civil, Structural and Architectural works shall be carried out in strict compliance with KOC Standards, KOC Recommended Practices, National/International Standards/Code of Practices.

18.1.5 The Project site is located in North-West Kuwait. The environmental conditions in Kuwait are severe and due regard shall be given to the consistently high levels of solar radiation experienced in Kuwait, which may develop surface temperatures up to 85°C (185°F) in exposed metals. The Site is generally in desert terrain and the atmosphere is highly dusty and corrosive (with traces of H2S presence). The Environmental Data is included in Company Standard KOC-G-007 that provides the detailed design information to be considered regarding the environmental, site and utility supply conditions prevailing throughout the facilities.

18.1.6 All dimensions, units of measurement and physical constants shall be in Metric units, unless otherwise specified. All coordinates and elevations shall be in Meters.

18.1.7 The entire scope of the project shall be the sole responsibility of the Contractor unless otherwise specified.

18.2 SCOPE OF WORK

The Contractor's scope shall consist of design, detailed engineering, construction and quality testing (site and laboratory), performance testing of complete Civil, Structural and Architectural work required for the satisfactory completion of the project including supply of materials, fabrication, manpower, tools, equipment and temporary facilities.

The Civil, Structural and Architectural work shall comprise of but not limited to the following;

18.2.1 Site investigation works including Topographical survey, exploratory slit trenching and Geo technical investigation.

18.2.2 Site preparation, earthwork such as cutting, filling, area grading, excavation in any type of soil and terrain, backfilling, compaction, leveling, shoring, hauling, disposal of surface water, dewatering, disposal of contaminated soil, demolition and carting away the existing facilities as per the requirement, relocation/re-routing and/or protection of existing underground and aboveground services/facilities.

18.2.3 Design, detailed engineering for all Civil, Structural and Architectural works and submission of design calculations, drawings (Design, shop/fabrication/construction, As-built drawings) and specifications pertaining to the complete project scope of works.

18.2.4 Design, supply and construct reinforced cement concrete (RCC) foundations and necessary structural supports for not limited to the following equipment/packages;

a) Inlet & Test System/Inlet Manifold
b) Multiphase flow meter Package
c) HIPPS Package
d) Pre-Heater Package
e) Multiphase Pump Package
f) Separator Package
g) Chemical Injection Packages
h) Fuel Gas Conditioning & Distribution System
i) HP Flare System & Network
j) LP Flare System & Network
k) Diesel Storage & Transfer System
l) Emergency Diesel Generator System / Black Start Diesel Generator
m) Power Generation and distribution System
n) Closed Drain System
o) Open Drain System
p) HOT Oil package system - Storage, transfer, heating and distribution System
q) Plant Air, Instrument Air and distribution systems
r) Nitrogen System and distribution systems
s) Firefighting System
t) Cathodic Protection System
u) Common Instrumentation Systems
v) Common Electrical Systems
w) Eye Wash & Safety showers
x) Drainage & Sewage System
y) Potable Water Storage Tank
z) Packaged equipment/equipment skids

18.2.5 Design, supply, fabricate and construct/install not limited to the following buildings;

a) Two Storey blast resistant Modular Control Building
b) Modular Sub-Station

c) Modular Laboratory Building
d) Fire Suppression Cylinder storage building
e) Labor/Field Operator Rest Room/Buildings
f) Workshop/Warehouse Building
g) Chemical Storage Building
h) Guard House/Security post Building

18.2.6 Design, supply and construct/install the following items/facilities;

a) Valve pits
b) Corrosion monitoring pit/Inspection pits
c) Drain Vessel Pits
d) Sump Pits
e) Manholes
f) Hand holes
g) Duct banks
h) Crash barriers
i) Concrete pipe sleepers
j) Bund Walls
k) Culverts

18.2.7 Design, supply and construct/install foundations for the following;

a) Steel Stacks
b) Junction boxes
c) Field instruments
d) Analyzers
e) Emergency Showers
f) Eye Wash Stations
g) Mechanical/Electrical/Instrumentation equipment
h) Panels/Cabinets
i) Fire Hydrants
j) Fire extinguishers & Equipment boxes
k) CO_2 Cabinets

18.2.8 Design, supply and construct RCC pits for Open & Closed drain vessels as per concerned discipline requirements.

18.2.9 Excavation, backfilling and compaction for cable trenches and pipe trenches.

18.2.10 Supply, fabricate/pre-cast and install cable markers/pipe markers.

18.2.11 Design, supply and construct Tie-in related supports/foundations/valve pits outside the Facility.

18.2.12 Design, supply and construct 6.0 meter wide asphalt road inside and outside the facility. Preliminary layout of asphalt road is indicated on reference drawing No. MRBF-SK-M-1001. Area near Guardhouse shall be provided with raised kerbs stones.

18.2.13 Design, supply and construct 7.0 meter wide Gatch road around the perimeter fence and around Toxic Gas prone area fence.

18.2.14 Design, supply and construct asphalt paving for car parking areas. Minimum 20 car parking shelter shall be constructed.

18.2.15 Temporary road works required during detour without disrupting the existing and new traffic, which is expected due to ongoing constructions.

18.2.16 Design, supply and construct 1000mm wide and 125mm thick RCC/60mm thick interlock brick with kerbstone walkways for pedestrian access to buildings, structural shelters, emergency showers and eye wash stations, other equipment, panels, drain/valve pits, pedestrian gates and other areas within the facility.

18.2.17 Design, supply and construct Local storm water drainage systems including swale.

18.2.18 Design, supply and construct/install foundations for all the necessary equipment which are required for the effective completion of the project

18.2.19 Design, supply and construct/install structural steel shelters for the following and for other equipment as required during the detailed engineering;

a) Multiphase Pumps/Pumps
b) Gas Turbines
c) Diesel Engine Packages
d) Chemical Injection packages
e) Analyzers
f) Car parking
g) Nitrogen generation Units
h) Transformers
i) Workshop

18.2.20 Design, supply and construct structural support structures and sun-shade with RCC foundations for instruments, panels and gauges.

18.2.21 Design, supply and construct structural support structures with RCC foundations for Manual Call Points, Fire & Gas Detectors, Beacon, Hooter and Evacuator sounders.

18.2.22 Design, supply and construct structural supports for pipes, valves, instruments, pipe racks including foundations.

18.2.23 Design, supply and construct RCC foundations with fence enclosure along with access gates for the cathodic protection rectifier.

18.2.24 Design, supply, fabricate and install Low Security chain link fence for sterile area of the flare with access gates (Drive gate and Emergency Pedestrian gate) as per Company Standard KOC-G-019 Part-2 and as per Company Standard Drawing Nos. 55-02-17 and 55-02-20.

18.2.25 Design, supply, fabricate and install Low Security chain link fence for Toxic Gas Prone area outside the facility security fence with access gates (Rig Gate, Drive gate and Emergency Pedestrian gate) as per Company Standard KOC-G-019 Part-2 and as per Company Standard Drawing Nos. 55-02-17 and 55-02-20. Fence for Toxic Gas Prone area shall be provided based on relevant HSE Studies.

18.2.26 Design, supply, fabricate and install Medium Security chain link fence for the facility with access/emergency gates as per Company Standard KOC-G-019 Part-2 and as per Company Standard Drawing Nos. 55-02-115.

18.2.27 Gates for the Medium security fence shall be as per Company Standard Drawing No. 55-02-35 and 55-02-102.

18.2.28 Fence shall be installed with warning sign boards as per the requirements.

18.2.29 Design, supply, fabricate and install the following structural items with foundations;

a) Cross-overs
b) Access Platforms
c) Ladders
d) Stairways
e) Handrails
f) Pipe Rack/Pipe supports
g) Cable Tray/Ladder Rack supports
h) Instrument Stand/supports
i) Shelter/Sunshade/Canopy
j) Light poles
k) CCTV Support Structure
l) Wind Sock support
m) Mast
n) Shelter for Car parking

18.2.30 Design, Supply, fabricate and install sign boards with mounting arrangement and concrete foundations for warning, guide, safety, traffic and hazard signs.

18.2.31 Load bearing members of steel structures and pipe racks shall be fireproofed for minimum 2 hours fire rating as per FERA outcomes.

18.2.32 Equipment Saddles shall be fire proofed as per FERA recommendations.

18.2.33 Any other specific requirements as per FERA recommendations shall be incorporated as part of the Project scope of works.

18.2.34 Storage Tanks containing Hydrocarbon/chemicals shall be provided with liquid retaining structure to contain any spillage.

18.2.35 Necessary Civil works for Cathodic Protection related works.

18.2.36 All Civil, Structural and Architectural work not listed above but as required for the effective completion of the project.

18.3 SPECIFIC REQUIREMENTS

18.3.1 The finished grade level (FGL) of entire facility (within the fenced area and 30 meters around the fence) shall be made uniform by the Contractor prior to the commencement of other construction activities. To establish the same FGL, site clearance, stripping, excavation/cutting, importing suitable soil, backfilling with suitable soil, compaction and disposal of unsuitable/surplus soil shall be carried out in accordance with KOC-C-005.

18.3.2 The entire area indicated on the reference Plot Plan shall be developed and fenced by the Contractor with required type of fence.

18.3.3 Toxic Gas prone area fence shall be provided as indicated on the reference Plot Plan drawing No.: MRBF-SK-M-1001 as minimum requirement. The fence area shall be further increased based on relevant HSE studies recommendations.

18.3.3.1 The minimum overhead vertical clearances for pipe supports/first tier of multilevel pipe rack shall be 4.0 m except for road crossings.

18.3.4 Fire Suppression Cylinder storage Building shall be constructed in accordance with Company Standard KOC-L-024. Storage Cylinder shall be located inside building, but not inside the building which it is intended to protect. Clean agent storage cylinders shall be located so that it is not exposed to heat, weather, mechanical damage, exposure to chemicals or harsh weather conditions. Proper ventilation shall be ensured for normal and accidental release of clean agent from the storage cylinders by natural or mechanical means. Ventilation shall comply with ASHRAE 62.1. Such requirements should be reviewed by use of minimum two exhaust fans in gas cylinder room for ventilation (normal and emergency) or as approved by the KOC. The emergency exhaust fan should be started automatically in case of oxygen deficiency alarm (triggered from oxygen deficiency detectors) in the room due to accidental release of storage cylinders.

18.3.5 Fire suppression system shall be provided for Substation and Turbines as minimum. Any other requirement shall be based on relevant HSE Study recommendations.

18.3.6 Dedicated asphalt road and parking bay shall be constructed for Fire Trucks. Preliminary layout for asphalt road and parking bay are indicated on reference drawing No. MRBF-SK-M-1001.

18.3.7 Concrete paving of minimum thickness 125mm shall be provided on the footprint of Air cooler areas.

18.4 DESIGN AND ENGINEERING

18.4.1 **General**

18.4.1.1 The detailed engineering work shall conform to the technical specifications and to relevant Company, National and International codes, Standards, Standard drawings and any others reference drawings, documents, details or schedules specified or provided by the company during the execution of the Contract. In the event of any conflict between any applicable Codes/Standards and Company specifications, the conflict shall be brought to the notice of the Company and the decision of the Superintendent shall be final and binding.

18.4.1.2 An engineering design basis shall be developed by the Contractor for the project, in order to establish the practical guidelines for describing various design aspects with a view to achieve safe, reasonably economical construction and reliable service life. The design basis developed by the Contractor shall be in line with Company Standards KOC-C-001 and KOC-C-002.

18.4.1.3 Compliance with Specifications, Codes and Standards shall not relieve the Contractor of their responsibility to design and produce the required work suited to meet the specified service conditions and applicable regulations.

18.4.1.4 The design shall conform to the necessary HSSEMS procedures to protect personnel and surrounding environment within the Company facilities for any Civil, Structural and Architectural works.

18.4.1.5 The design of any structure shall be made on the basis of the recommended soil parameters and allowable bearing pressures from the final Geo-technical report of the site.

