KUWAIT OIL COMPANY (K.S.C.)

A subsidiary of Kuwait Petroleum Corporation



PRODUCTION & PROJECTS (GAS) GROUP
GAS PROJECTS TEAM - II

Mutriba Remote Boosting Facility (MRBF) at North Kuwait

Appendix 17

Electrical Technical Specification

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KUWAIT OIL COMPANY (K.S.C.)
(Register of Commerce No. 21835)

Mutriba Remote Boosting Facility (MRBF) at North Kuwait

Appendix – 17
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Appendix – 17
Electrical Technical Specification

1.0 INTRODUCTION

1.1 GENERAL

In addition to Mutriba Remote Boosting Facility (MRBF) Project Technical Specification, the description of the Works to be executed on this document are not given by way of limitation but in amplification of the Electrical work shown on the Drawings and Documents as Annexures to this Technical Specification.

The Contractor shall execute the Electrical Works at MRBF, which includes detailed site survey, studies, detailed engineering, design, procurement & supply of materials, shipping, and delivery to site, construction, testing, pre-commissioning, commissioning, performance testing and as-built documentation.

1.2 UNITS OF MEASUREMENT

All dimensions, units of measurement, physical constants etc. shall be in metric units (SI), unless otherwise specified.

1.3 ABBREVIATIONS, DEFINITIONS AND TERMINOLOGIES

AC, ac	Alternating Current
CCR	Central Control Room
CP	Cathodic Protection
DALI	Digital Addressable Lighting Interface
DB	Distribution Board
DC, dc	Direct Current
DCS	Distributed Control System
DOL	Direct-on-Line motor starting
EDG	Emergency Diesel Generator
E-SCADA	Electrical - Supervisory Control and Data Acquisition
ESD	Emergency Shutdown
ETAP	Electrical Transient Analysis Programme
FAT	Factory Acceptance Test
GTG	Gas Turbine Generator
HDG	Hot Dip Galvanized
HV	High voltage (11kV and above)
HVAC	Heating Ventilation and Air Conditioning
HSE	Health, Safety & Environment
IEC	International Electro-technical Commission
IED	Intelligent Electronic Devices

IP	Ingress Protection
ITP	Inspection and Test Plan
KOC	Kuwait Oil Company
LAN	Local Area Network
LED	Light Emitting Diode
LV	Low voltage (up to 1000V)
MAA	Mina Al Ahmadi Refinery
MCB	Miniature Circuit Breaker
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
MOV	Motor Operated Valve
MV	Medium voltage (below 11kV and above 1000V)
NFPA	National Fire Protection Association
P&ID	Piping & Instrument Diagram
SAT	Site Acceptance Test
SI	International System of Units
SRU	Sulphur Recovery Unit
UPS	Uninterruptible Power Supply
VSD	Variable Speed Drive

2.0 CODES AND STANDARDS

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

In the event of conflict between this document and the latest Standards / Codes / Specifications / drawings referred herein or other purchase or contractual documents, the most stringent requirement shall apply.

3.0 SCOPE OF WORK

3.1 GENERAL

3.1.1 Contractor's electrical scope of work shall include design, engineering, fabrication, assembling, and supply of all related electrical equipment, materials, devices, consumables and associated accessories including tools, labor and supervision among others to complete the electrical installation. It includes shop testing, inspection, packaging, delivery, transportation, inspection, quality assurance and control, testing, pre-commissioning, commissioning, training and guarantees of all

electrical systems and equipment belonging to this project. Contractor's scope shall include other electrical systems and or materials/accessories, which not mentioned but deemed required for the proper performance of the facility.

3.1.2 All electrical works shall be done as per the latest KOC standards & specifications and international and national standards unless specifically indicated and required on this specification.

3.1.3 This technical specification is a minimum project specific technical requirement and shall be read, understood and interpreted in conjunction with the Project Specifications, Project Datasheets, Project Drawings, Contract Documents & its Appendices/ Annexures, latest KOC standards and HSE requirements.

3.1.4 The information given on the project drawings are indicative and used for describing the overall scope of work only. It shall be the Contractor's responsibility to survey, verify, identify and develop all the required documents and deliverables during detailed engineering. Soft copy submission shall include native files & program files of drawing, sizing calculation and study reports such as Auto-CAD file, excel sheet, lighting calculation, ETAP file, etc.).

3.1.5 Equipment ratings and quantities shown in the drawings are preliminary and indicative only. Contractor shall confirm all the electrical equipment quantities, sizes & ratings as per project requirements and studies during detailed engineering without additional cost to the Company.

3.1.6 All equipment, materials, devices, consumables and accessories supplied and installed by the Contractor shall be new, unused and certified to the hazardous area classification it is installed.

3.1.7 Contractor shall procure all electrical equipment, devices, materials, consumables and other accessories from manufacturers listed in KOC Approved Manufacturers' List, unless otherwise approved by the Company. For selection of manufacturer/vendor of the products not listed, Contractor shall consider internationally reputed manufacturers which has past experience of supplying similar equipment/materials and submit pre-qualification documents for Company review and approval.

3.2 ENGINEERING & DESIGN

3.2.1 Contractor shall perform engineering and design of Electrical works for the whole facility of MRBF with the following specific requirements.

3.2.2 Electrical system design shall be in line with KOC Recommended Practice for Design Basis and Selection of Electrical Systems KOC-E-003 and other applicable KOC Recommended Practices & standards.

