RAS MARKAZ CRUDE OIL PARK

INSTRUMENT & CONTROL PHILOSOPHY

REV	DATE	PAGES	DESCRIPTION	PP	CHK	APP-1	APP-2
							
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REVISION CONTROL SHEET

REV. NO.	DATE	PAGE NO.	DESCRIPTION OF CHANGE
A1	12 Dec 18	All Pages	First Issue
A2	07 Feb 19	All Pages	Revised as per Company Comments
B1	18 Apr 19	Relevant Pages	Revised as per Company Comments
B2	09 Jun 19	Relevant Pages	Revised as per Company Comments
01	01 Jul 19	All Pages	Final Issue

This page records the revision status of this document

NOTES:

Revisions after first issue are denoted as follows:

a) By a vertical line in the right-hand margin against the revised text and,

b) By a triangle symbol for graphics, the revision number being denoted within the symbol. Revision symbols are positioned adjacent to the revision.

1 GENERAL

1.1 Purpose

The purpose of this Instrument & Control Philosophy, covers the minimum requirements for application of process Instrumentation and Control Systems throughout the project life cycle at various facilities to be provided for the Ras Markaz Crude Oil Park, hereafter referred to as Project.

This document shall be read and construed in conjunction with other documents concerning or affecting EPC Contractor's execution of the Works. Nothing contained in the documents shall be construed as reducing or diminishing any of EPC Contractor's obligations described else in the Project Documents.

1.2 Definitions and Abbreviations

1.2.1 Definitions

Company	:	Oman Tank Terminal Company L.L.C. (OTTCO)
Contract	:	The EPC Contract between Company and EPC Contractor
EPC Contractor	:	China Petroleum Pipeline Engineering Co., Ltd. (CPP)
IPMT	:	Company Project Management Team comprising of OTTCO and Consultant personnel.
MAC	:	Main Automation Contractor
Project Location	:	Ras Markaz, Duqm, Sultanate of Oman
Shall	:	Indicates a mandatory requirement.
Should	:	Indicates that the requirement is strongly recommended to be adhered to
Sub-Contractor	:	Means any person or persons, firms, companies to whom any part of the work has been subcontracted (directly or indirectly) by EPC Contractor and the legal successors in title to each of these parties
Third Party Inspector	:	Nominated third party inspection agency
Vendor/Manufacturer	:	Means a supplier of Goods and/or Equipment for the Facility and/or the Works including related documentation and services, where necessary, in connection with the installation, testing, commissioning and start up support of any such Goods or Equipment.

1.2.2 Abbreviations

API	:	American Petroleum Institute
CCB	:	Central Control Building

CCR	:	Central Control Room
CCS	:	Central Control System
CMS	:	Custody Metering System
DAHS	:	Data Acquisition and Historisation System
DCS	:	Distributed Control System
EDD	:	Engineering Design Data
EDG	:	Emergency Diesel Generator
EPC	:	Engineering, Procurement and Construction Contractor
ESD	:	Emergency Shut Down
ESDV	:	Emergency Shut Down Valve
FAP	:	Fire Alarm Panel
FGS	:	Fire and Gas System
HSSD	:	High Sensitivity Smoke Detection
HVAC	:	Heating, Ventilation and Air Conditioning
IPCS	:	Integrated Protection and Control Systems
IRP	:	Interposing Relay Panel
ISO	:	International Organization for Standardization
IS	:	Intrinsically Safe
ISB	:	Instrument Satellite Building
LAN	:	Local Area Network
LIMS	:	Laboratory Information Management System
MOV	:	Motorized Operated Valve
MOVIC	:	Motorized Operated Valve Intelligent Controller
MTU	:	Master Telemetry Unit
P&ID	:	Piping and Instrumentation Diagram
PDP	:	Power Distribution Panel
PLC	:	Programmable Logic Controller
RTD	:	Resistance Temperature Detector
RTU	:	Remote Terminal Unit

SIF	:	Safety Instrumented Function
SIL	:	Safety Integrity Level
TAS	:	Terminal Automation System
TGS	:	Tank Gauging System
TMS	:	Terminal Management System
PLEM	:	Pipe Line End Manifold
SI	:	International System of Units
SPM	:	Single Point Mooring
STD	:	Standard
UPS	:	Uninterruptible Power Supply
VMS	:	Vibration Monitoring System

1.3 Units of Measurements

All documents, calculations and drawings shall be carried out using International System of Units (SI), in accordance with 9686-8850-PS-000-9001, Engineering Design Data (Onshore).

1.4 Site Environmental Conditions

The site environmental conditions are defined in Engineering Design Data (Onshore) doc. no. 9686-8850-PS-000-9001. Vendor shall comply with the requirements as defined in Engineering Design Data (Onshore).

1.5 Language

All documentation and communications shall be in UK English. Where documents (test certificates, Vendor data etc.) are originally produced in a non-English language, an English translation must be provided, and the English language version shall take precedence.

2 REFERENCE DOCUMENTS

2.1 Order of Precedence

The following list of documents is used in descending order of precedence in establishing applicable requirements for the project if and when a conflict with a specification arises:

1. Local Laws & Regulations of the Oman
2. National Standards
3. Project Specifications, data sheets, as applicable
4. Industry/ International Codes and Standards
5. Service Authority Standards

The information given in each of the above shall be used, in conjunction with all other above listed documents.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulation requirements, the most stringent and safest requirement applicable to the project will prevail to the extent of the inconsistency, conflict or discrepancy.

In such cases, EPC Contractor shall provide its interpretation in writing of the most stringent requirement for Company approval. In all such cases of conflict, Company's decision will be final.