18.4.1.6 All correspondences, instructions, drawings, data sheets, design calculations or any other information shall be in English language.

18.4.2 **Design Software and Standards**

18.4.2.1 The following Codes, Standards and tools shall apply in Analysis and Design of Steel, Concrete Structures and Civil works;

a) Design Requirements shall be in accordance with Company Standards KOC-C-001, KOC-C-002 and ASCE 7-16.

b) The Steel Structure design shall be in accordance with Company Standards KOC-C-002 & KOC-C-007, AISC Steel Construction manual (16th Edition) and Allowable stress design method (ASD).

c) The concrete Structure design shall be in accordance with Company Standards KOC-C-002, KOC-C-006 and Requirements for Structural Concrete and commentary (ACI 318/318M).

d) The technical requirements for design, materials and workmanship related to the construction of Roadways, Paving and Hard Standing shall be as per Company Standard KOC-C-024 Part 1 and Part 2.

e) The design calculations shall be submitted in the approved and widely used softwares. In general the design software used shall be internationally recognized and well proven.

Typical examples are STAAD Pro, RISA, Prokon, Mat3D, Foundation 3D, Inroad and Microdrainage. The Contractor shall furnish the list of proposed design softwares to be used during project execution for Company's information.

18.4.3 **Design Loads**

The engineering design basis of any Civil, Structural and Architectural work shall be established to consider all possible types of appropriate loads and combinations thereof that will act on the structure(s) within its service life. All categories of applicable design loads, such as static loads (dead & live), wind loads, seismic loads, dynamic loads (impact & machine induced), pipeway loads (on elevated pipe racks and or on grade pipe-ways sleepers), friction loads, Bundle Pull-out Loads (For Heat Exchangers), Thermal loads, earth pressures, load due to differential settlements, vehicular loads, fire loads including any unusual loads and blast load shall be accounted as specified in Company Standard KOC-C-001 and KOC-C-030.

18.4.4 **Load Combinations**

Loads and load factors shall be combined in accordance with ASCE 7-2016. The design of all the structures or part of structures shall consider the worst effects on structures generated out of several load combinations under different conditions such as erection, test and operating condition(s) in compliance with Company and International Standards.

18.4.5 **Stability ratios against overturning, sliding & uplifting**

The minimum stability against overturning, sliding and uplift shall be followed as per Company Standard KOC-C-001.

18.4.6 **Contact pressure under base plates**

The maximum concrete stress beneath base plates shall be limited to 8 N/mm² for sand / cement grout and 12 N / mm² for proprietary high strength grout.

18.4.7 **Vibration Limits**

The vibration limits due to dynamic loads of reciprocating and rotary machines shall be in compliance with the Manufacturer's recommendations. In the absence of Manufacturer's recommendations, to avoid resonance condition with the operating frequency of the vibrating machine especially compressors, the design shall conform to the recommended values limiting natural frequency and amplitudes of the foundation system including soil as specified in Company Standard KOC-C-001.

18.4.8 **Noise Limits**

Noise levels from all sources (external and internal) should not exceed the recommended values in plants and buildings as provided in the Company Standard KOC-C-001.

18.4.9 **Fire Rating**

Facility and service buildings shall be designed / constructed with the materials having fire ratings (minimum) as given in the Company Standard KOC-C-001.

18.4.10 STEEL STRUCTURES

18.4.10.1 Design conditions and Slenderness ratio limit

The design conditions and Slenderness ratio limits for steel structural members shall be followed as per the Company Standard KOC-C-002.

18.4.10.2 Deflection and Sway limit – Serviceability criteria

Deflection and sway limits for steel structural members shall be as per Company Standard KOC-C-001.

18.4.10.3 Steel pipe racks, pipe supports and shelters design – Strength criteria

Steel members shall be designed in accordance with Company Standards KOC-C-002, KOC-C-007, AISC Steel Construction Manual (16^{th} Edition) and Allowable stress design method (ASD).

18.4.10.4 Structural Steel Connections

Generally, structural steelwork shall be fabricated in the shop. All shop connections shall be by welding. However, bolting may be used if shown specifically on the design/shop drawings. All field connections shall normally be bolted at site during erection.

18.4.10.5 Corrosion Limits

The allowable corrosion rate of steel due to atmospheric (marine / industrial) conditions and fluctuation of water shall be limited as specified in the Company Standard KOC-C-001.

18.4.11 CONCRETE STRUCTURES

18.4.11.1 Deflection and Sway limit – Serviceability criteria

Deflection and Sway limits for concrete members shall be as per ACI 318M.

18.4.11.2 Concrete member design– Strength criteria

Concrete member's strength design shall be as per ACI 318M.

18.4.11.3 Bearing pressure and Settlement limit

The bearing pressure below foundations and settlements shall be limited as per Company Standard KOC-C-002 and approved Geotechnical report. However, the permissible range of settlements for storage tank foundations shall comply with Company Standard KOC-C-026.

18.4.11.4 **Crack control**

All reinforced cement concrete shall be provided with proper distribution of reinforcement to control flexural cracking. The crack widths shall be controlled by the expeditious use of combinations of reinforcement sizes, reinforcement spacing and cover.

The crack widths shall be calculated using the applicable formula in ACI 224.1R.

To achieve proper distribution of flexural reinforcement and to encourage good detailing practices, all structural calculations shall check the spacing (center to center distance of flexural reinforcements) requirement in accordance with ACI 350M/350RM and ACI 318/318M.

Crack width limitations shall be as mentioned in Company Standard KOC-C-001.

18.4.11.5 **Design Requirements for Concrete construction**

All concrete construction works shall be as per Company Standard KOC-C-006 and Company Standard drawings 55-02-01 & 55-02-02.

18.4.11.6 **Basic Design Plinth Levels**

Basic design plinth levels relative to the appropriate Finished Grade Level (FGL) of the various work(s) should be followed as a minimum as recommended in the Company Standard KOC-C-002.

18.4.11.7 **Minimum Concrete cover**

Minimum Concrete cover requirement shall be as per Company Standard KOC-C-006.

18.4.11.8 **Reinforcement anchorage length**

Reinforcement anchorage length shall be calculated as per the ACI 318M and Company Standard drawing Nos. 55-02-01 and 55-02-02.

18.4.11.9 **Reinforcement lapping length**

Reinforcement lapping length shall be calculated as per the ACI 318M and Company Standard drawing Nos. 55-02-01 and 55-02-02.

18.4.11.10 **Column bases**

Column base plate wherever applicable shall have the following dimensional clearances;

a) Clear distance from the edge of the base plate/ base frame to the outer edge of the pedestal shall be minimum 50mm.
b) Clear distance from the face of pocket to the outer edge of the pedestal shall be 100mm.

c) Clear distance from the edge of the sleeve or anchor plate to the edge of pedestal shall be 100mm.

18.4.11.11 **Foundation protection**

All underground and aboveground concrete surfaces shall be protected in accordance with Company Standard KOC-C-006.

18.4.11.12 **Foundation design**

The Company Standard KOC-C-002 shall also be considered for the foundation design and arrangement.

18.4.11.13 **Pipe sleepers**

The pipe sleeper ways shall be constructed from reinforced cement concrete. The pipe sleeper way design requirements shall be in accordance with Company Standard KOC-C-002. All sleepers shall be provided with future expansion space availability of 25%.

18.4.11.14 **Pipe support and Pipe rack foundation**

The pipe rack foundation design requirements shall be in accordance with Company Standard KOC-C-002. All foundations shall consist of a pedestal and footing at each column base. The top of pedestal elevation (TOG) shall be about 450m above finished grade level.

18.4.11.15 **Dynamic equipment foundation**

Dynamic machine/equipment foundations shall be designed in accordance with Company Standards KOC-C-001 and KOC-C-002. The dynamic equipment (reciprocating / rotating) such as pumps, compressors, turbines and similar machines shall be designed for their bases and foundations taking into consideration of all appropriate static and dynamic loads as recommended by the Manufacturer(s) and in accordance with BS CP 2012 Part 1. The top of foundation elevation (TOG) shall be minimum 450mm above finished grade level.

18.4.11.16 **Static equipment foundation**

Static equipment foundation shall be designed in accordance with Company Standards KOC-C-001 and KOC-C-002.

18.4.11.17 **Vertical and horizontal vessel foundation**

The Vessel foundations shall be designed in accordance with Company Standard KOC-C-002.

18.4.11.18 **Vertical stack and column foundation**

The Vertical stack and column foundations shall be designed in accordance with Company Standard KOC-C-002.

18.4.11.19 **Steel storage tank foundation**

Steel storage tank foundation shall be designed in accordance with Company Standards KOC-C-002, KOC-C- 026 and KOC-L-027. All foundations shall be generally of a ring wall footing/ring beam foundation type.

18.4.11.20 **Buildings/Shelters**

The Contractor shall conduct a detailed Building Risk Assessments (BRA) and Quantitative Risk Analysis (QRA) to identify potential facility hazards. All the recommendations of the BRA/QRA studies shall be implemented by the Contractor and shall be considered as a part of Scope of Work of the project.

Buildings shall be designed in accordance with Company Standards KOC-C-002 and KOC-AR-001.

18.4.11.21 **Underground pits**

Underground RCC pits shall be designed in accordance with Company Standard KOC-C-002. The Top of Pit shall be minimum 450mm above finished grade level.

18.4.11.22 **Cable trench and Duct banks**

Electrical and instrumentation cable trenches and cable ducts shall be in accordance with Company Standard KOC-C-002.

18.4.11.23 **Pipe sleeves**

Road crossing pipe sleeves shall be provided in accordance with Company Standard KOC-C-002 and Company Standard Drawing No. 55-04-77.

18.4.11.24 **Precast Concrete**

Precast concrete whether cast at the job site or at a designated facility shall be designed in accordance with ACI 318M.

18.4.11.25 **Widths of Access-ways**

Widths of access-ways shall be in such that they serve the intended purpose without any inconvenience, and shall be neither too narrow nor too wide. As a guidance, the minimum widths should conform to Company Standard KOC-C-002.

Minimum width of escape route access and recommendations shall comply with Escape Evacuation and Rescue Analysis (EERA Study).

18.4.11.26 **Recommended Overhead Clearances**

The minimum clear vertical distance for all overhead structures, platforms, piping supports, first tier of multilevel pipe rack and equipment should be maintained as recommended values given in Company Standard KOC-C-002.

18.4.12 **CIVIL WORK**

18.4.12.1 **Excavation and backfilling**

Excavation and filling works shall be carried out according to Geotechnical survey report and Company Standard KOC-C-005.

18.4.12.2 **Drainage**

The overall plant drainage concept & design and sanitary sewage drainage shall be in accordance with Company Standard KOC-C-025.

Within the process areas, slope of paving shall be provided as per KOC-C-025.

18.4.12.3 **Roads and paving**

The road and paving work design shall be in accordance with Company Standards KOC-C-002, KOC-C-024 Part-01 & 02, KOC-S-001and Company Standard drawing No. 55-02-94.

18.4.12.4 **Earthen/RCC Dike Wall**

The bund wall layout and details shall be in accordance with Company Standard KOC-L-027. The RCC bund wall construction shall be in accordance with Company Standard KOC-C-006.

Earthen Dike/bund wall/berm of minimum 1.0 meter height from the grade level shall be provided outside the facility fence as per the requirement to control windblown sand and ingress of rain water.

18.4.12.5 **Slope Erosion Protection**

Slope erosion protection shall be provided in accordance with KOC-C-002 and KOC-C-005.

18.4.12.6 **Concrete Dike Wall**

Diesel storage tank, diesel day tank or other similar equipment's containing hydrocarbons/chemicals shall be provided with liquid retaining structure to contain any spillage. It shall be made of RCC structure with provision of a local sump with grating cover for draining purposes.

Internal walls and floor slab shall be painted with light grey epoxy paint.