3.2.3 Electrical design, equipment and materials shall be manufactured and tested to meet the dusty and corrosive environment condition as specified in KOC-G-007. For electrical design of all electrical equipment (indoor or outdoor), ambient temperature to consider shall be -3°C to 50°C.

3.2.4 All the electrical equipment installed within an enclosed building suitably constructed to prevent the entry of dust & water shall have an ingress protection of IP 42 (minimum), and outdoor electrical equipment shall have an ingress protection of IP 55 (minimum) in accordance with IEC 60529.

3.2.5 Hazardous Area Classification shall be identified and determined as per the requirements specified in KOC-G-002. The term "Zone" shall be used for hazardous area designations for flammable gasses & vapours.

3.2.6 All electrical equipment/apparatus in hazardous area shall comply with the requirements of KOC-E-004 (Parts 1 to 6). Only certified approved electrical equipment are permitted in all hazardous areas. Certification bodies for all electrical equipment in hazardous areas shall be as per section 9.15 of KOC-E-004 Part 2.

3.2.7 Safety of life and preservation of installation are the most critical factors to be considered in the design of the electrical system. Due consideration shall be given to ease of maintenance, and availability of replacement parts. The Electrical system shall be designed considering a design life of 20 years.

3.2.8 All electrical equipment located outdoor shall be provided with sunshades/roof or shelters as a minimum.

3.2.9 Contractor shall provide Gas Turbine Generators (GTG) in n+1 configuration for the Power Generation System of MRBF.

3.2.10 The Power Distribution system of the facility shall be Dual Radial System and each feeder shall be sized for the Maximum Demand plus a minimum of 25% spare

capacity for future additions. Refer to Key Single Line Diagram - Annexure 1 of this Technical Specification for guidance.

3.2.11 Power feeder for redundant loads shall be from different bus section of the Switchgear/MCC for reliability and minimum interruption to the facility operation during maintenance.

3.2.12 Emergency Diesel Generator (EDG) shall be used in case of Power Generation loss. The EDG shall provide power for all GTG starting motors including its associated loads for GTG start-up and loads critical for personnel / plant safety or shutdown of the facility. All critical and essential loads specified in section 13.3.7 of KOC-E-003 Part 1 shall be considered as a minimum, any other loads identified as critical or essential during detailed engineering and HSE studies shall be included.

3.2.13 Contractor to plan an early delivery & readiness of EDG at site to be able to utilized as a power supply for pre-commissioning & commissioning activities of low voltage utilities & process equipment in the facility prior to GTGs availability.

3.2.14 Spares on equipment's shall be provided for future loads and shall not be less than 25% unless otherwise stated on this specification. Spare terminals on equipment shall not be less than 25%.

3.2.15 Equipment capacities/ratings shall meet the requirement of peak load plus 25% for future loads.

3.2.16 Contractor shall develop and submit to Company for approval the Electrical Load List of the facility, considering coincidence factors for the different load types such as continuous, intermittent and standby loads to determine the plant running load and peak demand load of the facility.

3.2.17 Contractor shall submit Illumination Calculation for outdoor and indoor lighting of the facility in accordance with lux level requirement specified in section 10.3 of KOC-E-017 for Company review.

3.2.18 Contractor shall follow the requirements as shown in KOC Electrical Standard Drawings (Series 55 drawings/documents) in the design, engineering, and installation of the electrical facility in addition to the KOC Standards and Specifications.

3.2.19 Contractor shall provide electric heat tracing on pipes, vessels and other items requiring electric heat tracing as shown in the P&ID's.

3.2.20 Contractor shall undertake a 3D model review (30%, 60%, and 90%) of the substation and electrical system showing the cable/tray routing under and inside the substation, equipment general arrangement and accessibility, bus duct routing, etc.

3.2.21 The following system voltage, frequency and neutral earthing shall be used for MRBF.

a. Frequency : 50Hz (±2.5%)

b. High Voltage : 11kV (±6%) 3 phase 3 wire impedance earthed

c. Medium Voltage : 3.3kV (±6%) 3 phase 3 wire with solidly earthed neutral

d. Low Voltage : 440V (±6%) 3 phase 4 wire solidly earthed neutral

: 250V (±6%) 1 phase 2 wire solidly earthed neutral

: 110V (±6%) 1 phase 2 wire center point solidly earthed

e. AC UPS System : 110V ±1%, 1phase 2 wire, 50Hz ±0. 5% solidly earthed neutral

f. DC System : 110V DC ±1% unearthed

g. DC System (F&G): 24V DC ±1% unearthed

3.2.22 Electrical Equipment shall be suitable for operation at the following voltages:

a.	Motors above 1200 kW	:	11kV
b.	Motors above 120 kW up to 1200 kW	:	3.3kV
c.	Motors up to 120 kW	:	440V
d.	Lighting supply	:	440V/250V, 3ph & neutral
e.	Lighting systems	:	250V, phase & neutral
f.	Instruments (non-vital)	:	250V, phase & neutral
g.	Instruments (vital) (note 1)	:	110V, phase & neutral
h.	E-SCADA System (note 1)	:	110V, phase & neutral
i.	Welding outlets	:	440V, 3ph & neutral
j.	Convenience outlets	:	250V, phase & neutral

k. Switchgear Control & Annunciator [(note 1)]: 110V DC floating

l. F&G System [(note 1)] : 24V DC

Note 1:
Supply from AC or DC Uninterruptible Power Supply System (UPS)

3.2.23 Perform and conduct full and extensive Power System Studies covering the Electrical Power System from the Gas Turbine Generators up to and including all electrical equipment and loads of the facility in order to determine the ratings of the electrical equipment, size the electrical equipment & devices. The following Power System Studies shall be undertaken using the latest version of ETAP Software. All Study reports shall be submitted to Company for review and approval.