2.2 Project Reference Documents

9686-8850-PS-000-9001	:	Engineering Design Data (Onshore)
9686-8110-PH-000-1005	:	Control and Operating Philosophy for Onshore
9686-8110-PH-000-1006	:	Emergency Shutdown Philosophy
9686-8110-PH-000-1008	:	Operation and Maintenance Philosophy for Onshore
9686-8550-PH-000-3001	:	Instrument Tagging Philosophy
9686-8150-PH-000-2002	:	Design Safety Philosophy
9686-8150-PH-000-2005	:	Ergonomic Philosophy
9686-8150-PH-000-2003	:	Fire Protection Philosophy
9686-8150-PH-000-2008	:	Operating and Control philosophy for Firewater System
9686-8150-PH-000-2004	:	Fire & Gas detection Philosophy
9686-8550-DB-000-3001	:	Instrument and Control Design Basis for Onshore
9686-8110-DB-000-1001	:	Process Design Basis for Onshore
9686-8110-PD-000-1003		Process Control Narratives
9686-8110-PD-000-1001	:	Process Description
9686-8530-DB-000-3501	:	Electrical Design Basis for Onshore

9686-8540-DB-000-3001	:	Telecommunication Basis of Design for Onshore
9686-8550-SP-000-3008	:	Specification for Motor Operated Valve Control System and Actuator
9686-8550-SW-000-0001	:	Scope of Work for Main Automation Contractor (MAC)
9686-8550-SP-000-3012	:	Specification for Central Control System (CCS)
9686-8550-SP-000-3019	:	Specification for Emergency Shutdown (ESD) System
9686-8550-SP-000-3020	:	Specification for F&G System (FGS)
9686-8550-SP-000-3014	:	Specification for Custody Metering System (CMS)
5440-8550-SP-500-0017	:	Tank Gauging System (TGS) Specification - Addendum
9686-8550-SP-000-3010	:	Specification for Instrumentation for Package Units
9686-8550-SP-000-3016	:	Specification for System Interfaces
9686-8550-SP-000-3011	:	Specification for Instrument Design and Installation
9686-8550-SP-000-3017	:	Specification for Instrument Cables
9686-8550-SP-000-3023	:	Specification for Instrument Bulk Materials
9686-8340-SP-000-4007	:	Specification for HVAC Power & Control panel
9686-8550-63-000-3001	:	Instrument Earthing Diagram (Typical)
9686-8550-64-000-3001	:	System Architecture Block Diagram for Central Control System
9686-8550-64-210-3001	:	System Architecture Block Diagram for ISB (210-ISB-01)
9686-8550-64-740-3001	:	System Architecture Block Diagram for ISB (740-ISB-02)
9686-8550-64-720-3001	:	System Architecture Block Diagram for ISB (720-ISB-03)
9686-8550-64-000-3002	:	Overall Control System Architecture Block Diagram
9686-8550-64-820-3003	:	Central Control room Console Arrangement layout
9686-8110-25-000-1009	:	P&ID Unit 000 Instrumentation Symbology - Motors and Diesel driven pump arrangement
9686-8110-24-000-1001	:	Cause & Effect diagram
9686-8150-24-000-2001	:	Fire and Gas Cause and Effect Charts

2.3 International Codes, Standards and Regulations

The industry codes and standards referenced in and/or applicable to this document are listed below. A reference, in this specification, to these documents, invokes the latest edition of the code, specification or amendment, unless otherwise specifically stated.

Vendor shall comply with all applicable codes, specifications and standards in accordance with this specification. Vendor shall strictly comply with all Company instructions and guidelines.

Vendor shall comply with Company standards, specifications and shall notify Company of any conflicts or discrepancies between standards and shall provide its interpretation in writing of the most stringent requirement for Company approval.

For all codes and standards related to field instruments, refer Instrument & Control Design Basis for Onshore, doc. no. 9686-8550-DB-000-3001.

American Petroleum Institute (API)

API RP 551	Process Measurement Instrumentation
API RP 552	Transmission Systems
API RP 553	Process Instrumentation and Control
API RP 554	Process Control Systems
API RP 555	Process Analysers
API STD 670	Machinery Protection Systems
API RP 2003	Protection Against Ignitions Arising out of Static, Lightning & Stray Currents
API 2218	Fireproofing Practices in Petroleum and Petrochemical Processing Plants
API STD 2610	Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities
API MPMS Chapter 4	Proving Systems
API MPMS Chapter 5	Liquid Metering
API MPMS Chapter 6	Metering Assemblies
API MPMS Chapter 7	Temperature Determination
API MPMS Chapter 8	Sampling
API MPMS Chapter 11	Physical Properties Data Section
API MPMS Chapter 12	Calculations of Petroleum Quantities

British Standards Institute (BSI)

BS 6739	Code of practice for instrumentation in process control systems: installation design and practice
BS 7430	Code of Practice for Protective Earthing of Electrical Installations
BS 7671	Requirements for Electrical Installations. IET Wiring
BS EN 50288	Multi-Element Metallic Cables used in Analogue and Digital Communication and Control

Energy Institute (EI)

EI 15	Model Code of Safe Practice Part 15: Area Classification Code for Installations Handling Flammable Fluids

EEMUA

Publication 191	Alarm Systems – A Guide to Design Management and Procurement

International Electrotechnical Commission (IEC)

IEC 60079 (Parts -1, 7, 11, 25)	Explosive Atmospheres Standards
IEC 60529	Classification of Degrees of Protection provided by Enclosures
IEC 60079	Explosive Atmospheres (All Applicable Sections)
IEC 60529	Degrees of Protection provided by Enclosures (IP Code)
IEC 60331	Tests for electric cables under fire conditions - Circuit integrity
IEC 60332	Tests on electric and optical fibre cables under fire conditions
IEC 61499	Function blocks - Part 1: Architecture
IEC 61000	Electromagnetic Compatibility (EMC) Immunity to Electromagnetic Interference
IEC 61508	Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems
IEC 61511	Functional Safety– Safety Instrumented Systems for Process Industry Sector