The containment volume shall be based from Contractors detailed engineering but shall not be less than 115% of volume of liquid to be contained. Other type of retaining structure shall be subject to Company's prior written approval.

18.4.12.7 **Concrete masonry works**
The masonry works shall be in accordance with Company Standard KOC-C-008.

18.4.12.8 **Fence and gate**

Fence and gate work shall be in accordance with Company Standards KOC-C-002 and KOC-G-019 Part-2.

18.4.13 **ARCHITECTURAL WORK**

18.4.13.1 The Company Standard KOC-AR-001 and KOC-AR-002 shall be used as a guidance to develop the complete set of architectural drawings and documents, which are required to construct, extend the buildings.

18.4.13.2 All architectural building materials, finishes, furniture and fittings shall be as per Company Standards KOC-AR-001,KOC-AR-002 and KOC-C-008.

18.4.13.3 The Contractor shall comply with the typical finishing schedule provided in Company Standard KOC-AR-001 for internal/external finishes, Process/non-process, Plant/non-Plant, Industrial/non-industrial buildings. For Temporary Site offices, Contractor shall follow Company Standard KOC-C-035.

18.4.14 **Fabrication/ Shop Drawings**

18.4.14.1 The Contractor shall develop the fabrication drawing based on the approved relevant design drawings. The Contractor shall submit fabrication drawings to the Company for review. Fabrication shall commence only after the Company has completed the review and informed the Contractor in writing to proceed with the work.

18.4.14.2 Bill of materials in Standard format shall be an integral part of each fabrication drawings listing all materials and weights of each member.

18.5 SUPPLY OF MATERIALS

All materials to be used for Civil, Structural and Architectural works shall be new, free of defects that will impair integrity of materials.

18.6 MATERIAL SPECIFICATIONS AND WORKMANSHIP

All the materials shall comply with the requirements stated in the Company Standard KOC-C-006 for concrete works, KOC-C-007 for structural steel works, KOC-AR-001 for Architectural works and KOC-C-024 Part 1 & 2 for road works as well as with the accepted International Standards adopted in this Project.

18.6.1 CONCRETE STRUCTURE

18.6.1.1 Cement

Cement for use in concrete works above ground level shall be Ordinary Portland Cement (OPC) confirming to BS EN 197-1 or ASTM C150/C150M designated as Type-I.

Cement for use in concrete works below ground level shall be Sulphate Resisting Portland Cement (SRPC) confirming to ASTM C150/C150M designated as Type-V.

18.6.1.2 Concrete

The static modulus of elasticity (Ec) of normal concrete to be used for elastic analysis shall be appropriate to the cube strength of the concrete at the age considered in conformity with the Company Standard KOC-C-001.

The other elastic properties and thermal expansion of normal concrete shall be considered as follows;

a) Poisson's Ratio = 0.20
b) Shear Modulus (G) = 0.42 Ec
c) Co-efficient of Linear Thermal Expansion (αc) =12 x 10^E-6 / ºC
d) Unit weight of concrete = 23 kN/m^3 or more

The minimum compressive strength (cube) of concrete at 28 days shall be as follows;

a) Blinding concrete = 15 MPa (K150)
b) Structural concrete = 30 MPa (K300)
c) Pre-cast = 40 MPa (K400)

18.6.1.3 Aggregates

The aggregates to be used for concrete works shall be generally normal-weight aggregates with an oven-dry particle density greater than 2000 kg/m^3 but less than 3000 kg/m^3, when determined according to BS EN 1097-6. Lightweight or heavyweight aggregates shall be used only for special purpose concrete, when specified and not in normal concrete.

The aggregates, both coarse and fine being considered as separate ingredients, shall comply with the requirements of ASTM C33/C33M or BS EN 12620; and in case of aggregates being made of carbonate or dolomite materials; they shall be initially checked for potential alkali reactivity in accordance with ASTM C586 or ASTM C1105.

All aggregate materials and the test requirements shall comply with Company Standard KOC-C-006.

18.6.1.4 Water

Water used in all types of concrete shall be clean and free from injurious amounts of acid, alkali, oil and organic or any other deleterious substances, and shall be of drinkable quality having no pronounced odor or taste.

The pH value of water shall be within the range of 6.0-8.0. Water shall be tested in accordance with BS EN 1008 or ASTM C94/C94M and the acceptable criteria limiting the impurities in water shall not be exceeded the limits mentioned in Company Standard KOC-C-006. Soluble chloride ion content in water shall be limited as per the provisions given in ACI 318/ACI 318M.

18.6.1.5 **Formwork**

The Contractor shall be entirely responsible for the design, supply and construction of all the form works and for its safety and adequacy. All form work supply and construction shall be in accordance with BS EN 1992-1-1.

The Contractor shall give the Superintendent a minimum of 24 hours' notice of readiness formwork for inspection and shall be deemed to have allowed in his tender for any necessary adjustments and re-inspection.

Any formwork showing sign of damage or failure through premature loading or through overloading shall be replaced, repaired or reconstructed as deemed necessary by the Superintendent's Representative and shall be entirely at the Contractor's cost. Only good quality form work shall be used for construction.

Formwork shall be made of timber and/or metal.

Workmanship on formwork shall be in accordance with BS EN 1992-1-1: 2004 + A1: 2014.

Samples are required to demonstrate the quality of the Contractor's formwork design/details. The Contractor shall prepare a sample for inspection by the Superintendent at no additional cost and/or time to the Company.

18.6.1.6 **Reinforcement**

The characteristic yield strength of reinforcements Fy = 420 MPa (Grade 60) shall be followed as given in Company Standard KOC-C-001 in accordance with ASTM A615/A615M Standards.

The modulus of elasticity and thermal expansion of reinforcements shall be as follows;

a) Modulus of Elasticity (Es) = 200 kN /mm^2
b) Co-efficient of Linear Thermal Expansion (αs) =10 x 10^E-6 /ºC

18.6.1.7 **Grouting**

The grouting materials for equipment and steel bases shall be in accordance with the Company Standard KOC-C-023. The Epoxy Grout shall be used as per the conditions mentioned in the

Company Standard KOC-C-023.

18.6.1.8 **Expansion Joints**

Expansion joints shall be formed by using 20mm thick filler strip and 20mm deep Company approved sealant suitable for environment. Filler and sealant shall be in accordance with ASTM D1751 and ASTM cno respectively or similar.

18.6.1.9 **Curing**

Curing shall start continuously after concrete is placed and finished. Concrete shall be kept continuously moist for 24 hours.

Curing shall be continued for at least 7 days except in case of high early strength concrete for which the period shall be 3 days and for mass concrete for which the period shall be minimum 10 days unless specified otherwise.

18.6.1.10 **Testing for Quality of Concrete**

Compression tests of Concrete shall be conducted in KOC Laboratory located at Burgan (South Kuwait) / the Laboratory approved by the Superintendent of the Contract. The preparation of cubes for test (7 days & 28 days) and transportation of the same from site to laboratory shall be carried out by the Contractor.

Testing samples shall be made at the time of placement at the rate of six (6) test specimens per $20m^3$ of concrete or concrete work per day, whichever is less. Three (3) specimens shall be cured and tested for crushing strength at 7 days after casting and three (3) at 28 days. The test results for crushing strength after 28 days shall be deemed acceptable provided the following conditions are met;

The average strength of any group of four (4) consecutive test results exceeds the required characteristic strength by 3 N/mm^2.

For none of the test results, the strength determined is less than the required characteristic strength minus $3N/mm^2$.

Minimum Compressive Strength of Normal weight Concrete shall be as follows;

Concrete Strength	Characteristic Strength for Cubes at 7days (N/mm^2)	Characteristic Strength for Cubes at 28 days (N/mm^2)
C15	10	15
C30	21	30
C40	28	40

18.6.1.11 **Anchor Bolts**

All anchor bolts shall conform to ASTM A307 Grade A or ASTM F1554 Grade 36 or BS 4190

Grade 4.6 or BS EN ISO 898-1, Property Class 4.6.

Anchor bolts for equipment shall be specified by equipment manufacturers for the allowable tensile stress conforming to the relevant ASTM specification. As a minimum, use 20mm diameter bolts for structural columns and typical equipment and 16mm bolts may be used for small pumps and guardrails. Anchor bolt projections shall not protrude more than one bolt diameter above top of nut.

Nuts shall conform to ASTM A563M Grade A or ISO 898-2, Class 5 and washers shall conform to ASTM F436M, Type-1.

All anchor bolts including nuts and washer shall be hot-dip galvanized in accordance to ASTM A153/A153M or BS EN ISO 1461 with mean coating thickness of 50 Microns (Minimum).

All anchor bolts shall comply with the Company Standard drawing No. 55-02-62.

18.6.1.12 **Embedded Items**

All embedded items shall conform to ASTM A36/A36M and shall be hot-dip galvanized in accordance with ASTM A123/A123M or BS EN ISO 1461 having mean coating thickness of 85Micron (Minimum). The Contractor has to effectively seal the junction of embedded items and concrete with materials approved by the Company.

18.6.2 **STEEL STRUCTURES**

18.6.2.1 **Structural Steel**

All Structural plates and shapes tolerance shall be in accordance with ASTM A6/A6M having a minimum yield strength of 250 N/mm^2 (36 Ksi). The Structural steel materials shall comply with Company Standard KOC-C-001.

Structural steels with minimum 345 N/mm^2 (50 Ksi) yield stress which are widely used for economy replacing ASTM A36/A36M in many applications shall comply with ASTM designations as follows;

a) ASTM A572/A572M high strength low-alloy Columbium-Vanadium Structural steel for most of the applications.
b) ASTM A529/A529M high strength carbon manganese structural steel for thin plate members.
c) ASTM A242/A242M and A588/A588M high strength low alloy structural steel for atmospheric corrosion resistance.

The structural steel properties are as follows;

a) Modulus of elasticity (Ec) = 200 kN /mm^2
b) Co-efficient of Linear Thermal Expansion (αc) =10 x 10^E -6 / ºC
c) Unit weight of steel = 78.5 kN/m^3

d) Specified yield strength of steel = 250 N/mm^2

Structural steel shall be designed, fabricated and erected in accordance with the requirements of Company Standard KOC-C-007.

Fabrication

Generally, structural steel shall be fabricated in the shop. All shop connections shall be welded. All field connections shall normally be bolted at site during erection.

Bolt holes shall be cut, drilled or punched and shall not be made or enlarged by burning. For bolts up to 24mm diameter, hole diameter shall be maximum 2mm more and for bolts over 24mm diameter, hole diameter shall be maximum 3mm more.

Erection

The erection tolerances shall comply with BS EN 1090-2 or AISC. For all safety requirements ANSI A10.13 for steel erection shall be adhered to and all modern techniques and lifting equipment shall be utilized.

The Contractor shall furnish an erection marking system identifying all members prior to fabrication.

All the foundations including anchor bolts shall be checked for accuracy before commencing the erection. Setting out shall be carried out for all column bases and tops for accurately positioning, plumbing, alignment and leveling of all other members of the structures.

Field holes shall be made only by drilling. Burning or punching shall not be allowed unless otherwise authorized. Field openings in gratings shall be band.

18.6.2.2 **Structural Bolts**

The ordinary bolts shall comply with the requirements of ASTM A307 Grade A or ASTM F1554 Grade 36 or ISO 898-1, Property class 4.6. Nuts shall be ASTM A563M, Grade A or ISO 898-2, Class 5. Washers shall conform to ASTM F436, Type-1.

High tensile bolts shall comply with the requirements of ISO 898-1, Property class 8.8 or ASTM A325M, Type 1 or ASTM A490M, Type-1. Nuts shall be ASTM A563M, Grade 10S or ISO 898-2, Class 8. Washers shall conform to ASTM F436M.