a. Load Flow

b. Short Circuit

c. Motor Starting

d. Harmonic Analysis

e. Relay Coordination

f. Earthing System

3.2.24 Conduct Lightning Protection System Study covering the whole MRBF facility. Risk Analysis shall be done in accordance with the requirements of IEC 62305-2 to determine the level of Lightning Protection System requirements for the entire facility. All parts (Part 1-4) of IEC-62305 shall be considered for Lightning Protection against physical damage to structures, life hazard, electrical & electronic systems within structures. The study shall not be limited on buildings, vessels, tanks, pipelines and valves, stacks and towers. Consideration shall include a person working in any area of the facility. Study reports shall be submitted to Company for review and approval.

3.3 ELECTRICAL EQUIPMENT & SYSTEMS

Contractor shall Design, Procure, Supply, Install, Test, Pre-Commission and Commission all the equipment's and materials required for the electrical system including but not limited to the following main electrical equipment with specific requirements as indicated.

3.3.1 Substation

a. All Substation buildings shall be elevated, modular prefabricated structural steel type, as defined in Appendix-18 - Civil, and Structural & Architectural Technical Specifications.

b. MRBF facility shall consists of one Main Substation (Substation-1) for Oil, Water Sections, Utilities & Common Loads and Flare.

c. Substation of pre-fabricated modular type shall be compact robust structure design, walk-in type metal housing with thermal insulation that can withstand the radiation intensity, which shall be determined during fire zone analysis & Risk Assessment.

d. Substation shall be unmanned, pre-installed with small power socket outlets, lighting (normal & emergency), HVAC system with maintained positive pressure inside, and associated Distribution Boards.

e. Substation shall be equipped with all the electrical equipment inside such as Switchgears, MCCs, Distribution Boards, Control Panels/Annunciators, VSD's, DC/AC UPS, Batteries among others, Welding outlets, earthing & lightning protection system, telecommunication system, all safety equipment and Fire Alarm Detection and Protection/Suppression System as described in KOC Standard KOC-E-003 Part 1 section 10.5.

f. Contractor shall ensure proper coordination with the electrical equipment vendor/manufacturers for the design and supply of all electrical equipment inside the Substation and to meet the building requirements.

g. Substation shall be with separate room for Instrumentation Panels. Separate battery room with the required HVAC system shall be provided for DC & AC UPS System.

h. Optimum size of the substation shall be as per actual equipment's dimensions including all future electrical equipment. Floor space (without panels) shall be provided in the substation for 11kV Switchgear extension at both ends for future GTGs and Transformer connection.

i. All clearances between equipment including the elevation of the substation shall be as per section 10.4 of KOC-E-003 Part 1.

3.3.2 Power Generation System

a. Power Generation System using Gas Turbine Generators (GTG) shall be required for the facility with N+1 configuration (N-running + 1-standby).

b. The design, manufacture, supply, inspection and testing of Gas Turbine Generator Package shall be as specified in Mechanical Design Criteria Appendix 12 of Technical Specification, GTG Data Sheet (Annexure -3 of this Technical Specification), KOC-E-007 & KOC-ME-012.

c. GTG package shall be complete with all mechanical, civil/structural steel support, piping, electrical, instrumentation, safety & fire protection/suppression systems.

d. Operating GTG quantity and rating shall be determined by calculating the peak demand load of the facility plus 25% future load.

e. The rating of each GTG shall be @ 50°C Ambient Temperature (11kV, 3Ph, 50Hz). Quantity and rating of GTG shall be N+1 numbers (N-running +1-standby) for approximate load of 13-16 MW based on GTG manufacturer's standard equipment rating to meet this power requirement. It is Contractor's responsibility to optimize the load of the facility so as not to exceed the GTG quantity and rating. Contractor may increase the rating or add a GTG as per Contractor's design and engineering. Any increase or addition of GTG shall be at no cost & time impact to Company.

f. GTG shall be capable of running in parallel after synchronization. GTG Monitoring panel shall be provided to monitor and control the status of each GTG remotely.

g. GTG Batteries shall be Ni-Cad, self-contained and maintenance-free. Batteries shall be installed in a battery room of Substation 1.

h. The GTG shall be provided with necessary outputs to interface with E-SCADA and DCS for control and monitoring.

i. GTG's enclosure shall be as specified in the GTG Datasheet and installed in a shelter. Dust gasket in Generator enclosure for dust protection shall be provided. For shelter requirements, refer to Appendix 18 - Civil/Structural & Architectural Technical Specification.

j. Generator Protection shall be provided by equipment suppliers as part of a total package. The generator protection shall be certified as a protection device for generator and the minimum protection required shall be as per section 12.2 of KOC-E-006.

3.3.3 HV/MV Switchgears

a. The design, manufacture, supply, inspection and testing of HV/MV Switchgears and control gears shall comply with the requirements of KOC-E-002 Part 1.

b. The switchgear shall be arc resistant as per IEC 62271-200. Means for release of overpressure due to causes such as internal flashover shall be provided and directed away from the operator in accordance with IEC 62271-200.

c. The switchgear shall have a capability to be controlled and monitored remotely via E-SCADA.

d. Contractor shall provide a dummy panel to avoid switchgear vertical sections with cable entries being located directly below a structural beam.

e. Vacuum Circuit breakers shall be rated for 3 cycles opening time at the rated voltage.

f. Annunciator Panel shall be provided for Switchgear. The requirements for the Annunciator panel shall follow section 26.0 of KOC-E-002 Part 1.

g. Remote Control Panel shall be provided for Control (Open and Close) of all circuit breakers (incoming, bus section, outgoing) and shall be installed inside the Substation. Close control to be operative only when circuit breakers are selected for remote control. The requirements for the remote control panel shall follow section 25.0 of KOC-E-002 Part 1.

h. The Switchgear shall be indoor type installed inside the substation.