International Society of Automation (ISA)

ISA 5.1	Instrumentation Symbols and Identification
ISA 5.2	Binary Logic Diagrams for Process Operations
ISA S5.3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems
ISA S5.4	Instrument Loop Diagrams
ISA S5.5	Graphic Symbols for Process Display
ISA 84.01	Application of Safety Instrumented Systems for the Process Industries
ISA 18.1	Annunciator Sequences and Specifications

International Organization for Standardization (ISO)

ISO 9000	Quality management systems
ISO 9004	Quality management - Quality of an organization - Guidance to achieve sustained success

National Fire Protection Association

NFPA 70	National Electrical Code (NEC)
NFPA 72	National Fire Alarm Code

3 SPECIFICATION DEVIATIONS/CONCESSION CONTROLS

Deviations from this specification are only acceptable where the Vendor has listed in their quotation the requirements they cannot, nor does not wish to comply with, and the EPC Contractor/ Company has accepted in writing the deviations before the order is placed. This deviation list shall be prepared by Vendor with technical explanations and shall be included in Vendor's proposal. In the absence of a list of deviations, it will be assumed that the Vendor complies fully with this specification.

All EPC Contractor/ Company approved deviations shall be included in Purchase Requisition prepared by EPC Contractor and issued to Vendor.

Any technical deviations to the Contract and its attachments including, but not limited to the EPC Contractor/Company Requirements shall be sought by Vendor only through Concession Request format. Concession requests require the EPC Contractor/Company's review/approval, prior to the proposed technical changes being implemented. Technical changes implemented prior to EPC Contractor/Company's approval are subject to rejection.

EPC Contractor/ Company is not liable for any Cost and Schedule impact due to deviations or alternatives other than those stated in the deviation list and /or approved in writing by EPC Contractor/ Company

4 FIELD INSTRUMENTS AND GENERAL REQUIREMENTS

4.1 General

General requirement of field Instruments, process analysers, Ingress protection requirements, Electromagnetic Compatibility, Hazardous area classifications, Power Supplies, Earthing, Instrument identification, SIL requirements etc. are specified in the Instrument & Control Design Basis for Onshore; Doc No. 9686-8550-DB-000-3001.

This document shall be read in conjunction with Instrument & Control Design basis for Onshore for more clarity and further details.

4.2 Process Interface Protection Requirements

The instrument connections shall be designed to protect instrumentation and ensure their correct operation by addressing as a minimum:

- Undesirable condensation or separation of fluids
- Interference with the proper operation of an instrument by a viscous fluid
- Damage to an instrument by corrosive or hot fluids
- Damage due to corrosive environment
- Ingress of solids into impulse lines and instruments
- Change in chemical composition of measured fluid
- Risk of exposure to personnel from hazardous/ toxic materials, and/or systems containing hot/cold fluids
- Flashing of low boiling point liquids
- All instrument wetted parts shall be compatible with fluids to which they shall be exposed.

5 CENTRAL CONTROL SYSTEM PHILOSOPHY

5.1 Central Control System (CCS) Overview

The Central Control System (CCS) shall be the primary control system for the Terminal. The CCS shall perform continuous/regulatory control, basic sequential/interlock control, alarm processing, emergency shutdown, real-time data collection as well as equipment and control system integrity monitoring and safety functions.

The CCS shall interface with the following systems thereby providing a fully integrated automation system for the terminal;

- Distributed Control System (DCS)
- Emergency Shutdown System (ESD)
- Fire and Gas Detection System (FGS)
- Terminal Management System
- Terminal Automation System
- Laboratory Information Management System (LIMS)
- Alarm and Event Management System
- Asset Management System
- Data Acquisition and Historisation System (DAHS)
- Machine/ Vibration Monitoring (at DCS)
- Tank Gauging System (TGS)
- Motor Operated Valve Intelligent Controller (MOVIC / Master System)
- Custody Metering System (CMS)
- Offshore SPM Control and Safety Systems interface
- HVAC Control System interface
- Package Units (PLC Based Systems-UCP) and Local Control Panels (LCP) interface
- Cathodic Protection-Remote Monitoring and Control System (CP-RMCS interface)

5.2 Operational Facilities

5.2.1 Central Control Building (CCB)

The main control facility shall be at CCB. The CCB is located within the utilities area and shall accommodate the following;

- Central Control Room (CCR)
- Equipment Room
- Engineering Room

- Computer Room
- UPS Room
- Battery Room
- HVAC Room
- Telecommunication Room
- Supervisor Office
- Permit Office
- Prayer Room
- Electrical room

The CCR shall house operator consoles categorized in to two sections Operator Console #1 and Operator Console #2. Each operator console shall contain workstations dedicated to specific operating areas according to section Table-1.

Although workstations shall be dedicated to specific areas each workstation shall provide view only access to all operating areas. Workstations for monitoring and control of auxiliary systems (e.g. CCTV) shall also be provided.

The consoles shall also house hardwired Emergency Shutdown (ESD) matrix panels with manual shutdown pushbuttons and maintenance override enable switches.

FGS hardwired Mimic panels are required in locations such as Control Room and Fire station.

Console-1 shall be dedicated for berth monitoring and marine communication equipment allowing CCR operators to communicate with the harbor master and marine vessels during loading / unloading operations.

Console-2 shall be dedicated for Onshore Pipeline Transfer/Tank Farm and Utilities.