High Strength bolts (ISO 898-1, Property class 8.8 & ASTM A325M, Type-1), nuts and washers shall be hot dip galvanized in accordance with ASTM A153/A153M or mechanically galvanized in accordance to Class 55 of ASTM B695 with mean Coating thickness of 50 Micron (Minimum).High Strength bolts (ASTM A490M, Type-1), nuts and washers shall be coated in accordance with ASTM F1136/F1136M, Grade 3 or ASTM F2833, Grade 1.

High strength friction grip (HSFG) bolts with associated nuts and washers shall comply with the

requirements of BS 4395, Part 1, general grade or ASTM A449 with A563M nuts and F436 washers.

All ordinary bolts, nuts and washers shall be hot-dip galvanized in accordance to ASTM A153/A153M or BS EN ISO 1461 with mean Coating thickness of 50 Micron (Minimum).

Unless noted otherwise on the drawings, steel connection bolt size shall be as follows;

a) For main members and connections: M20 high strength bolts
b) For railings, ladders and secondary connections: M16 ordinary bolts
c) For ladder cages: M12 ordinary bolts
d) For stair treads: M10 ordinary bolts

Minimum of two bolts shall be used for all steel connections.

18.6.2.3 **Welding**

Welding and welding electrodes filler metal requirements shall conform to AWS D1.1/ D1.1M. For structural steel applications, the minimum electrode tensile strength shall be 480 MPa. Welded connections shall be carried out using the manual metallic arc process as per AWS D1.1/ D1.1M. Welding procedure specification (WPS) for each class of work and procedure qualification records (PQR) as per AWS D1.1/ D1.1M requirements shall be submitted to Company prior to commencement of work.

18.6.2.4 **Grating**

Grating shall conform to ASTM A1011/A1011M, SS Grade 40 or BS 4592, Part-1. The grating size and method of attachment shall be indicated in the approved project drawings. Grating and fixing material (clips) shall be hot-dip galvanized in accordance to ASTM A123/A123M or BS EN ISO 1461 with mean coating thickness of 85 Microns (Minimum). Use of Stainless, Aluminum, and GRP grating shall be used in specialized condition with prior approval from the Company.

Steel flooring shall be of open grid type. However, chequered plate flooring should be considered for safety where any chance of spillage exists from upper level to lower platforms or equipment.

The open grid type metal flooring in rectangular pattern is normally preferred with load bearing bars having anti-slip serrated top surface. The load bearing main bars shall be 30 mm deep x 5 mm thick at 30 mm centers with 10 mm twisted cross bars at 100 mm centers in transverse direction. Floor panel shall be limited to span (L) having deflections not more than L/250 or 10 mm, whichever is smaller.

The Contractor shall submit the design calculations for welded steel grating for light and heavy duty traffic for Company’s review.

18.6.2.5 **Floor Plate**

Chequered floor plate shall be four-way, raised pattern steel plate in accordance with ASTM A786/A786M with a minimum thickness of 6mm, exclusive of the raised pattern height. Plate material shall conform to ASTM A36/A36M. Chequered floor plate shall be hot-dip galvanized in accordance to ASTM A123/A123M or BS EN ISO 1461 with mean coating thickness of 85 Microns (Minimum).

The use of Chequered Floor Plates shall be discouraged, except for some applications where the use of grating is not practical. Chequered floor plate may only be used with Company's prior specific approval.

18.6.2.6 **Handrail**

The handrail structural members shall conform to ASTM A36/A36M or BS EN 10056-1 and hollow pipes shall conform to ASTM A53/A53M, Grade B or BS EN 10210-2. All handrails shall be hot-dip galvanized in accordance to ASTM A123/A123M or BS EN ISO 1461 with mean coating thickness of 85 Microns (Minimum). Company Standard drawing No. 55-02-58 shall be referred for the construction of handrails.

Handrails shall be provided for all platforms which are 500mm or more above ground or any operating level.

18.6.2.7 **Painting and/or Galvanizing**

a) All structural steel including miscellaneous metal items shall be prepared and shop painted or galvanized in accordance with Company Standard KOC-P-001.

b) Painting shall be excluded from the areas within 50mm of joints to be welded.

c) The areas of contact surface for friction type connections (HSFG) in crane girders and girder supports, and other friction type connections with high tensile bolts, shall not be painted.

d) All surface preparation and shop coating application shall be carried out by the Contractor in compliance with Company Standard KOC-P-001.

e) All steelwork for platforms, stiles, walkways including open grid flooring, handrails, stair treads, ladders, gratings, cages and safety guards shall be hot dip galvanized in accordance with Company Standard KOC-P-001.

f) All steelwork for valve pits and trenches including chequered plate cover, steel beams and appurtenances shall be hot dip galvanized in accordance with Company Standard KOC-P-001.

g) All bolts, nuts and washers shall be galvanized as specified in the Company Standard KOC-C-007.

h) If any fabrication or welding is carried out after shop painting, damaged areas of coating

shall be re-blasted and re-coated.

i) Painted surfaces shall be free from pinholes, runs, sags, thin spots, dirt inclusions and other evidence of poor workmanship. Care shall also be taken to prevent damage to the coated surfaces during handling and transportation.

18.6.2.8 **Fire Proofing**

a) The passive fire protection for structural steel shall be provided as per Company Standard drawing No. 55-02-04 by covering steel surface to provide fire protection in accordance with Company Standard KOC-C-027.

b) Primary load bearing members of steel shelters, pipe racks, pipe supports, equipment, and packaged type skid equipment's in fire hazardous area shall be fire proofed for two (2) hour fire rating.

c) Fire resistance requirement of all steel structures shall be in accordance with the Company Standard KOC-C-027.

d) Active and Passive fire protections shall be carried out in accordance with FERA study.

18.6.2.9 **Concrete masonry work and Plastering**

The masonry work and plastering shall be in accordance with applicable sections of Company Standard KOC-C-008.

18.6.2.10 **Floor Screeds**

All screed materials and workmanship shall comply with Company Standard KOC-AR-002.

18.6.2.11 **Building Roof System**

All building roof properties and workmanship shall be in accordance with Company Standards KOC-AR-001 and KOC-AR-002.

18.6.2.12 **Doors and Ironmongery**

Doors and ironmongery materials, installations and workmanship shall be in accordance with Company Standard KOC-AR-001.

18.6.2.13 **Windows and Glazing**

Windows and glazing materials, installations and workmanship shall be in accordance with Company Standard KOC-AR-002.

18.6.2.14 **Painting, Floor, Wall Finishes, Metal Cladding**

All painting, floor and wall finishes materials, installations and workmanship shall be in

accordance with Company Standard KOC-AR-002.

18.6.2.15 **Suspended Ceiling**

All suspended ceiling materials, installations and workmanship shall be in accordance with Company Standards KOC-AR-001 and KOC-AR-002.

18.6.2.16 **Raised Access Flooring**

All raised floor system materials, installations and workmanship shall be in accordance with applicable Sections of Company Standards KOC-AR-001 and KOC-AR-002.

18.6.2.17 **Sanitary Fixtures & Fittings and Furniture**

All sanitary fixtures, fittings materials and furniture, installations and workmanship shall be in accordance with Company Standards KOC-AR-001 and KOC-AR-002.

18.6.2.18 **Materials, workmanship and Testing for Asphalt Road**

The fill material, sub-grade material, sub-base material, asphalt concrete materials required for the construction of asphalt road and the workmanship, testing shall be in accordance with Company Standard KOC-C-024 Part-1.

18.7 SPECIFICATIONS FOR WORKS TO BE EXECUTED

The Scope of Civil, Structural and Architectural works to be executed by the Contractor shall consist of carrying out all design, detailed engineering, and construction works in line with the technical specifications, Drawings and further elaborated hereafter including provision of all labor, procurement of materials, supplies, fabrication, tools, equipment installation, supervision, inspection, quality testing and performance testing.

18.7.1 Topographical Survey

18.7.1.1 Preliminary site survey drawing (Contour Layout) provided with Annexure-2 to Appendix-18 is for Contractor's reference. The Contractor shall carryout independent Topographical survey in compliance with Company Standard KOC-C-004. All levels shall be in meters and shall be with respect to Mina Ahmadi Construction Datum (MACD). All coordinates shall be in meters and shall be referenced to UTM WGS-84 Zone 38N. The Contractor's submitted survey report/drawings and proposed locations shall be subject to the Superintendent's review and approval.

18.7.1.2 Minimum four (4) Permanent Bench marks shall be established for each site/facility. Both UTM co-ordinate and site co-ordinate shall be established for each Permanent Bench marks. The Contractor shall be responsible for obtaining the required data related to the existing survey control stations/bench marks from the Company, verification of the same at the site and transferring, establishing the bench marks at required locations.

18.7.1.3 The Contractor shall carry out detailed topographical survey for the proposed facilities including associated facilities and existing services which are to be re-routed/protected and removed prior to commencement of any construction work, taking note of all existing structures, aboveground pipelines and markers of underground services crossing through the construction site. Based on the survey report, the Contractor shall prepare layout plan to show the proposed facilities as well as associated existing services with their coordinates and orientations.

18.7.1.4 On completion of the survey work, Contractor shall deliver the report and drawings to the Company for review. The Contractor may have to undertake re-survey of certain areas of surveyed plot for incorporating any comments offered by the Company. Re-survey shall be carried out without any time and/or cost impact to the Company.

18.7.1.5 The Contractor shall produce all drawings in latest AutoCAD format.

18.7.2 **Exploratory Slit Trenching**

18.7.2.1 The Contractor shall manually excavate exploratory slit trenches prior to the commencement of any construction works at Project locations of new facilities to determine the presence of underground services in the proposed location/vicinity. The Contractor shall scan the area using electronic metal/cable detector prior to start manual excavations.

18.7.2.2 The clearance between new construction and the existing aboveground and underground services shall be in accordance with the relevant Company Standards and Specifications. Slit trenches shall be minimum 1.0 meter wide and 1.5 meters deep from the adjacent ground level. In some locations, the Contractor may have to excavate deeper in order to locate the existing services without any additional cost to the Company.

18.7.2.3 Once the slit trenches are excavated an additional scanning for the slit trenches bottom surfaces using the metal detecting systems shall be carried out to detect deeper Services that may be located up to 3.0m to 4.0m from the surface ground. Should investigation reveal any objects at the limits of the extended zones, then investigation shall progress around and onward in direction of the object until it is identified or, if necessary.

18.7.2.4 The open trenches shall always be protected all around with suitable barricades as specified in HSSEMS procedures. All excavated slit trenches shall be properly backfilled, compacted to 90% of the maximum dry density and reinstated in original condition after the completion of the work.

18.7.3 **Geo-Technical Investigation**

18.7.3.1 The Contractor shall carryout the Geo-technical investigations to ascertain the soil properties at the locations of all facilities with suitable number of bore holes agreed with the Company in order to obtain sufficient soil properties data for design of foundations/facilities. Bore holes at Storage Tanks locations shall be of minimum 20.0 meters depth and 10.0 meters depth at other facilities. The Contractor shall submit the Geo-technical investigation report for Company's review and approval. The Contractor's design shall be based on the approved Geo-technical

investigation report. Geo-technical investigation works shall be carried out in accordance with the Company Standard KOC-C-003.

18.7.3.2 The Geo-technical investigation report provided along with Appendix-19 to the Technical Specification is only for guidance to the Contractor. The Contractor shall conduct completely independent Geo-technical investigation and the reports shall be submitted to the Company for review and approval. The Contractor shall carryout detailed engineering based on Contractor's Geotechnical investigation report, which is approved by the Company.

18.7.3.3 The Contractor shall submit the final Geo-technical report to the Company for approval after incorporating all the comments provided by the Company. The Geo-Technical report shall include all the minimum requirements mentioned in the Company Standard KOC-C-003.

18.7.3.4 The Contractor will not be entitled to claim any additional cost and/or time due to the variance in the actual properties of the soil from the Contractor submitted Geo-technical report.