3.3.4 LV Switchgears/MCC

a. The design, manufacture, supply, inspection and testing of the new 440V switchboards for MRBF shall comply with the requirements of KOC-E-009 and shall be designed, constructed and tested for internal arc containment in accordance with the requirements of IEC/TR 61641.

b. The LV switchgear/MCC Communication protocol shall be compatible with the E-SCADA System and DCS. The Contractor/Manufacturer shall ensure the inter operation between different Intelligent Electronic Devices (IED) and E-SCADA/DCS for achieving data exchange, monitoring & control requirements.

c. The various functional units of the switchgear (incomers, motor starters, contactor / other feeders) shall be provided with Intelligent Devices (IED / relays / interface modules as required to communicate with E-SCADA / DCS for control, monitoring, diagnostics etc. Contractor/Manufacturer shall provide a redundant communication connection between the Intelligent Switchgear/MCC and DCS/E-SCADA for reliability. Contractor/Manufacturer shall also provide the software and hardware required to operate, program/set-up and maintain the Intelligent Switchgear/MCC.

d. Contractor shall provide a dummy panel to avoid switchgear vertical sections with cable entries being located directly below a structural beam.

e. The 440V Switchgear/MCC shall provide power to motors, UPS, MOV's, Lighting DB's, HVAC, welding outlet, small power loads and other 440 VAC loads of MRBF.

f. Earth fault protection for all feeders shall be provided.

g. Busduct shall be used to connect between the MV/LV Switchgear/MCC assemblies and Transformers and shall be as per section 12.0 of KOC-E-009.

3.3.5 Power Transformer

a. The design, manufacture, supply, inspection and testing of Power transformers shall comply with the requirement of KOC-E-005.

b. Contractor shall supply Power Transformers for MRBF. Transformer ratings and quantity shown in the preliminary Key Single Line diagram are minimum and should be reviewed and updated by Contractor based on the actual loads and on the result of the transformer sizing calculation.

c. Each Power Transformer shall be sized with Peak Demand Load plus 25% for the future load. Transformer shall be rated at 55°C ambient temperature.

d. The Power Transformer shall be installed outdoor adjacent to the modular type substation with foundation on the ground level with steel channel for transformer wheels. It shall be provided with fence and shelter.

e. The Power Transformers status shall be monitored by E-SCADA.

3.3.6 DC Power Supply Unit (DC UPS System)

a. The design, manufacture, supply, inspection and testing of DC Power Supply system at MRBF shall comply with the requirements of KOC-E-012.

b. The DC supply unit shall include the following;

   i. One (1) set of battery bank

   ii. Redundant battery chargers, each rated to take the full load. The chargers shall be in hot stand-by to take the load in case one charger fails. During normal operation, the chargers shall share the load equally.

   iii. One Main DC Distribution Board.

c. Batteries shall be Nickel-cadmium, maintenance-free, no addition of water required, and medium-discharge type conforming to IEC 62259.

d. The battery chargers shall be connected to the emergency switchboard for back-up power.

e. DC power supply units shall be indoor type and shall be installed inside the Substation. Batteries in a battery rack with Isolator shall be installed inside the battery room. The battery room shall be hazardous area classified Zone 1 and all electrical equipment/devices installed shall be certified to Zone 1 Ex d IIB+H2 T3 minimum.

f. An additional 25% spare capacity shall be added to the ampere-hour rating of the batteries to cater for future additions to the load.

g. Battery autonomy shall be 8 hours.

h. The DC system status and control shall be monitored by E-SCADA.

3.3.7 Uninterruptible Power Supply System (AC UPS System)

a. The design, manufacture, supply, inspection and testing of AC UPS system at MRBF shall comply with all the requirements of KOC-E-011.

b. The UPS system shall be a parallel dual redundant system having duplication of all parts except the by-pass supply, the battery and its isolator.

c. The redundant UPS shall be provided with main distribution board with two (2) main incomers from each UPS.

d. Batteries shall be Nickel-cadmium, maintenance-free, no addition of water required, and medium-discharge type conforming to IEC 62259.

e. The UPS shall be fed from emergency switchboard for back-up power.

f. UPS shall be indoor type and shall be installed inside the Substation. Batteries in a battery rack with Isolator shall be installed inside the battery room. The battery room shall be hazardous area classified Zone 1 and all electrical equipment/devices installed shall be certified to Zone 1 Ex d IIB+H2 T3 minimum.

g. An additional 25% spare capacity shall be added to the ampere-hour rating of the batteries to cater for future additions to the load.

h. Battery autonomy of various control, monitoring and safety systems (DCS, ESD, PAGA, CCTV, E-SCADA, etc.) shall be provided as per section 11.1.7 of KOC-E-011.

i. A dedicated UPS System shall be provided for Fire & Gas System with 24.5hours battery autonomy as specified in KOC-I-001 section 9.16.1-b and KOC-I-005 section 6.2.3-e-6.

j. Contractor shall size and provide sizing calculation based on the load duty cycle of each UPS. Any increase of the UPS rating during detailed engineering shall be at no cost and time impact to Company.

k. The UPS system status and control shall be monitored by E-SCADA.