System cabinets associated with CCR equipment and the utilities plant area shall be located in the Equipment Room at CCR. Application servers and engineering work stations (EWS) shall be located in the Engineering Room.

Operating Area	Service	Operator Console	Operator Workstation	No. of CCR Operators
Marine Transfer	SPM-110 SPM-120 (Future)	OPCON#1	OWS #1	1 No.
	SPM-130 (Future) SPM-140 (Future)	OPCON#1	OWS #2	1 No.

Operating Area	Service	Operator Console	Operator Workstation	No. of CCR Operators
	TGS Work station	OPCON#1	OWS #3	1 No.
	ESD Matrix Panel	OPCON#1	-	1 No.
	CCTV Work station	OPCON#1	-	1 No.
Onshore Pipeline Transfer/Tank Farm	Onshore Pipelines/ Tank Farm	OPCON#2	OWS #4	1 No. Each
	ESD Matrix Panel	OPCON#2	-	
Utilities	Utilities	OPCON#2	OWS #5	
	IPCS (by electrical)	OPCON#2	OWS#6	
	CCTV Work station	OPCON#2	-	

In addition to the above, there are 4 nos. of 60" LED Screens (2 nos. for CCS, 1 No. for FGS and 1 no. for CCTV) shall be provided with ceiling mounted. The no. of Operator Work stations shall be as per Specification for Central Control System, doc.no. 9686-8550-SP-000-3012.

Refer drawing no. 9686-8550-64-820-3003; Central Control room Console Arrangement layout for more details.

5.2.2 Instrument Satellite Buildings

Normally, unmanned Instrument Satellite Buildings (ISB) are strategically located within the Terminal near to the process equipment.

The following are the Instrument Satellite buildings associated with the project in phase 1.1:

- Booster Pump Station Area - Instrument Satellite Building (210-ISB-01)
- Waste Water Treatment Area - Instrument Satellite Building (740-ISB-02)
- Oil Recovery Area - Instrument Satellite Building (720-ISB-03)
- DUQM Storage Tanks Facility - Instrument Satellite Building (810-ISB-04)

ISB's shall be climate controlled and house the marshalling cabinets, systems cabinets, shutdown cabinets and auxiliary systems cabinets to interface to field instrumentation.

ISB's shall not contain any workstations, however it should be possible to connect to the CCS network using a laptop/ note book with appropriate application software.

5.3 Central Control System Architecture

The CCS shall utilise a distributed architecture consisting of controllers, input output modules, workstations and communications networks. The CCS system shall comprise of a fully integrated system utilising DCS technology to provide a single operating interface for Terminal.

The CCS architecture shall be fully scalable for future expansions of the control and automation facilities without any system and / or network constrains. CCS shall follow an open architecture system concept enabling seamless integration of 3rd party package control systems via industry standard protocols. The overall architecture shall consist of following level of networks:

- Safety Network (for ESD and FGS Systems, SIL certified, Level-2 LAN)
- Process Control Network (for DCS System, Level-2 LAN)
- Automation Network (for TGS, CMS, etc., Level-3 LAN)
- Business Network (for future ERP, Office Systems, MES, etc., Level-4)

Package control systems shall communicate to CCS via redundant Ethernet based process control network allowing supervisory control & monitoring from CCR.

Due to the phased construction of Terminal, the CCS architecture shall be fully scalable allowing future expansion of the control and automation facilities. Refer to Overall Control System Architecture Block Diagram dwg. no. 9686-8550-64-000-3002; for more details.

5.4 DCS System Overview

The process control and monitoring signals from field instruments shall be interfaced to DCS Marshalling cabinets and further to DCS system cabinets located in each ISB's and CCB. The controllers and I/O units shall further communicate to the CCS via the process control network/ safety network. All third-party control systems such as CP-RMCS, Wind Monitor, SPM-MTU, IPCS etc. shall communicate to Process control network via fire walls.

5.4.1 Sequence Control

Marine cargo transfers, oil movements and blending operations shall be fully sequenced by TAS. Sequenced operations shall be monitored from the CCR operator consoles. CCR operators shall be required to initiate sequences once field conditions are verified and monitor progress during operations. Refer doc. no. 9686-8110-PD-000-1001, Process Description for more details on sequence control of Oil movements such as Tanker Unloading into Storage Facilities, Booster pumps, Inter-Tank Transfer, Crude oil Import from pipelines. Crude oil blending and Export to DUQM Refinery, Fire water systems, Slops OWS Sump, Recovered Oil System, Emergency Diesel Generator and all related Package units.

Sequence control of packaged equipment shall be implemented in dedicated PLCs supplied by package Vendor. Operations shall be monitored and controlled remotely from operator consoles within CCR.

5.4.2 Availability and Reliability

CCS shall be designed for high availability and reliability. CCS components shall be of proven reliability and employ sufficient redundancy such that no single point of failure can degrade overall operational performance. The CCS Vendor shall include in the reliability calculations as a minimum, the component and system MTBF (Mean Time Between Failure) assuming an MTTR (Mean Time to Repair) of 8 hours, stating the basis for calculation.

The equipment and system shall be designed and engineered to provide a total availability of critical equipment (highways, controllers, and workstation processors) of 99.99%.

5.4.3 Redundancy

5.4.3.1 Power Supply Redundancy

The Power supply to each cabinet shall be provided with redundant PSU modules. Failure of any one PSU module shall not affect the system performance. All necessary Power supply Unit controller module shall be provided with status indication (Such as O-ring).

5.4.3.2 Network Redundancy

The CCS system shall have dual redundant network redundancy shall have automatic switchover and generate a system diagnostic alarm. No loss of data or control shall occur due to failover.