18.7.3.5 The Contractor may require to carryout soil stabilization and/or lowering of the foundation level to achieve the design soil bearing capacity, if the actual soil bearing capacity is lower than the values in the geo-technical report. Such cases the Contractor will not be entitled to claim any additional cost and/or time for the soil stabilization and/or redesign and construction of the foundations/facilities in those areas.

18.7.3.6 If the actual bearing capacity of the soil is more than the bearing capacity mentioned in the Geo-technical report submitted by the Contractor then the Contractor will not be entitled to claim any additional cost and/or time for the excavation/construction in such areas.

18.7.4 **Site Preparation and Earthworks**

18.7.4.1 All site preparation and earth works shall comply with the requirements of Company Standard KOC-C-005. The Contractor shall strictly follow the KOC HSSEMS Procedure for Handling of Explosive Materials, Substance and EOD.

18.7.4.2 All the work areas shall be cleared of vegetation, contaminated soil, debris, refuse or other deleterious materials. At all times the work areas shall be free from surplus materials and rubbish. Wind-blown sand shall be removed for a minimum depth of 600mm or as specified by the Company. This shall include removal of all abandoned structures or debris from the site.

18.7.4.3 Prior to the starting of any construction activities, the Contractor shall carry out necessary earthworks for cutting of the existing soils and/ or filling in order to achieve the finished levels of facilities, buildings and roads in accordance with proposed finished level as indicated in relevant project drawings and applicable Company Standards. The Finished ground level of the facilities shall be adequately higher than the surroundings in order to drain out storm water. The complete fenced areas of the facilities and the area minimum ten (10) meters wide outside the fence shall be uniformly spread with approved Gatch and shall be compacted to 95% of Modified Proctor's dry density at optimum moisture content. The minimum thickness of Gatch layer shall be 150mm after final compaction.

18.7.4.4 The Contractor shall take proper care to control dust generating from construction activities/site preparations and prevent its spread to create a nuisance in the surrounding areas.

18.7.4.5 Where unsuitable material is encountered in the subgrade, and where excavations are taken below the formation level, it shall be removed and backfilled with suitable borrowed materials in layers not exceeding 200mm loose depth and mechanically compacted.

18.7.4.6 Depth of open excavations shall be limited to 1.50 meters without supports to the sides of the excavated surfaces. For excavations deeper than l.50meters, the Contractor shall be responsible for design, supply, fixing and removal of all planking, shoring, strutting or sheet piling required to provide safe and adequate supports to the sides and the slopes of excavation. Where excavation for foundations is made below the founding level, the over excavated areas shall be filled with concrete grade having minimum characteristic strength of 15 N/mm2.

18.7.4.7 Backfilling shall be carried out with approved Gatch in layers up to finished ground level after construction of the foundations and concrete necks at prescribed levels. Each layer of Gatch shall be uniformly spread and compacted and shall not be more than 150 mm thick. Selection of Gatch, its compaction and tests shall be in accordance with Company Standard KOC-C-005.

18.7.4.8 Gatch or other filling materials shall not be provided by the Company. Suitable imported materials shall be procured by the Contractor and hauled to Sites from borrow pits located outside the Company areas. The Contractor shall bear all costs pertaining to testing, procurement and transportation of the Gatch. The Contractor shall submit test certificates of the Gatch material of his proposed borrow pit for the company's approval before commencing procurement of Gatch. The Contractor shall also be responsible for obtaining all necessary permits and licenses from relevant authorities. All excess materials shall be removed and hauled to approved locations. The supplied Gatch samples shall be tested after delivering at the site.

18.7.4.9 Where the difference of elevation between adjacent grading is more than 500mm, slope protection shall be provided with bitumen sand mix lining in accordance KOC-C-033.

18.7.4.10 Temporary disposal pits to draining out the hydro-test water in accordance with Company Standard drawing No. 55-02-41 and location shall be decided by the Contractor during detailed design as directive from Superintendent Representative.

18.7.4.11 The Contractor shall be responsible for removal, transportation and treatment/disposal of hazardous wastes including contaminated soil (defined as soil having hydrocarbon content greater than 1.0 % by weight) encountered during the course of works, at the Solid Waste Treatment Plant in Shuaiba Industrial Area in accordance with KOC HSE and HSSEMS procedures and the applicable statutory guidelines of Kuwait Public Authority of Industry and Kuwait Environmental Public Authority (KEPA).

18.7.5 **Shoring, Disposal of surface water, dewatering and disposal of oil spills**

18.7.5.1 The Contractor shall consider in the scope of work the necessary due allowance for shoring the sides of the excavation and dewatering the accumulated water 'due to rain water or the underground water table' that may occur during the course of works.

18.7.5.2 The Contractor shall be responsible for disposal of all surface water during the construction period. The Contractor shall provide necessary drainages in the form of ditches, ponds, culverts, manholes and soakaway pits for this purpose.

18.7.5.3 The Contractor shall also be responsible for disposal of oil spills during the course of works in an appropriate manner in accordance with KOC HSSEMS procedures and the applicable statutory guidelines of Kuwait Public Authority of Industry and Kuwait Environmental Public Authority (KEPA) and as directed by the Company without any cost and/or time impact to the Company.

18.7.6 **Precautions against flooding**

The Contractor shall assess the flooding of the areas during the construction and take appropriate measures to divert any potential flood water from the area of work.

18.7.7 **Relocation of Existing Services, Utilities and Pipeline Works**

18.7.7.1 The Contractor shall relocate all existing aboveground and underground utilities, and structures that are in conflict with the proposed work, which may be discovered during surveying and slit trenching and/or during the execution of the Project. The Company will review and approve the proposed relocation of the existing utilities and structures to be undertaken by the Contractor prior to the relocation.

18.7.7.2 The clearance requirements and protection of buried services shall be in accordance with the requirements of Company Standard KOC-L-002. The Contractor shall be responsible for identifying all occurrences of existing underground/aboveground services and structures, which conflicts with the new works.

18.7.8 **Design and Detailed Engineering**

18.7.8.1 The Contractor shall perform detailed engineering and design for all Civil, Structural and Architectural works based on all the parameters described under 'Design and Engineering' Clause of this Technical Specification. The Contractor shall prepare and submit design calculations, specifications, design drawings and working/Shop drawings for Company's approval prior to the execution of any part of the work. Drawings provided by the Company are for guidance only. The final design of all items related to the Civil, Structural and Architectural works shall be in accordance with the project scope, applicable specifications, codes, Standards, approved process, mechanical, piping, electrical, instrumentation requirements, drawings, documents, details, Vendor information, HSE requirements and to the complete satisfaction of the Superintendent.

18.7.8.2 All design and detailed engineering works shall be in compliance with Company Standard KOC-C-001, KOC-C-002, KOC-AR-001, KOC-AR-002 and other applicable codes, Standards and specifications.

18.7.8.3 The design of any structure shall be made on the basis of the recommended soil parameters and allowable bearing pressures from the Geotechnical Report of the Site which is carried out by Contractor.

18.7.8.4 Soil design parameters including soil classification, depth of soil layers, suitability of soil for grading, groundwater data, soil bearing capacity, excavation and fill slope, hydraulic conductivity or soil permeability, structural fill gradation and specifications, and road pavement recommendations shall be obtained from the detailed site Geo-technical investigation report.

18.7.8.5 Native files of design calculations (Staad Pro, MS Excel), drawings (AutoCAD) shall be submitted to the Company for review.

18.7.9 **Area Grading and Drainage System**

18.7.9.1 Carry out comprehensive drainage system encompassing the complete Contract scope. Drainage system shall cater for storm water, over flow from fire water tanks, contaminated water and all other types of wastes generated. Design and construction of drainage system shall be in accordance with the Company Standard KOC-C-025.

18.7.9.2 Carry out detailed topographical survey at work site to establish correct ground formation level to design complete site drainage systems. The work includes general site grading, cutting, filling, and compaction as necessary to establish a slope to prevent water logging in and around the facilities. The Contractor shall obtain approval on drawing/details from the Company prior to commencement of any related work at site.

18.7.9.3 Study drainage system and prepare details of swales/ditches and discharge route to surrounding low-lying areas. The Contractor shall also consider construction of impounding basins that may be required to collect the storm water from the drainage system. The Contractor shall obtain approval on drawing/details from the Company prior to commencement of related work at site.

18.7.10 **Equipment/ Vessel /Tank Foundations**

18.7.10.1 The Contractor shall design, supply and construct RCC pedestals, footings and various type of foundations for equipment at facility. The design of these pedestals, footings and foundations shall be based on foundation loading data from the approved mechanical / Vendor detailed drawing, soil conditions at the locations and the Manufacturer's recommendations.

18.7.10.2 The Contractor shall also design, supply and construct the RCC foundations for the equipment/vessel/Tank at facility in accordance with design forces as provided by the Vendor/Manufacturer.

18.7.10.3 RCC grade slab of minimum 150 mm thick shall be provided all around the pump foundations and concrete curb wall shall be provided on the periphery of the grade slab. The Contractor shall size the grade slab in accordance with approved size and layout details of pump foundations and all other approved piping requirement, operation and maintenance requirements to suite relevant Company Standards. The grade slab shall have medium duty surface hardener. The paved area shall be provided with a shallow sump with grating cover and grade slab shall be sloped to the sump to collect and removal of sludge and wastes.

18.7.10.4 Locations of the pedestals and footings shall be in accordance with detailed Mechanical/ Piping drawings.

18.7.10.5 The equipment/vessel /tank foundations shall be generally designed to fully accommodate the maximum combination of stresses from static, dynamic, wind and temperature effects with accepted safety factors.

18.7.10.6 All underground and aboveground surfaces of the concrete foundation shall be protected in accordance with Company Standard KOC-C-006.

18.7.11 **Buildings and Shelters**

18.7.11.1 Contractor shall conduct a detailed Building Risk Assessments (BRA) and Quantitative Risk Analysis (QRA) to identify potential facility hazards. All the recommendations of the BRA/QRA studies shall be implemented by the Contractor and shall be considered as a part of Scope of Work of the project.

18.7.11.2 Design, supply and construct Buildings and Pre-engineered structural steel shelters as per Table-1 below:

Sl No.	Description	Remarks
1	Two Storey Blast resistant Control Building (Modular Type)	Refer Annexure- 2 to Appendix-18
2	Elevated Substation Buildings (Modular type)	
3	Laboratory Building (Modular type)	
4	Labor/Field Operator Rest Shelter (Modular Type)	
5	Workshop	
6	Fire Suppression Cylinder Storage Building	(Refer below Note)
7	Transformer Shelters	(Refer below Note)
8	Multi-Phase Pump Shelters	(Refer below Note)
9	Fire Water Pump Shelters	(Refer below Note)
10	Chemical Injection Shelters	(Refer below Note)
11	Air Compressor Shelter	(Refer below Note)
12	Nitrogen generation package shelter	(Refer below Note)
13	Gas Turbine Generator Shelters	(Refer below Note)
14	Diesel Generator Shelter	(Refer below Note)

15	Car Parking Shelter	Refer Standard Drawing No. 55-02-69
16	Chemical Storage building	(Refer below Note)
17	Guard House	Refer Standard Drawing Nos. 55-02-88 to 90
Note: Dimensions as per Contractor's detailed engineering.		

18.7.11.3 The above buildings and shelters are minimum requirements only, Contractor shall identify additional shelter for other equipment's as required and finalize dimensions to include operational/maintenance clearances during detailed engineering. All building and shelter layouts shall be subject for Company's approval in accordance with equipment Vendor and building/shelter services requirements.

18.7.12 **Modular Control Building**

18.7.12.1 Design, supply and construct Two Storey Modular Blast resistant Control Building as per Annexure-1 to this Technical specification. The Modular Blast resistant Control Building shall be in an appropriate and safe location within the facility. The Contractor shall reconfirm the proposed location and design the orientation of the Control Building as per HSE & Building Risk Assessment Studies and their recommendations in addition to the other requirements specified in this Contract. The Project drawings indicating the Control Building is for Contractor's reference only. The Contractor shall design the Control Building to accommodate all the requirements mentioned under Annexure-1 and by considering future expansion possibilities. After installing all the equipment/panels, 25% of additional areas shall be available in the Control room and Panel rooms for future expansion. The relevant Project drawing is indicating the minimum requirements and dimensions of the Company. The same shall be modified by the Contractor as per the equipment installation requirements, operation requirements and detailed engineering without any additional cost and/or time impact to the Company.