3.3.8 Variable Speed Drives (VSD's) Controllers

a. The design, construction, performance and testing of the variable speed drives (VSD) controllers/ shall comply with all the requirements of KOC-E-014.

b. The VSD controller shall be designed and constructed for internal arc containment in accordance with requirements of IEC 62271-200 (for above 1000V) and IEC TR 61641 (for up to 1000V). The VSD Controller, including its structural frame work, sheet steel enclosure, doors etc. shall be capable of withstanding the internal pressures within the structure created by faults such as short circuit or malfunction.

c. Requirements for variable speed drive (VSD) controllers on 11kV/3.3kV/440V motors shall be based on Process requirement and considering the study report on short circuit rating, motor starting current & voltage drop.

d. The manufacturer itself shall provide all interconnection cables within the equipment supplied by the equipment manufacturer.

e. VSD's shall be indoor type and shall be installed inside the Substation.

f. VSD Controllers shall be provided with necessary outputs to interface with E-SCADA and DCS for various control and monitoring.

g. VSD Controller (11kV or 3.3kV) shall be provided with suitably rated arc resistant Isolator for local isolation of VSD. Key interlocking system shall be provided to ensure that the HV/MV door compartment of the VSD Isolator are not being able to open unless the upstream 11kV or 3.3kV Switchgear' Circuit Breaker is locked in Off-position.

3.3.9 High Voltage Induction Motors

a. The design, manufacture, supply, inspection and testing of high voltage induction motors at MRBF shall comply with the requirements of KOC-E-001.

b. Motors shall be premium efficiency type (IE-3) as per IEC 60034-30.

c. Motors shall be designed for variable speed drive application.

d. Motor terminal boxes shall be oversized and large enough to accommodate incoming cable bending radius and the cable termination accessories.

e. Motors shall be certified to the area classification where it shall be installed.

f. Motors shall be provided with shed or shelter as part of the equipment skid when installed outdoors.

g. Orientation of motor terminal boxes shall be coordinated with piping and other nearby equipment where it is installed for accessibility and maintenance purposes.

h. Motor control and stations shall comply with the requirements of section 13.6 of KOC-E-006 and section 23 of KOC-E-003 Part 1.

3.3.10 Low Voltage Induction Motors

a. The design, manufacture, supply, inspection and testing of low voltage induction motors at MRBF shall comply with the requirements of KOC-E-010.

b. Motors shall be premium efficiency type (IE-3) as per IEC 60034-30.

c. Motors used for variable speed drive application shall be designed for variable speed drive duty.

d. Motor terminal boxes shall be oversized and large enough to accommodate incoming cable bending radius and the cable termination accessories.

e. Motors shall be certified to the area classification where it shall be installed.

f. Motors shall be provided with shed or shelter as part of the equipment skid when installed outdoors.

g. Orientation of motor terminal boxes shall be coordinated with piping and other nearby equipment where it is installed for accessibility and maintenance purposes

h. Motor control and stations shall comply with the requirements of section 13.6 of KOC-E-006 and section 23 of KOC-E-003 Part 1.

3.3.11 Lighting, Receptacles and Small Power Loads

a. The design and selection of lighting, receptacles and small power loads at MRBF shall comply with the requirements of KOC-E-017.

b. Lighting, receptacles and small power loads shall include but not limited to the following: lighting fixtures, poles and its accessories, welding receptacles, socket outlets, distribution boards, and lighting controllers.

c. Contractor shall supply all materials, consumables, accessories and other items required to install and mount the items as stated above.

d. All lighting fixtures at MRBF shall be LED type.

e. State of the art lighting control system using 'Digital Addressable Lighting Interface (DALI) system' shall be provided in Control Building.

f. In areas where critical activities are performed, all light fixtures shall be backed-up by emergency generator supply. Emergency lights shall be 20% of the total lighting in any area.

g. Battery-powered emergency and exit lights shall provide illumination for a minimum period of One and Half (1½) after power failure. Batteries shall be sealed Ni-Cad, self-contained and maintenance-free.

h. Lighting fixtures, welding receptacles, socket outlets, distribution boards, switches, controllers and related electrical devices shall be certified to the hazardous area classification where installed.

i. Lightings in the following outdoor areas are required and shall be controlled by photocells with built-in time delay;

   i) Road Lighting (Main and access roads, in 10m min. height HDG pole)

   ii) Fence Lighting (Facility perimeter fence including flare area & evaporation pond illuminating both sides of the fence, in 6m min. height HDG pole)

   iii) Area Lighting (General/Open areas, in 20m High Mast HDG pole)

   iv) Tank Lighting (Roof & stairs, in 2m min. height stanchion)

   v) Stairs and platforms lighting for vessels, stacks, multi-level skid platforms and similar structures (in 2m min. height stanchion and/or surface mounted on the steel structure)

   vi) Open shelters & exterior lightings of buildings (mounted on steel structure or walls)

vii) Aviation Obstruction Lights (AOL) and control system shall be provided for high-rise structures with more than 45 meter tall such as Flare / Stacks among others in accordance with the requirements of Federal Aviation Administration (FAA). AOL shall be retractable type for maintenance purposes at the ground level.