5.4.3.3 Processor and I/O Redundancy

All Controllers/ processors (CPU's) shall be redundant. All Servers and data storage memory shall be redundant. Critical equipment of CCS system shall be fully redundant so that neither power supply, hardware nor a software failure shall significantly disturb process operation.

Input/output modules or channels where failure could have significant impact on the economic operation or safety of the facility shall be deemed 'critical' and be provided with redundancy. Critical is defined as:

a) All outputs

b) Inputs involved in control narratives (complex loops)

c) Inputs involved in sequence and interlock logic

d) Inputs having High Priority alarms (as defined in HAZOP & SIL Classification studies)

5.4.4 Security

CCS Vendor's design shall address the risks to the cyber environment. CCS Vendor shall consider the extensive and detailed nature of the system networks and provide in built protection toward threats originating at internal equipment, through external data links and through any wireless connections.

CCS Vendor shall protect the network extremities and provide defence in depth throughout and between the CCS sub-networks to impede propagation. CCS Vendor shall describe the approach proposed and show cyber security protection equipment within their system architecture with De-Militarised Zone (DMZ) Servers, Routers, Firewalls, DMZ Networks, etc.

5.4.5 Pumps / Motors

To support the automation strategy, it shall be possible to start and stop all pumps remotely from CCS either via soft interface or hardwired as shown in P&ID's. The Pumps/ Motors are mainly categorised as M1, M2, M3 and M4 types as indicated in P&ID Legends & Symbols (9686-8110-25-000-1009). Further detailed signal interfaces are listed in table-1 in doc. no. 9686-8550-SP-000-3016; 'Specification for Systems Interface' on types of Pumps/ Motors with electrical systems interface.

Any auto starts or stops shall be specified in the process control narratives. Motor control logic (auto-start / stop, auto-changeover, non-safety related interlocks etc.) shall be implemented within the CCS. Safety related interlocks/ trips shall be implemented within the ESD system via interposing relays. For each motor the following status signals shall be made available in the CCS as a minimum.

- Running status
- Fault
- Remote/Local (Manual / Off / Auto)

The booster pumps with VFD requires additional information like Current, Winding/Bearing Temperature etc. for selected motors (e.g. HV Motors with VFD's) shall also be made available on CCS via IPCS (OPC-UA communication). The systems shall generate additional signals (like Trip from ESD based on Safety Interlocks, Permissive from CCS, etc.) especially for HV motors, based on P&ID requirements. Pumps shall be provided with Local Control Panels (LCP) allowing personnel to operate motor locally in field and Unit Control Panels where Package Units that requires PLC systems.

5.4.6 Human Machine Interface (HMI)

5.4.6.1 Operator Workstations

The CCR Operator Workstations (OWS) are the primary operator interface for monitoring and controlling operations at the facility. Workstations shall be the primary location for annunciation of alarms and events. Each workstation shall include dual displays with standard keyboard (both in English & Arabic) and mouse.

The workstations shall display process mimics, graphics, group & trend displays, interlock trip status and alarms. Displays shall include operational menus linking terminal operating areas.

From the Operator workstations the operators shall be able to view;

- Tank farm status
- Oil movement status
- SPM and PLEM status

- Custody Transfer status
- Workstations shall be configured with the following access levels;
  - View only Level – This level allows view only of the process.
  - Operator Level – This level includes typical operator functions and requires a key or password.
  - Supervisor Level – This level includes all operator functions as well as preconfigured supervisory functions and requires a key or password.
  - Engineering Level – This level includes all functions and requires a key or password.

The security and access levels shall not be limited to Workstations but shall be built into the system to ensure only authorized users have access to various levels of control and configuration in the system.

5.4.6.2 Engineering / Maintenance Workstations

Engineering workstations (EWS) shall be provided in CCR engineering room to perform systems engineering tasks for Terminal central control systems.

The EWS includes engineering software for each of the Terminal control systems allowing engineers to perform systems modifications and database administration from CCB via Terminal process control network.

The following Engineering work stations are to be provided at Engineering room in CCR, however, the no. of works stations shall be as per Specification for Central Control System, doc. no. 9686-8550-SP-000-3012:

- DCS Engineering Work Stations – 1 No.
- ESD & FGS Engineering Work Station – 2 Nos.
- CMS Operator Work Station – 1 No.
- TGS Engineering Work Station –1 No.
- LIMS Engineering Work Station –1 No.
- SPM Engineering Work Station –1 No.
- IPCS Work Stations -2 Nos. (By Electrical)
- Laptops - 1 No. for DCS, 1 No. for FGS & ESD systems, 3 Nos. for MOVIC.

The Laptop shall be provided complete with software, licences, etc.

5.4.6.3 Other Operator Interfaces

The other operator interfaces shall include surveillance of facility through Process CCTV, PAGA & ACS system. Refer doc. no. 9686-8540-DB-000-3001, Telecommunication Design Basis for Onshore for more details on operator interfaces.

5.4.7 Process Interlocks and Safety Trips

Process interlocks and safety trips are protective functions that execute under specific conditions to prevent process variable excursions from normal operating ranges. All process interlocks shall be implemented in DCS. All safety functions and Trips shall be implemented in ESD system via SIL certified Inter Posing Relays. Manual reset facilities shall be provided in CCR to reset the equipment after a trip has occurred.

5.5 Emergency Shutdown (ESD) System Overview

The purpose of ESD System is to safely shutdown the operating plant when the conditions exceed the normal working range. The ESD system is SIL-3 Certified system and shall accommodate all I/O's related to the facility. The ESD system shall have a dedicated safety network which is SIL certified.