18.7.13 **Modular Substation**

18.7.13.1 As per the electrical/instrumentation design requirements, the Contractor shall design and construct elevated modular structural steel type Substations in compliance with minimum requirements as mentioned in the applicable section of Company Standard KOC-C-002. The size of the substation shall be as per approved Electrical equipment layout. 25% of additional areas shall be available in the Substations for future expansions.

18.7.13.2 The substation buildings shall be air-conditioned and pressurized by factory assembled air-handling units.

18.7.13.3 Substation shall be designed to maintain a positive internal pressure level (approximately 0.2 IWG (inch of water)) to prevent ingress of hazardous vapor/ fumes inside the building.

18.7.13.4 Substations buildings shall be elevated type for a minimum 2100mm from finished grade level to bottom of beam. The open space between ground beam and equipment floor beam of Substation buildings shall be provided with Chain link fence and personnel entry gates in

accordance with Company Standard KOC-C-002. The Chain link fabric shall be of 25 mm X 25mm mesh, hot dip galvanized with PVC coating.

18.7.13.5 Structural design of Substations buildings shall cater the installation of heavy Electrical, Instrumentation and Mechanical equipment.

18.7.13.6 Adequate openings/cutouts shall be provided in the equipment floor slab for cable entry with future openings.

18.7.13.7 Substation buildings finished floors shall be painted with light grey color epoxy paint. If required, steel rolled sections (joists or channels) should be embedded flush with the floor to roll out the equipment. Epoxy floor paint for Substations shall be provided and applied in accordance to Company Approved Manufacturer's recommendations. The accuracy of the floor level shall be according to the Panel/equipment Manufactures requirements.

18.7.13.8 Necessary openings for the cable entry, Arc Ducts, Bus ducts, HVAC and any other facilities shall be provided on the Substation.

18.7.13.9 Necessary space shall be considered for UPS in the Substation.

18.7.13.10 Necessary space for future E-SCADA shall be considered while finalizing the equipment layout of Substation.

18.7.13.11 Transformer bays for Substation buildings shall be designed and constructed in accordance with Company Standards KOC-C-002 and KOC-E-003, Part-1. The oil drains from transformer bays shall comply with Company Standard KOC-C-025. Fire walls of minimum two (2) hours fire rating made of reinforced cement concrete work should be constructed between the adjacent transformers to minimize the degree of fire risk. Transformers shall be protected by enclosures and roof including fences with gates.

18.7.13.12 The Eyewash station with drainage arrangement shall be provided in battery room of Substation buildings. The finished floor of battery room shall be tiled with acid resistant tiles, sloped to a chemical drain network and constructed with acid resistant material of anti-slip type.

18.7.13.13 Battery room walls shall be tiled with acid resistant tiles up to 2100mm from finish floor level or 1000mm from top of battery rack whichever is higher. All grouting materials shall be acid resistant type. Battery room drainage system shall comply with Company Standard KOC-C-025.

18.7.13.14 Battery rooms shall be independently ventilated. The walls of battery room shall extend up to roof soffit. False ceiling shall not be used in battery room. Additional requirements of Battery room in Substation shall be referred to Company Standard KOC-E-003, Part-1.

18.7.13.15 The Substation building shall also include a room for Instrumentation equipment. It shall consist of raised flooring system with minimum height of 600mm. Typical to Battery room, walls shall extend up to roof soffit with provisions of HVAC system and suspended ceiling as per Company Standards KOC-AR-001 and KOC-AR-002.

18.7.14 **Modular Laboratory Building**

18.7.14.1 Modular Structural steel type Laboratory building shall be provided with a dedicated Chemical drainage system and shall be in accordance with Company Standard KOC-C-025 including provision of Vacuum tanker connection. The Laboratory building shall include the following basic amenities;

a) One (1) Office room
b) Chemical Store Room
c) Laboratory equipment area
d) Toilets (Male & Female) including fresh water supply and sanitary drainage system
e) Dedicated HVAC System
f) Air Lock (Entry/Exit)

18.7.14.2 The finished floor of Laboratory building shall be tiled with acid resistant tiles, sloped to a chemical drain network and constructed with acid resistant material of anti-slip type. All grouting materials shall be acid resistant type.

18.7.14.3 Laboratory building shall be designed to maintain a positive internal pressure level (approximately 0.2 IWG (inch of water)) to prevent ingress of hazardous vapor/ fumes inside the building. A minimum of half air changes per hour of fresh air shall be used as exfiltration air. Mechanical ventilation system using wall/duct mounted propeller fans and associated electrical works shall be included as part of the scope. Airlocks shall be provided at the main entrance / emergency exit of the building.

18.7.14.4 Laboratory building shall be furnished with fire and gas alarms/detectors in accordance with Company Standard KOC-L-006 and shall be equipped with firefighting facility as per Company Standard KOC-L-009 as appropriate.

18.7.15 **Labor/Field Operator Rest Area**

18.7.15.1 Labor/Field Operator Rest room shall include the following basic amenities;

a) Toilets (Male & Female) including fresh water supply and sanitary drainage system
b) HVAC system
c) Pantry/dining area including basic necessities
d) Ceramic tiles floor finish
e) Suspended ceiling
f) Furniture
g) Other amenities as required

18.7.15.2 Labor/field operator rest area shall be designed to maintain a positive internal pressure level (approximately 0.2 IWG (inch of water)) to prevent ingress of hazardous vapor/ fumes inside the building.

18.7.16 **Equipment Shelter/Workshop/Warehouse Building**

18.7.16.1 Equipment shelters and Workshop/Warehouse building shall be designed and constructed from structural steel sections (pre-engineered) to meet functional requirements of the facility in accordance with applicable Company Standards as a minimum. Installation of Shelter, Workshop/Warehouse shall be carried out only by experienced Contractors.

18.7.16.2 Equipment shelters shall be built as partial opened type structures. The shelters shall be ventilated by roof-mounted extract fans or louvers to allow gases to escape. Final arrangement of ventilating system shall be provided by Contractor for Company's approval during detailed engineering.

18.7.16.3 Equipment shelter and Workshop/Warehouse building dimensions shall be finalized by Contractor during the detailed engineering to include Electrical, Instrumentation, and Mechanical works minimum operational & maintenance requirements. Final layout shall be submitted by Contractor for Company's approval.

18.7.16.4 The Contractor shall include the following minimum requirements while designing and constructing the shelter/workshop;

a) Equipment shelters and Workshop building shall include electric overhead travelling (EOT) cranes required for equipment maintenance purposes. The crane capacity shall be determined by Contractor during detailed engineering based on the heaviest equipment (or part of equipment) to be lifted and shall be in accordance with KOC-ME-005 requirements.

b) All equipment shelters shall be provided with concrete base slab with smooth finish and sloped to drains, 150mm high perimeter kerb and drain sump with removable grating cover to contain any hydrocarbons. Provisions of access ramps and concrete walkways (1000mm wide x 125mm thick) shall be included as part of scope.

18.7.16.5 Workshop building shall include the following minimum amenities;

a) One (1) office room, including HVAC system
b) Equipment Store Room
c) Work area
d) Toilets (Male & Female) including fresh water supply and sanitary drainage system

18.7.16.6 Workshop/Warehouse building shall be provided with roller shutter door (for entry & exit) for mobile equipment access and personnel access door. The width and height of doors shall be finalized by Contractor based on the facility operation and maintenance requirements.

18.7.16.7 The Workshop/Warehouse building shall be built as closed type structure (pre-engineered). The building shall be mechanically ventilated by roof-mounted extract fans to limit solar and internal heat gains. The fans will be operated by a thermostat located in a suitable location within the building. The final arrangement of ventilating system shall be provided by the Contractor for Company's approval during detailed engineering in accordance with Mechanical requirements.

18.7.16.8 The Workshop/Warehouse building shall be equipped with firefighting system as per Company Standard KOC-L-009.

18.7.16.9 All structural shelter shall be provided with RCC floor slab and kerb wall (height as per design) on perimeter of the slab. The shelter shall be provided with RCC ramp for vehicular approach on the front side and reinforced cement concrete plinth protection cum walkway on the remaining sides (minimum 1000mm width x 125mm thickness).

18.7.16.10 The structural steel shelter shall be covered on the roof and the sides with insulated metallic cladding consisting of color coated outer multi-layer profiled sheeting and an inner liner, each made of galvanized steel substrate, 22 gauge thick with fiberglass insulation. The structural steel shelter shall be supported on reinforced cement concrete substructure of grade beams, pedestals and footings.

18.7.16.11 EOT cranes shall be provided for Workshop, Multi-Phase Pump Shelters and Fire Water Pump Shelters. Other shelters shall be provided with EOT cranes based on equipment manufacturers recommendation.

18.7.16.12 All metal roof and wall cladding materials shall comply with Company Standard KOC-AR-002. The shelter which are not provided with EOT cranes shall be provided with removable type roof on top for accessing the equipment using cranes.

18.7.16.13 All building services including HVAC, Mechanical works, firefighting system (active & passive), fire alarm control Panel (FACP, plumbing, Electrical, instrumentation,) as required shall be considered as part of Contractor's scope.

18.7.17 **Chemical Storage Building**

18.7.17.1 A modular Chemical Storage building shall be designed and constructed by the Contractor. The Chemical Storage building shall be fully covered (roof and walls) with corrugated sheets. Necessary opening shall be provided with Steel doors, rollup shutter, windows, louvers and ventilators.

18.7.17.2 The external walls of the Chemical Storage Building shall be 22 gauge thick corrugated sheet. 100mm thick vinyl faced fiberglass insulation (density –12kg/m3) shall be provided for Roof and wall sheeting.

18.7.17.3 The floor of the Chemical Storage shall be constructed with minimum 150 mm thick reinforced cement concrete and shall be painted with chemical resistant epoxy paint.

18.7.18 **Guard House/Security Post Building**

18.7.18.1 The Contractor shall follow Company Standard KOC-G-019 Part-2 and Company Standard drawings (55-02-88 to 90) for the design and construction of Guard house/security post building for the facility.

18.7.19 **Valve Pits**

18.7.19.1 Construct new valve pits with chequered plate covers in accordance to the details provided in Company Standard drawing 55-02-39. The location, numbers and size of valve pits shall be in accordance with mechanical/piping detailed design and drawings. The walls of the pits shall be

designed for active soil pressure, surcharge and ground water pressure (if present). Base of the pit shall be designed for moments from walls, equipment load and uplift pressure.