3.3.12 Earthing, Bonding and Lightning Protection System

a. The design, manufacture, performance, installation, testing and commissioning of the earthing, bonding and lightning protection system at MRBF shall conform to the requirements of KOC-E-024 and to various related international standards as stated therein.

b. Contractor shall undertake an overall plant lightning protection system study and design, supply, install, test and commission the overall plant lightning protection system at MRBF as per KOC-E-024.

c. Contractor shall supply all materials required for the earthing, bonding and lightning protection of the entire facility and electrical system. This includes the earthing, bonding and lightning protection of the packaged equipment, fencing around the facility and fencing around the flare stack area, the pipe racks and pipe supports, tanks, vessels, all steel structures, buildings and equipment.

d. Contractor shall interconnect all the packaged equipment at MRBF earthing, bonding and lightning protection system and the same shall be connected to the main earthing, bonding and lightning protection system of the facility. There shall be a minimum of two (2) earthing connection for each packaged equipment/skid to the main existing earthing system.

e. Contractor shall supply and install earth pits at MRBF as per KOC Standard drawing detail no. 55-07-11. The quantity and length of the earth electrodes shall be such that the combined electrode resistance to earth of the facility Electrical Earthing system shall be four (4) ohms or less under all soil conditions.

f. Insulated (green/yellow colored) earthing cables shall be used to meet the requirement of section 10.1.5 of KOC-L-015.

g. Rolling sphere method shall be used for determining the positioning of air terminals of Lightning Protection System. The protected zone shall be shown in the layout drawings and sections for clarity.

3.3.13 Motor Operated Valves Actuators (MOV) and Isolators

a. The supply, design, manufacture, performance, inspection and testing of motor operated valve actuators (MOV's) at MRBF shall comply with the requirements of KOC-E-013.

b. MOV actuators shall be smart type and equipped with field control unit modules to support control and monitoring from remote station using two-wire loop.

c. MOV's shall be provided with isolator switches for maintenance purposes.

d. Contractor shall confirm the power supply requirement of the MOV's whether normal or emergency depending on the criticality of the MOV function.

e. MOV actuators and isolators shall be certified to the hazardous area classification where installed. Minimum hazardous area classification shall be Ex 'd' IIB T3.

3.3.14 Electric Surface Heating

a. The design, supply, selection, installation, testing and commissioning of the electric surface heating systems for vessels, piping and pipelines and other items required to be electrically heat traced at MRBF shall conform to the requirements of KOC-E-018.

b. Contractor shall identify and provide Electric Surface Heating based on Process requirement and as per the P&ID.

c. Contractor shall provide calculations, bill of materials, electric heat tracing isometric drawings, single line diagrams, documentation and design deliverables for Company review and approval as per Appendix A of KOC-E-018.

d. Contractor shall provide records of installation, inspection and testing of the electric heat tracing system as per Appendix A of KOC-E-018.

e. Electric Surface Heating shall be suitable and certified to the hazardous area classification where installed. Minimum hazardous area classification shall be Ex 'd' IIB T3.

3.3.15 Cathodic Protection System

a. The design, manufacture, supply, inspection and testing of the cathodic protection system of MRBF shall comply with the requirements of KOC-L-012, KOC-L-015, KOC-L-018 and KOC-L-026.

b. A Cathodic Protection Specialized Contractor approved by Company shall carry out the design and installation of the CP system.

c. A Cathodic Protection Specialist Engineer (NACE certified as CP-Specialist or equivalent) shall carry out the design and commissioning of Cathodic Protections Systems.

d. Power supply for the cathodic protection shall be derived from the nearest Substation. Supply and installation of power cables including CP Systems (CP Transformer Units, anode, CP cables & associated equipment/accessories) shall be part of Contractor's scope of work.

e. All design calculations, schematic drawings/diagrams and layout shall be submitted to Company for information.

3.3.16 Cables and Cabling System

a. The design, manufacture, supply, inspection and testing of Cables of MRBF shall comply with the requirements of KOC-E-008 and KOC-E-023.

b. All cables shall have annealed stranded circular or shaped copper conductors.

c. Power Distribution Cables (11kV or 3.3kV) from Main Substation to other substations shall be routed underground.

d. All underground cables shall be suitable for underground use and shall have appropriate lead sheath.

e. Cable type shall be Cu/XLPE/LC/PVC/SWA/PVC for lead covered cables or Cu/XLPE/PVC/SWA/PVC for non-lead covered cable.

f. Aboveground cable installation on cable trays / ladders utilizing the main pipe racks route are the preferred installation for MRBF. However, Contractor shall ensure that sufficient accessibility for installation / maintenance of cables are provided and areas prone to mechanical damages to cables are avoided.

g. Aboveground cables shall be Copper, XLPE/PVC/SWA/PVC.

h. The PVC outer sheath used for cables shall be flame retardant type, meeting the requirements in accordance with IEC 60332-3-22.

i. Fireproofing of aboveground cables/cable trays/ladders shall be provided wherever fire hazards are identified during HSE Studies.

j. Fire resistant cables shall be used for power supply to "Emergency Systems/Circuits" as specified in section 10.1 of KOC-E-008.

k. Cable ladder racks shall be the primary support for the above ground routing of all electrical cables. Wherever pipe rack is not available in the routing of cables, cable ladder racks shall be provided. Cables from Substation to nearest main pipe rack shall be routed with cable trays/ladder on a cable rack.

l. Cable ladder racks and accessories shall be heavy duty hot dipped galvanized steel.

m. Cable ladder and trays exposed to the sun shall be provided with covers.

n. Cable ladders and trays shall be sized to provide a minimum of 25% spare space for future use.

o. Where cable ladders or trays pass through walls of rooms that are designated as fire barriers, they shall be effectively sealed using fire resistant non-combustible materials.