This shall be achieved by:

- Preventing process conditions from reaching design values.
- Shutdown and/or isolating equipment
- Containing significant liquid inventories so as to minimise the potential for loss of containment and the creation of a hazardous situation.
- ESD functions shall be implemented where malfunctioning or maloperation of plant equipment or a control system can give rise to either:
- Hazards to personnel;
- Damage to the environment;
- Considerable economic loss, e.g. damage to main plant equipment.

The ESD system shall be independent of DCS and use separate tapping points, instruments, I/O, and logic solvers. Alarms from ESD system (including all actuation of shutdown functions) are repeated to the DCS for display and historisation.

Positive feedback shall be provided to confirm that ESD System final elements have reached their safe positions. Feedback signals shall be wired to DCS with indication on DCS graphics.

The operator interface to ESD system shall be via the Operator consoles, which shall be provided with the necessary screens, switches and alarm facilities. Any manual plant trip pushbuttons shall be located on the Hardwired Console and suitably protected from accidental operation. Override enable switches shall be provided on the Hardwired Console.

Suitable security shall be provided at the operator interface to ensure that only authorised personnel can implement overrides in the ESD system. It shall not be possible to modify an ESD logic function or trip levels from an operator console.

The emergency shutdown related field I/O's shall be interfaced (via hardwire) to SIL-3 certified ESD system, located in each ISB's. The ESD system at each ISB's shall further communicate to the central ESD control unit via a dedicated safety (SIL) certified safety network which is FO/Ethernet based network. The ESD System shall further interface to the CCS via process control network for transfer of non-safety related data. Safety related signals between the ESD systems and external systems shall be hardwired. The ESD trip signals for pumps shall be hardwired to Switchgears/MCC's via interposing relay panels.

5.5.1 ESD Reset Philosophy

ESD soft switches shall be used to reset all logic functions tripped by ESD system. This function shall also be fulfilled by hardwired switches on the Hardwired Console/ ESD Matrix for critical emergency shutdowns. If any trip initiator is still active then that logic block cannot be reset, unless an override is available.

In principle, a reset shall be provided for each Safety Instrumented Function (SIF), which may be either a soft switch or hardwired switch on ESD Matrix Panel/ Console. Individual resets are additionally required for each UZV's, which are with manual overrides at solenoid valve.

5.5.2 ESD Override Philosophy

5.5.2.1 Maintenance Overrides

Maintenance Override Switches (MOS) shall be used to override ESD System initiators to enable maintenance or on-line functional testing and shall be connected to ESD system. The MOS's shall be further divided into protection groups.

MOS switches shall be initiated from the Hardwired ESD Matrix Panels/Consoles.

For a MOS to be initiated, the group Master Maintenance Override Enable Switch (MOES) on the ESD Matrix Panel must be enabled along with status indication.

When a MOS is activated, an appropriate override signal shall be sent from DCS via process control network to the ESD System. This signal shall only be processed by the ESD system provided, a command has been received from the MOES for its group.

When a MOS is active, this shall be indicated on all DCS graphics where the ESD System initiator appears, including the DCS graphics and live Cause and Effect diagrams.

Additionally, MOS active status shall be shown on the Hardwired Console adjacent to the relevant MOES.

MOS overrides shall override the ESD System trip input but shall not override the trip alarm. MOS shall not be applied for:

- ESD Outputs;
- Manual ESD switches;
- Sensors where there is no backup of associated measurement with pre-alarm from which the operator can deduce if there is a problem.

The DAHS shall log and report MOS activation and de-activation. The maintenance override duration shall be 8 hours during day time based on Operation and Maintenance Philosophy for Onshore (9686-8110-PH-000-1008).

A summary page of active MOS's shall be available for operator to check during each shift.

5.5.2.2 Start-up Overrides

Start-up overrides (SO) shall be avoided wherever possible by use of conditional logic or timer functions. Where they cannot be avoided, these shall be enabled from DCS. Start-up overrides are all momentary pushbuttons.

Each start-up override shall be reset by any of the following:

- All initiators overridden by the start-up override remain healthy for the duration of a timer (process has reached appropriate steady state);
- Backup timer expired.

The DAHS shall log and report start-up override activation and de-activation.

5.5.3 ESD Level Hierarchy

The ESD system shall be configured with a hierarchy of four levels as per Emergency shutdown Philosophy doc. no. 9686-8110-PH-000-1006:

- ESD Level 0
- ESD Level 1
- ESD Level 2
- ESD Level 3

Activation of a higher level ESD also activates the lower levels for the relevant equipment item(s). The Terminal comprises 3 functionally independent operating areas; Marine Transfer, Nahada Pipeline Import (future), and Duqm Export Pipeline. Each operating area shall be provided with an ESD Level-0 and 1 allowing emergency shutdown of operations within that area.

ESD Level 0

The total Terminal Shutdown shall be achieved manually via a single ESD level-0 PB located in CCR in case of fire emergency in specific Area of Terminal at which Operator decides to Shutdown entire Terminal. This is the only cause for an ESD level-0 shutdown. Total Facility Shutdown shall act on appropriate ESD valves and systems.

ESD Level 1

ESD Level 1 shutdown shall be initiated either by manual activation of ESD Level 1 hardwired push PB and/or soft switches located in the CCR. Automatic actuation of ESD Level 1 shall be based on abnormal process conditions as presented in Cause & Effect Diagram.

Marine Transfer:

ESD Level 1 shall be provided to enable shut off of flow to/from tankers in the event of fire or loss of containment and bring the transfer equipment to a safe state. Activation of an ESD Level 1 during marine transfer operations shall also initiate shutdown of the Tanker Loading and/or Crude Oil Booster Pumps. A Subsea Isolation Valve (SSIV) shall be installed at the PLEM at the end of each subsea pipeline to minimize oil leakage due to failure of hoses,

risers, or self-sealing hose or riser couplings. The Terminal ESD system shall be extended to the PLEM allowing remote actuation of the SSIVs.