18.7.19.2 The Contractor shall design and submit detailed construction drawings of valve pits for Company's review before constructing the same. Construction of valve pits shall be as per the following minimum requirements;

a) Excavate to the underside of the blinding level and cast 75 mm thick blinding with Grade-E2 concrete having 28 days characteristic cube crushing strength equal to 15 MPa in accordance with Company Standard KOC-C-006.

b) All the concrete work shall be in accordance with Company Standard KOC-C-006.

c) Cast RCC base slab with Grade-D1 concrete having 28 days characteristic cube crushing strength minimum 30 MPa in accordance with Company Standard KOC-C-006 forming kickers to the forthcoming wall.

d) Cast reinforced cement concrete wall in lifts not exceeding 1.00meter with Grade-D1 concrete having 28 days characteristic cube crushing minimum strength 30 MPa in accordance with Company Standard KOC-C-006.

e) Paint the exterior underground faces of valve pit walls with three (3) coats of approved bituminous paint in accordance with Company Standard KOC-C-006.

f) Paint all exposed external faces of valve pit walls including 150mm below ground level and complete inside faces walls and base slab with light gray color epoxy paint in accordance with Company Standard KOC-C-006.

g) Backfill and compact around the wall in accordance with the procedure described in Company Standard KOC-C-005.

h) Where pipes penetrate walls, the pipe should be fitted with puddle flanges. Fill and seal gap between Pipeline and sleeve using approved mastic or similar approved joint filler and sealant.

i) Fabricate and install a galvanized steel access ladder. Fix cross joist in the designated pockets on top of the concrete wall. Place galvanized chequered plate cover with lifting hooks and supporting steel frame works in accordance with the Company Standard drawing (55-02-39) and Company Standard KOC-C-007.

j) Fabricate and install operating platforms for valve operation including handrails and access ladders.

k) The Contractor shall install minimum 4mm thick water proofing membrane on the outer sides of valve pit walls and below the valve pit base to ensure water tightness of the valve pit.

l) Water Stoper of approved Manufacturer and size shall be provided in all Construction Joints.

m) The Contractor shall provide localized Sump of adequate size inside the Valve pit and the pit base shall be sloped to the sump. Pits shall be provided with suction pipe with vacuum tanker quick connection for draining of liquid/sludge.

n) Fabricate and install crash barriers all around the pits in accordance with the Company Standard drawing 55-02-40.

o) In-case the water table is above the underground RCC pit base, the Contractor shall install a layer of 4mm thick elastomeric water proofing membrane to the outer sides of pit walls. After installation of water proofing membrane, the Contractor shall construct 100mm thick protection wall of cement sand blocks all around and shall paint the exposed face of this block wall with bituminous paint as per Company Standard KOC-C-006 before commencing to back-fill.

18.7.20 **Corrosion Monitoring Pit**

18.7.20.1 Underground corrosion monitoring pits for retrieval of corrosion monitoring coupon/probe shall be constructed with water proof material for any underground station.

18.7.20.2 All the structural items not limited to Ladders, chequered plates, handrails, and safety cages shall be supplied and fabricated in accordance with Company Standard KOC-C-007 and the Company Standard drawings listed in the Technical specification.

18.7.20.3 In order to access the Corrosion Coupons, the Contractor shall provide a structural Platform inside the Pit.

18.7.20.4 Water stopper from an approved Manufacturer shall be provided in all construction joints of the Pit.

18.7.20.5 Corrosion Monitoring Pit's wall surface in contact with the earth shall be painted with 3 coats of cold applied modified Bituminous Paint of 1000 Microns (1mm) overall thickness and Pit base and inside faces of walls shall be painted with Light grey color epoxy paint as per Company Standard KOC-C-006.

18.7.20.6 Necessary tests not limited to Proctor Compaction Test for Soil and Cube Test for Concrete shall be conducted.

18.7.21 **Drain Vessel Pit**

18.7.21.1 The Contractor shall design and submit detailed construction drawings of pit and vessel foundation for Company's review before construction of the same. Open drain vessels and closed drain vessels shall be installed inside RCC pit with necessary supports. Appropriate access to drain sumps without the need to enter the concrete pit shall be provided.

18.7.22 **Manhole and Handhole**

18.7.22.1 The Contractor shall follow the Company Standard KOC-C-025 and Standard drawing 55-02-95 and 55-02-96 for the design and construction of manholes. Hand-holes shall be designed and constructed as per concerned disciplines' requirements and following Company Standard KOC-T-008. All manholes / handholes shall be provided with structural frames, hinged covers with locking facilities to prevent pilferage.

18.7.23 **Duct Bank**

18.7.23.1 The Cable ducts shall be constructed by following the Company Standard KOC-C-002 and the Standard drawings No. 55-02-111, 55-08-22 and 55-08-30.

18.7.23.2 Spare ducts requirements shall be followed by the Contractor as per Company Standard KOC-E-008.

18.7.24 **Crash Barrier**

18.7.24.1 Pipe crash barrier details shall be as per Company Standard drawing No. 55-02-40. The Crash barriers shall be installed for protecting the drain pits, valve pits, any other underground facilities, buildings, structures, piping, firewater hydrants, cables, equipment from potential damages due to loss of vehicle control.

18.7.24.2 The barriers shall be painted in compliance with Company Standard KOC-P-001.

18.7.25 **Valve/Pipe Supports and Pipe Sleepers**

18.7.25.1 Design, supply, fabricate and install valve/pipe supports and sleepers including RCC foundations at different locations as per mechanical/piping design.

18.7.25.2 The pipe sleepers and pipe supports shall be designed to fully accommodate the maximum load of pipe and accessories with accepted safety factors.

18.7.25.3 All the concrete work shall be in accordance with Company Standard KOC-C-006.

18.7.25.4 Design and fabrication of steel structure for supports shall be in accordance with AISC 325 & 360 (latest edition).

18.7.25.5 All structural steel material, fabrication and installation shall be strictly in compliance with the Company Standard KOC-C-007.

18.7.25.6 All structural steel members including frames, base plates, anchor bolt top and nuts shall be provided with passive fire protection by covering them with light weight vermiculite cement to provide fire resistance of minimum 2 hours in accordance with the Company Standard KOC-C-027 based on FERA recommendations.

18.7.25.7 Painting and coating of steel members shall be in accordance with the Company Standard KOC-P-001.

18.7.25.8 All steel sections shall be new from approved sources. The Contractor shall submit mill test certificate for approval of Superintendent prior to its incorporation into the Works.

18.7.26 **Bund/Dike Wall**

18.7.26.1 Bund wall shall be designed and constructed in accordance with Company Standard KOC-C-033.

18.7.26.2 Asphalt / RCC paved access ramps shall be provided in large compound bund walls for vehicular access to assist major maintenance works and to aid firefighting in certain situations. The Contractor shall refer Company Standard KOC-L-027 for further layout details. Warning signs indicating, "Access is limited to trucks / maintenance vehicles with valid permits only" shall be placed at prominent locations. Maintenance vehicles shall be allowed to access these areas with necessary work permits. Post (minimum height of 1.2meter) with chain shall be provided at the entry point of access ramp to prevent unauthorized vehicle entry to the Bund wall area.

18.7.27 **Culvert**

18.7.27.1 The design and construction of culverts shall be complied with Company Standard drawing Nos. 55-02-36. All the reinforced cement concrete work shall be according to Company Standard KOC-C-006.

18.7.28 **Structural Steel Shelters/Sunshade**

18.7.28.1 Design, supply, fabricate and install the structural steel shelter in accordance with Company Standard KOC-C-007. The Contractor shall size the shelter in accordance with the approved size and layout detail of equipment skid and all other approved piping requirement, operation & maintenance requirements to suite relevant Company Standards.

18.7.28.2 Design calculations, as required by the Company, and shop drawings shall be submitted for Company's review prior to the construction stage. Design and fabrication of steel structure for shelter shall be in accordance with AISC-325 Manual of Steel Construction – WSD (latest edition) for worst load combination.

18.7.28.3 Shelter shall be provided with RCC perimeter dike wall and RCC floor slab having minimum 150 mm thick with double layer reinforcement and provided with medium duty surface hardener. The dike walls shall be sized for loss of containment of the secondary storage tanks of skid based on Company Standard KOC-L-027.

18.7.28.4 The concrete floor shall be provided with an adequately sized RCC sump with grating cover and floor slab shall be sloped to the sump to collect and removal of sludge & wastes. RCC plinth protection cum walkway shall be provided on the outer sides all around the shelter.

18.7.28.5 RCC foundation shall be provided for the skid inside the shelter and it shall be designed by the Contractor by using foundation loading data from the approved skid Vendor/Mechanical GA drawing. The foundation shall be in the form of mass concrete covering full area of skid and projecting beyond the skid by minimum 200 mm on all sides. The base of the skid shall be elevated with respect to the floor of the shelter such that in the event of loss of containment of the skid tank, the collection of fluid remains below the base of the skid with a minimum clear free board of 150 mm. This aspect shall also be considered in deciding the height of the dike wall. Pipe supports / trench inside the shelter shall be as per mechanical/electrical design.

18.7.28.6 All internal faces of the sump walls and the bottom slab of the sump shall be protected as per Company Standard KOC-C-025. All other exposed faces of the concrete shall be painted with chemical resistant epoxy paint.

18.7.28.7 The structural steel shelters shall be supported on RCC substructure of grade beams, pedestals and footings and covered on the roof and the sides with insulated metallic cladding consisting of color coated outer multi-layer profiled sheeting and an inner liner, each made of galvanized steel substrate, minimum 22 gauge thick with fiberglass insulation.

18.7.28.8 All load bearing members of the steel shelter shall be fire proofed for two (2) hour fire rating in accordance with Company Standard KOC-C-027. All structural pipe supports for chemical skid piping and all structural pipe supports within the concrete dikes of the skid shall be fire proofed for minimum two (2) hour fire rating in accordance with Company Standard KOC-C-027.

18.7.28.9 Cast RCC foundations, equipment plinth, and foundation for skid, trench and slab on grade as per Company Standard KOC-C-006.

18.7.29 **Cathodic Protection Transformer / Rectifier (T/R) Units**

18.7.29.1 Construct RCC foundations and fencing for cathodic protection transformer / rectifier units in accordance with Company Standard drawing 55-02-49.

18.7.29.2 Distinct fence and Gates shall be provided for the Cathodic Protection Transformers as indicated on the reference Overall Plot Plan drawing No.:MRBF-SK-M-1001.

18.7.30 **Chain Link Fence with Access Gates**

18.7.30.1 Fencing materials for the plant facility shall be Medium Security Fence – Chain link barrier (MSF-CLB) and Flare area shall be Low Security Fence – Chain link (LSF-CL) in accordance with Company Standard KOC-G-019 Part-2.

18.7.30.2 Emergency pedestrian gates shall be provided as per FERA recommendations and at every 300-meter maximum spacing along the fence perimeter and shall comply with Company Standard KOC-G-019 Part-2.

18.7.30.3 Supply and install security gates as per Company Standard drawing No. 55-02-20 for the flare area.

18.7.30.4 Supply, fabricate and install fence as per the relevant Standard Drawings referred in this Technical Specification, and generally as directed by the Superintendent's Representative.

18.7.30.5 All steel posts, chain link fabric, concertina, extension arms, barbed wires, horizontal arms and all other miscellaneous supports structures and fixtures shall be hot dip galvanized in accordance with ASTM A153/A153M.

18.7.30.6 The Gate shall be fitted with heavy duty lock with key.

18.7.30.7 Supply and Install Signboards on the Fence as per Company Standard Drawing No. 55-02-21.

18.7.30.8 Outside the fenced area up to 10.0 meters shall be leveled and dressed-up by the Contractor, and the area to be left clean and tidy.

18.7.30.9 The Contractor shall compact and level the area inside the fence enclosure.

18.7.30.10 Adequate earthing shall be provided for fence/Gate/facilities as per Company Standard KOC-E-024.

18.7.31 **Access Platforms, Walkways, Ladders and Handrails**

18.7.31.1 Supply, fabricate and install access platforms, walkways and crossovers with ladders and handrails including their foundations in accordance with the detailed mechanical/piping design requirements.

18.7.31.2 The Contractor shall submit the design calculations and detailed drawings for Company's review as per the requirement of final mechanical/piping design.

18.7.31.3 Design and fabrication of steel structure for supports shall be in accordance with AISC Manual of Steel Construction (latest edition) for worst load combination.

18.7.31.4 Platform live loads shall be as per the Company Standard KOC-C-001.

18.7.31.5 Open grid flooring shall be serrated rectangular open grid type load bearing bars 30mm deep x 5mm thick at 30mm center to center with 10mm twisted bars at 100mm c/c in transverse direction.

18.7.31.6 Open grid flooring to be attached to supporting steelworks using approved Manufacturer's Standard clips. All cutouts and holes in open grid flooring shall be shop fabricated unless otherwise noted.