p. All cable ladders and trays shall be bonded to earth. Earth continuity shall be ensured throughout cable ladder systems by the provision of earth bonds across all joints, by bonding together adjacent ladders and trays, and by bonding each end of each run and every 30 meters to earth.

q. All incoming and outgoing cables from Substations shall be from bottom of the elevated substation. Contractor shall provide cable trays/ladders under the substation to support and route the cables properly. No cable shall be run unsupported.

r. Use of intermediate junction box for cable termination at the equipment shall be avoided. All long cable runs and sizes shall be properly coordinated with the equipment termination box and/or terminals.

s. Cable grouping and segregation with other cables and services whether above or below ground; it shall be designed and installed as per section 13.2 of KOC-E-008 and all relevant standard referred therein. Protection & Clearance requirements stated in KOC-L-002 shall also be followed.

t. Cable warning tape shall be provided at a depth of 300 mm from the surface level for all underground installation such as direct buried, in conduits or in duct banks.

3.3.17 E-SCADA System (Future)

a. Supply of E-SCADA system is excluded from the project scope. However various electrical equipment, which shall include but not limited to the following, shall be designed for interface with future E-SCADA System as per KOC-E-027 and Technical Specification.

   i) Gas Turbine Generators
   ii) Switchgears (11kV/440V)
   iii) MCC's
   iv) Emergency/Black Start Diesel Generators
   v) Power Transformers
   vi) VSD's
   vii) UPS & Battery Chargers
   viii) Substation HVAC / Fire Alarm / Fire Suppression Systems
   ix) DCS

b. Each Substation shall be provided with space for future local outstation, which communicates to Main E-SCADA Panel in the Control Building in future. Space provision shall be considered in Control Building for future E-SCADA Panel.

c. The communication protocol of various intelligent components used in all electrical equipment/system shall be compatible with the E-SCADA system to which the inter-operability is envisaged.

d. Space for Workstation of E-SCADA System shall be considered in Control Building Electrical Supervisor room.

3.3.18 Emergency / Black Start Diesel Generator (EDG)

a. The design, manufacture, supply, inspection and testing of Emergency / Black Start Diesel Generator system at MRBF shall comply with the requirements of KOC-E-007.

b. EDG shall be preferably supplied as a Modular Package design in a walk-in type metal housing enclosure with thermal and sound insulation complete with all its auxiliary equipment and devices like batteries, chargers, lighting, socket outlets, interconnecting cables/bus duct, earthing, HVAC, EDG Switchgear & Load Bank, etc. pre-installed in the modules.

c. The modular package shall be equipped with associated safety systems like Fire Alarm & Detection and Fire Suppression System.

d. EDG shall be provided with enclosure of IP 54 rating and shall be installed in a shelter (if supplied in non-modular package design specified above) with dummy load bank and its associated Switchgear. Refer to Appendix 18 – Civil/Structural & Architectural Technical Specification for shelter requirements.

e. Where switchgear is installed in the EDG Shelter, it shall be provided with Switchgear room complete with lighting & socket outlet, HVAC, fire alarm / detection and fire suppression systems.

f. The EDG shall be rated for the Emergency Peak Demand calculated plus a minimum of 25% for future addition. The minimum rating of the EDG shall be 2.0MW @ 50°C Ambient Temperature.

g. EDG shall be provided with all piping connections and fuel day tank of minimum capacity to supply fuel for 24 hours of continuous operation.

h. Two sets of batteries shall be provided for EDG intended for electric starting. Each battery sets shall be provided with independent battery charger units. Batteries shall be Ni-Cad, self-contained and maintenance-free.

i. Generator Protection shall be provided by equipment suppliers as part of a total package. The minimum protection required shall be as per section 12.2 of KOC-E-006.

3.3.19 Electrical Power Systems and Protection & Control Schemes

a. The minimum requirements for power system studies, guidelines for design and selection of protection and control schemes for the electrical distribution network of the facility shall conform to the requirements of KOC-E-006.

b. Contractor shall submit the electrical power systems protection and control scheme for MRBF for Company review and approval.

c. Contractor shall provide relay programs and settings, shall download the relay programs to the relays and shall test and commission the relays. All relays (for protection, control and monitoring/metering) shall be provided with programs & settings and shall be tested and commissioned before the corresponding equipment is energized.

d. Electrical equipment shall be rated to handle the maximum available fault current from the power system without damage. The selected standard equipment short circuit rating shall have a minimum of 10% allowance to a calculated or available fault current in the power system, whichever is higher.

e. Contractor shall determine the maximum available fault current taking into consideration that all equipment's including standby equipment's (loads and generators) and other power supplies are connected and running.

f. Contractor shall also determine the minimum available fault current for protection purposes.

g. Contractor shall include arc flash labelling of all electrical equipment based on the result of the arc flash study. Contractor shall refer to NFPA 70E for details.

h. All contacts for trip indication shall be volt-free and wired fail-safe.

i. Any use of short circuit limiting devices such as IS limiters and resonant links (short circuit limiting couplers) or DC links shall be avoided. Company review

and approval is required for use of any alternatives in limiting the fault currents as stated in section 7.5.1c of KOC-E-006.