Future Nahada Pipeline Import:

ESD Level 1 shall be provided to isolate the Terminal from the Nahada pipeline to stop the flow of crude oil in case of fire or loss of containment. The Nahada pipeline will be operated by an external pipeline operating company. The Terminal will interface with the Nahada pipeline operator to initiate an emergency shutdown in a safe and controlled manner, preventing overpressure of the pipeline and potential damage to equipment.

Duqm Pipeline Export:

ESD Level 1 shall be provided to isolate the Terminal from the Duqm pipeline and bring the transport equipment to a safe state in case of fire, loss of containment or emergency shutdown at Duqm refinery. The Duqm pipeline will be operated by an external pipeline operating company. The Terminal will interface with the Duqm pipeline operator to initiate an emergency shutdown in a safe and controlled manner, preventing overpressure of the pipeline and potential damage to equipment.

ESD Level 2

ESD Level 2 activation shall shutdown specific process equipment for protection of personnel, the environment or assets. ESD Level 2 systems shall be provided where deemed appropriate by process hazard and risk analysis. ESD Level 2 shall be automatically activated based on abnormal process conditions as per Cause & Effect diagram.

ESD Level 3

ESD Level 3 activation shall be based on Utility Package shutdown levels for individual equipment or packages such as Desalination Unit, Potable Water Unit and Sanitary Treatment Package. The utilities packages shutdown levels shall be based on ESD level 3. Vendor package units shall shutdown automatically or manually depending upon service.

5.6 Fire & Gas Detection System (FGS)

A Fire and Gas Detection system (FGS) shall be provided at the facility for detection of fire and Gas inside buildings, Booster pump area, Process and Utilities areas and at SPM offshore marine areas. The fire & gas system comprises a main FGS panel in the CCR, mimic panels in CCR and Fire station, manual call points, beacons and sounders. High sensitivity smoke detection and alarm systems shall be installed in the CCB, ISB's and Electrical Substations, Instrument Equipment Rooms (server rooms), Electrical rooms, UPS rooms, Telecom Rooms, and all enclosed cabinets where hot spots may develop. The HSSD requirement shall be in accordance with F&G philosophy and project F&G Detector layouts.

The FGS shall also interface with building Fire Alarm Panel (FAP), where addressable type F&G devices are connected at each ISB's, CCR, and Electrical substations along with Clean Agent Systems and Panel and shall have the capability to raise local audible and visual alarms. It shall indicate and alarm at a continuously attended mimic panel showing the locations of the activated detection and fire extinguishing system. The FGS shall have hardwired interface with ESD system.

The FGS system shall be connected to DCS to transmit all the fire & gas related information which shall be made available to operator via the CCS consoles, and dedicated graphics.

The buildings such as CCB, ISB's, Electrical sub-stations, Guard houses, messing facility, Main Gate/ Guard house, Office buildings, Prayer hall, Fire station, workshop buildings etc. shall be provided with Building Fire Alarm Panel along with addressable F&G devices, where specified in the F&G detector layouts and F&G detection and protection philosophy.

The FGS shall interface to the site Access Control System, process CCTV System and PAGA to give audible alerts and visual warnings respectively on confirmed fire detection.

The FGS system shall also to be interfaced with signals of Fire water and Foam system packages as per P&ID and F&G Cause & Effect Matrix doc. no. 9686-8150-24-000-2001. Applicable interfaces with DUQM Storage Tank facility (EPC 1.1.3) related to Foam pumps/ Foam skids shall be interfaced as per F&G cause & effect matrix.

All Clean Agent Systems and Panel and fire monitor deluge solenoid valves shall be designed as normally de-energized under normal operating conditions and energized on abnormal event to release the clean agent or deluge water. The clean agent system shall be activated as per F&G detection philosophy.

All the pump logics for Fire Water pumps such as start, stop controls and status indications shall be implemented in PLC based Unit control panel at 720-ISB-03 and further communicated to CCS at CCB. The functionality of firewater system shall be as per Fire Protection philosophy, Doc. no.: 9686-8150-PH-000-2003.

The Foam package for Rim seal/ Tanks shall be initiated from CCR - F&G OWS to initiate respective foam skid/ foam distribution network MOV's and foam pourer system riser(s) MOV's in accordance with F&G Cause and Effect Matrix. Refer for more details on Control functionality of Fire Water Pumps/ Foam skids in "Operating and Control Philosophy for Firewater System, Doc. no.: 9686-8150-PH-000-2008".

The FGS shall interface to the terminal ESD system to provide automated shutdown of process equipment on confirmed fire & gas detection. Refer F&G detection Philosophy (9686-8150-PH-000-2004)& Fire Protection Philosophy (9686-8150-PH-000-2003) for details. All necessary system cables, connectors, graphics, etc. shall be considered by MAC.

5.7 Terminal Management System (TMS)

A Terminal Management System (TMS) shall be provided for overall inventory movement and management of terminal operations. The TMS comprises application servers, a web enabled operating system, workstations and network equipment enabling integration of Company business and process automation systems.

A TMS workstation shall be located in the administration building allowing administrative personnel to perform the following functions;

- Order Scheduling
- Order Management
- Stock Accounting and Management

- Product Reconciliation
- Fraud and Loss Prevention
- Product Validation and Audit Train
- Tank Lease Contract Management
- User Account Management
- Material Batch Transfer Management
- Invoice Management

TMS shall interface to CCS via Automation network providing access to Terminal operational data. TMS shall gather data from the CCS for high level reporting of terminal operations.