18.7.31.7 Holes and edges of open grid floor panels shall be banded and welded properly.

18.7.31.8 All structural steel material, fabrication and installation shall be strictly in compliance with Company Standard KOC-C-007. All members of the structural steel supports shall be fire proofed for two (2) hours fire resistant in accordance with Company Standard KOC-C-027.

18.7.31.9 All steel sections shall be new from approved source. The Contractor shall submit mill test certificate for approval of Superintendent prior to its incorporation into the work.

18.7.31.10 All the concrete work shall be in accordance with Company Standard KOC-C-006.

18.7.32 **Water Bars/ Water Stoppers**

18.7.32.1 Ribbed type water bars with bulbs made from polyvinyl chloride (PVC) shall be installed in concrete joints for water retaining structures such as pits, manholes, septic tank.

18.7.33 **Pipe Racks**

18.7.33.1 Design, fabricate and construct/install the new structural pipe racks including RCC foundation for the new process and utility pipe lines at the Facility. New pipe rack width shall be worked out in accordance with all new process/utility lines and its spacing as per approved mechanical / piping drawings. Additional space and Load of 25% for future piping shall be considered on each Tier while designing the pipe racks.

18.7.33.2 All structural pipe racks in classified Hazardous zone relevant scope of this Project shall be fire proofed for minimum two (2) hour fire rating in accordance Company Standard KOC-C-027.

18.7.33.3 The minimum overhead vertical clearances for pipe supports/first tier of multilevel pipe rack shall be 4.0m except for road crossings.

18.7.33.4 The minimum overhead vertical clearances for pipe supports/first tier of multilevel pipe rack shall be 5.5 m in accordance with KOC-C-002.

18.7.33.5 Clear distance of 1.2 m to 1.8 m should be considered from top of the first tier beam to the underside of the second tier beam for the average lines.

18.7.33.6 Minimum headroom clearance for platforms and stairways shall not be less than 2150 mm.

18.7.33.7 Expansion joints for pipe rack shall be limited as per KOC-C-001.

18.7.33.8 Design and fabrication of steel structure for pipe racks shall be in accordance with AISC 325 Manual of Steel Construction – WSD (latest edition) for worst load combination.

18.7.33.9 Pipe rack shall be designed to carry the loads of the pipes from approved piping stress report, wind load and other applicable pipeway loads as per Company Standard KOC-C-001. The Contractor shall design the foundations to carry the reaction forces of pipe rack structural column from approved structural analysis by STAAD Pro (Latest version).

18.7.33.10 The steel Sections used for pipe racks shall conform to ASTM-A36 or ASTM-A575 and shall be painted in accordance with Company Standard KOC-P-001.

18.7.33.11 All steel sections shall be new from approved source. The Contractor shall submit mill test certificate for approval of the Superintendent prior to its incorporation into the works.

18.7.34 **Instrument Stand**

Fabrication, installation of Instrument stand and shed shall follow Company Standard drawing No. 55-02-56.

18.7.35 **Light Poles and Foundations**

18.7.35.1 The Contractor shall construct new RCC foundations for light poles. Numbers, locations and height of light poles shall be in accordance with Technical Specification and Drawings for Electrical works.

18.7.35.2 The structural design calculations for the light poles and its foundations shall be submitted to the Company for review.

18.7.35.3 Light poles including RCC foundations shall be designed and constructed in accordance with Company Standard drawings 55-02-68, 55-07-4 and 55-07-06.

18.7.36 **Car Parking Shelter**

Car parking shelters for minimum 20 Nos. cars shall be constructed by the Contractor in accordance with the Company Standard drawing No. 55-02-69.

18.7.37 **Sign Boards**

Design, supply, fabricate and install safety/warning/escape signs with necessary information to the visiting and operational personnel. The Signs shall be provided throughout the Facility in both English and Arabic languages as per Company HSSEMS Procedure/Guidelines. The information shall include the working conditions, obligations and precautions to be all the times. All safety/warning/escape signs and notices shall be photo-luminescent types having a luminous intensity of eight (8)-million candle light per meter^2 after 30 minutes of complete darkness. The Contractor shall refer Company Standard KOC-L-009 for the requirements.

18.7.38 **Dismantling/Demolition Works**

18.7.38.1 The Contractor shall include required dismantling works of the existing steel structures including its foundation. The salvage materials shall be handed over to the Company yards and all debris including demolished concrete materials shall be disposed to an approved dumping area. The same shall be deemed included in the unit price of the respective activity. No separate item dismantling works shall be considered for the completion of any activity.

18.7.39 **Excavation/Trenching**

18.7.39.1 All excavations during the course of work shall be carried out by hand unless prior written permission is given for machine excavation.

18.7.39.2 Except as specified and/or otherwise ordered by the Superintendent's Representative, the minimum width of trenches shall be one (1) meter.

18.7.39.3 The soil excavated from trenches shall be deposited at a "clear" distance of not less than 1.2 meters from the edge of trenches. The sides of the trench should have proper slope depending upon the angle of repose of the soil to avoid cave-in.

18.7.39.4 The Contractor shall excavate trenches to the depths as determined by the Superintendent's Representative if not already specified in the appropriate Drawings.

18.7.39.5 Where the pipes crosses other lines, services or cables a minimum vertical clearance of one (1) meter shall be maintained.

18.7.39.6 Excavated soil/materials shall be completely removed on daily basis from the Facility/Plant area and the trenches shall be barricaded adequately. If the excavated soil is suitable for backfilling then the soil shall be brought back after carrying out thorough mixing outside the Facility/Plant area. Extensive care shall be taken by the Contractor to keep the Facility/Plant area free from accumulated soil.

18.7.39.7 Contractor shall comply with KOC.SA.026 Excavation Safety Procedure.

18.7.40 **Bedding and Padding**

18.7.40.1 Bedding and padding material shall be placed all around the pipes (bottom, both sides and top) and back fill material shall be placed above the bedding and padding. The bedding and padding activity shall be carried out as per Company Standard KOC-C-005.

18.7.40.2 Prior to placing bedding, the bottom ground surface of the trench shall be inspected and any loose soil (minimum 150 mm in thickness) shall be scarified and re-compacted to the required density. The bottom of the trench shall be covered with 150mm of Sifted sand prior to the placement of the pipeline. Sifted sand shall be placed all around the pipe line, at least 150mm thick above the top of the pipe line.

18.7.40.3 Electrical cable and instrumentation cable installations shall be as per Company Standards KOC-E-008 and KOC-I-002 respectively. A layer of sifted sand not less than 100 mm deep shall be laid and compacted to form a cable bed. The first 100 mm of backfill shall be sifted sand, well compacted and levelled. The cable tiles of an approved type inscribed in Arabic and English shall be laid over the first 100 mm of compacted sand, the tiles shall be carefully centered and interlocked and of width sufficient to provide a minimum coverage of 50 mm beyond cable edges.

18.7.41 **Backfilling**

Backfilling shall be carried out as per relevant clauses of Company Standard KOC-C-005 and shall commence only after written approval by the Superintendent's Representative is obtained. Backfilling shall include the initial cover of 150 mm of soft sand underneath and around the lowered in line. The remaining backfill material in 225 mm thick layers shall be consolidated /compacted by hand held machine (mechanical rammers) as per Company Standard KOC-C-

005. The Contractor shall stabilize the backfill for the full length of the buried lines by hand held machine, and shall ensure that the ground matches existing levels.

18.7.42 **Storm Water Drainage**

18.7.42.1 The Contractor shall design and construct a comprehensive drainage system encompassing the complete project scope including the areas inside and outside the fence of the facility and all roads in accordance with Company Standard KOC-C-025. The Contractor shall carryout the detailed design of drainage system with respect to the annual rainfall intensity as per Company Standard KOC-G-007 and other related design parameters and submit to the Company in the form of drawings and calculations for approval.

18.7.42.2 All paved and unpaved area shall be sloped in such a way to discharge storm water to the adjacent reinforced cement concrete drain channel/swale. The Contractor shall design and provide suitable rain water flow (RWF) conduits wherever required for the proper drainage. All internal roads shall be properly designed by the Contractor in such a way to drain out all storm water to the main drainage system by means of slope and / or drain conduits with manhole, as required.

18.7.42.3 All earth works shall be in accordance with Company Standard KOC-C-005.

18.7.43 **Fire Proofing of Structural Steel Work**

Fire Proofing of structural steel work shall be carried out in accordance with Company Standard KOC-C-027.

General

All load bearing members of the structural steel in classified Hazardous zone (pipe racks, supports, shelters) shall be fire proofed for minimum two (2) hour fire rating as per API 2218, FERA study outcomes and in accordance with Company Standard KOC-C-027, they are mainly;

a) Structures supporting equipment containing flammable materials, compressor house, pipe racks carrying overhead main gas / oil lines or supporting overhead fin fan air coolers and their assemblies shall be fire proofed.

b) The minimum extent of fireproofing shall be clearly indicated on approved design and construction drawings.

Fire Rating

Steel structures identified for passive fire protection shall be encased with fire proofing materials suitable to limit the steel surface temperature to 538 deg.C for a period of two (2) hours.

18.7.44 **Asphalt Road**

18.7.44.1 Design and construct all internal asphalt access road including all necessary road markings and signboards as per Company Standard KOC-C-024 Part-I & II and State of Kuwait Traffic Sign Manual.

18.7.44.2 The asphalt road sections shall comply with Company Standard drawing No. 55-02-94.

18.7.44.3 All the necessary quality tests shall be carried out in the Company's approved laboratory on Contractor's expense.

18.7.44.4 The Contractor shall connect the internal plant asphalt road with the nearby existing external asphalt road. All the necessary modification works shall be carried out where the new asphalt road connecting with the existing KOC road. The Contractor shall follow the asphalt pavement details as per existing KOC road section for the connecting portion.

18.7.44.5 Diversion road/detour shall be constructed by the Contractor, if there is any closing of the existing road is envisaged for construction.

18.7.44.6 Internal access road shall be provided between major equipment such as Multiphase pumps, GTG for maintenance vehicle entry.

18.7.45 **Gatch Road**

18.7.45.1 The Gatch road construction shall comply with Company Standard drawing No. 55-02-94 and KOC-C-024 Part 1 & 2 requirements.

18.7.45.2 The Gatch road shall comprise of minimum 300mm thick Gatch layer with properties as specified in the Company Standard KOC-C-024 Part-1 laid over a well compacted subgrade and compacted to 95% of maximum dry density at optimum moisture content. Where the soil at the specified sub-grade level is unsuitable, excavation shall continue until a suitable soil is encountered. The surface of acceptable ground shall be scarified for a depth of minimum 200mm and shall be levelled with approved batch of fill materials compacted to 95% of maximum dry density at optimum moisture content. The Contractor shall submit complete details of the Gatch road prior to the commencement of construction works.

18.7.46 **Disposal of Contaminated Soil**

18.7.46.1 Disposal of contaminated soil and dangerous wastes obtained from trenching works or other excavations inclusive of costs incurred towards hauling, loading transporting, delivering to designated area in Shuaiba Industrial area.

18.7.46.2 Contaminated soil shall be transported to a designated location in Shuaiba Industrial area and dispose after necessary treatments. Removal, transportation, treatment and disposal of the contaminated soil shall be strictly in compliance with the Company HSSEMS Procedures, Kuwait EPA regulations and any other applicable State regulations.

18.8 QUALITY TESTS

18.8.1.1 Contractor is responsible for conducting all field and Lab tests as per Company Standard /procedures and Reports shall be submitted to the Company. If the Construction is not meeting the requirements of the Company quality procedures/Standards/requirements, then Contractor is responsible for repairing/reconstructing the same at Contractor's own cost.

18.9 LIST OF ANNEXURES

ANNEXURE -1 TO APPENDIX-18	Specification for the Two Storey Blast resistant Modular Control Building
ANNEXURE -2 TO APPENDIX-18	List of Civil Drawings