3.3.20 Packaged Equipment Electrical Requirements

a. Electrical Scope of Works for Package Equipment at MRBF comprises of detailed engineering, design, procurement, supply, install, test, pre-commission and commission of package units.

b. The design, manufacture, supply, inspection and testing of electrical system in the Mechanical Packaged Equipment at MRBF shall comply with the requirements of KOC-E-020 as a minimum and relevant specification of each electrical equipment/devices/materials specified on this technical specification.

c. Contractor shall identify and provide connection point for power and control cables from Substation and control room to corresponding package electrical equipment and devices. Connection point can be to motors, junction boxes and/or distribution/panel boards and other electrical equipment that requires power supply or is part of control circuit.

d. Contractor shall provide all electrical equipment, devices, materials, consumables and accessories as required completing the electrical system of packaged units at MRBF. Electrical equipment shall consist of electric motors, MOV's, electric heaters, transformers and all other equipment's requiring electric power as required in the packaged unit.

e. Each Packaged units Electrical Works shall include power supply, control wiring, earthing & lightning protection, lighting fixtures, small power receptacles, welding outlets, distribution boards/panel boards, switches, isolators, relays. Including conduits, junction boxes, control stations, control panels, cable trays, cable ducts or conduits, cable support, mounting brackets, mechanical protection and other electrical devices within the battery limits of packaged unit of MRBF as required.

f. Contractor shall undertake Hazardous Area Classification (HAC) study for the package equipment and all electrical equipment and devices shall be certified to the area classification where it is installed. Electrical equipment minimum hazardous area classification rating shall be EEx "d" IIB T3.

g. Class II location (e.g. SRU Sulfur pit) where combustible dust is or may be present shall be identified. Accordingly, the electrical equipment and devices to be installed on this location shall be certified.

h. Contractor shall carry out & supply all interconnections of electrical equipment's and devices within the Package.

i. All electrical equipment & devices, vessels/tanks and steel structures within the Package units shall be properly earthed. A minimum of two (2) earthing connection shall be required for each packaged equipment.

j. Electrical load for all equipment and devices in the Package shall be included in the overall electrical load list. Each package vendor shall provide electrical load list for integration in the overall load list by Contractor.

k. All electrical equipment & devices shall be properly shown in the 3D model provided by the package vendor/manufacturer and shall be incorporated in the main 3D model by Contractor. Refer to Appendix 15 for 3D model requirements.

l. Contractor shall undertake a 3D model review (30%, 60%, and 90%) of the substation showing the cable/tray routing under and inside the substation, equipment general arrangement and accessibility, bus duct routing, etc.

m. Contractor shall carryout full functional test of the complete package and provide test results for client's review and approval.

n. All package which may require the use of batteries for any means, shall use Ni-Cad type of batteries.

3.3.21 Electrical Interface / Integration Works

a. Power supply to MOV's, Lighting & Small Power and Cathodic Protection in Pig Launcher area near to MRBF shall be integrated with the facility electrical system. Therefore, Two (2) nos. of LV feeders shall be allocated & reserved by Contractor in the nearest facility Substation LV switchboard for Pig Launcher area as follows:

   i. One (1) cubicle in MCC, complete with 100A Circuit Breaker with earth fault protection and associated wirings for Power Distribution Board in Pig Launcher receiver area near MRBF facility.

ii. One (1) cubicle in MCC, complete with 100A Circuit Breaker with earth fault protection and associated wirings for Power Distribution Board in Pig Launcher receiver area near MRBF facility (For future use).

b. Suitably sized Cable trays/ladder and/or conduits/duct bank/trench inside facility shall also be provided under scope of MRBF facility for the feeder cables.

4.0 ELECTRICAL- INSPECTION, TESTING & COMMISSIONING

4.1 Contractor shall inspect, test and commission the electrical power equipment and system of MRBF based on the requirement of the latest revision of KOC-E-003 Part 2 and the manufacturer's recommendation.

4.2 Contractor shall provide Inspection and Test Plans (ITP's) and detailed commissioning procedure and schedule for every equipment and system that will be tested and commissioned and shall submit the same for Company review and approval. All Inspection & Testing shall be as per approved ITP.

4.3 The Inspection and Test Plan shall cover the various stages of inspection and test procedures for FAT, SAT, etc.

4.4 All electrical equipment shall undergo factory acceptance testing (FAT) prior to delivery. The FAT shall not be conducted until the in-house test results and certificates have been submitted to Company. Contractor shall inform the Company of the scheduled witness testing at least two weeks (14) working days in advance by sending a notification letter to the Company. It is the Company's prerogative to attend the witness testing. Any non-conformance or defects discovered during the witness testing shall be recorded and the vendor shall correct any non-conformance or defects to the satisfaction of the SQS inspector and/ or the Company representative. All non-conformance and defects shall be rectified and corrected to the SQS inspector's satisfaction before shipment.

4.5 The Site Acceptance Test of the electrical equipment shall be conducted with the involvement of Company Representative. SAT shall include fully integrated test to verify the functioning of all components of electrical equipment, its communication if any and as applicable.

4.6 Contractor shall function test all electrical power equipment and systems to ensure that the equipment's functions as per its intended use.

4.7 All the test carried out during FAT shall be repeated during SAT to ensure the performance of the electrical equipment.

4.8 Contractor shall provide equipment and relay settings and shall download the same to the equipment and/or relays.

4.9 Contractor shall provide all the test results for company review and information.

5.0 LIST OF ANNEXURES TO APPENDIX -17

Annexure No.	Document No.	Rev.	Description
Annexure 1	MRBF-SK-E-001	0	Key Single Line Diagram
Annexure 2	MRBF-SK-E-002	0	Substation 1 – Preliminary Equipment Layout
Annexure 3	MRBF -DS-E-001	0	Data Sheet of Gas Turbine Generator
Annexure 4	MRBF -DS-E-002	0	Data Sheet of Black Start / Emergency Diesel Engine Generator