The following reports are required as a minimum;

Oil Movement Reports including;

- Nomination Number
- Type of Operation (import, export, tank to tank transfer etc.)
- Tank Number (issuing, receiving),
- Tank Density
- Gross Dip
- Gross Volume Observed
- Gross Volume Standard
- Net Volume Observed
- Net Volume Standard
- Start Date
- Start Time
- Tank Temperature
- Water dip

End of Day / On Demand Tank Inventory Report including;

- Date
- Gross Dip
- Gross Volume Observed
- Gross Volume Standard
- Gross Volume Metric Ton
- Tank Density
- Tank Temperature
- Volume Correction Factor
- Net Volume Observed

- Net Volume Standard
- Net Volume Metric Ton

The system shall generate monthly inventory reports detailing stock in and stock out for the terminal. TMS shall interface to Company business information network via firewall and Demilitarized Zone (DMZ) for terminal management and accounting purposes.

5.8 Terminal Automation System (TAS)

A Terminal Automation System (TAS) shall be provided to enable operators to safely execute marine cargo transfers, oil movements and blending operations at the terminal. TAS shall provide oil movement route planning, execution and crude blending functions as well as movement, inventory and quality monitoring.

TAS shall interface to TMS via Automation network to exchange information for customer order execution. TAS shall provide status information to TMS following order execution. TAS shall run on a dedicated application server and interface to CCS via the process control network for control of field devices during movements and blending.

CCS HMI shall provide the operator interface to TAS allowing the operators to initiate, monitor and control operations from the CCR. The CCS shall also be used for TAS alarm annunciation and event logging. The TAS shall gather data from the CCS and CMS during operations for storage tank and pipeline inventory and quality monitoring.

For operational requirements of tanker loading, unloading, crude oil blending, inter tank transfers between storage tanks, de-watering, oil movement, path selection, pigging, flushing, operation of utilities, emergency shutdown, import/ export by pipelines, etc., refer Operating and Control Philosophy, doc. no. 9686-8110-PH-000-1005 and Process descriptions, doc. no. 9686-8110-PD-000-1003 for details.

5.9 Laboratory Information Management System (LIMS)

Crude oil samples from Terminal facilities shall be analysed in Terminal laboratory. Laboratory Information Management System (LIMS) system shall be provided for management of laboratory result.

The LIMS provides sample planning and tracking, validation and approval of sample results, interfaces to laboratory analysers and reporting and quality assurance tools. The LIMS shall interface to the TMS for quality management purposes.

LIMS shall be a dedicated system, interfaced to the CCS system to allow transfer of analytical data for control and historisation purposes. LIMS shall be provided by CCS Vendor.

LIMS shall be provided with a minimum of two (2) dedicated PC workstations (LIMS -OWS at laboratory and LIMS-EWS at Engineering Room) with 5 user licenses.

The final quantity of hardware and software licenses shall be based on assessment of required usage by operators collecting samples, laboratory technicians entering and handling data, and laboratory supervisors and managers. Each user type shall have appropriate level of access to their job role.

The PC workstations shall be capable of accepting data automatically from bar code readers, laboratory analysers, and manual keyboard entry. They shall also have facility to print reports and bar codes for sample control.

LIMS software shall be a Commercially Off-the-Shelf product, requiring no specific programming or customization unless any special requirement is made by EPC Contractor/ Company.

The CCS shall interface to LIMS through a dual redundant communication link using an industry standard protocol such as OPC-UA.

The minimum requirement for each sample is as follows:

- Unique sample number
- Sample point or source identification
- Date and time of sampling

The minimum requirements for each analysis associated with the sample are:

- ✓ Property or component name
- ✓ Property or component value
- ✓ Unit of measure
- ✓ Measurement reference method
- ✓ Technician name
- ✓ Technician comments

5.10 Alarm and Event Management Systems

The objective of the alarm and event management system is to direct the operator's attention to a condition requiring timely assessment and action and to ensure a consistent and appropriate response.

As such alarms must:

- Focus the operator's attention using suitable audible and visual cues;
- Be unambiguous, informative and relevant;
- Require a predetermined course of remedial action from the operator;
- Allow sufficient time for operator to take remedial action before additional automatic action is taken;
- Recognise human limitations.

The control system shall be set-up to distinguish and handle three types (priority levels) of process alarms as follows:

- Emergency Alarms;
- High Priority Alarms;

- Low Priority Alarms.

Alarm priorities shall be assigned based on the time that the operator has to respond and consequence of the operator failing to respond. Alarm annunciation shall be both visual and audible. Different alarm priorities shall be immediately distinguishable by different audible tones and different colours on the DCS display.

Provision of a large number of alarms are generally counterproductive, as operators become conditioned to nuisance alarms and therefore fail to take appropriate action when real alarms occur. To avoid this situation, alarms shall be specified such that:

- The number of standing alarms is minimized (no alarms shall be set that shall remain while the plant is running normally)
- Each individual alarm provides maximum information (common trouble alarms shall be avoided, and redundant alarms shall not be specified)
- Alarms shall be presented in a clear and effective manner, utilizing best HMI design principals and practice

Where process equipment is provided with a local panel, the protection system alarms, manual shutdown alarms, and related process alarms shall be indicated on local panel and repeated in DCS at CCR.

All alarms shall be individually displayed and recorded by the DCS. Alarms shall be displayed on DCS graphics in the vicinity of the equipment affected by the alarm, and on a dedicated Alarm Summary screen. The Alarm Summary screen shall normally display standing alarms in chronological order with most recent alarms on top, but the display can be sorted to show the highest priority alarms on top.

For analysis of trips and incidents, the alarm management system shall provide an integrated Sequence of Events recording system (SOE). The SOE shall display sequence of events on a process unit basis. In applications (Package PLC's) where several faults can cause a shutdown via an interlock system, a "first up" alarm shall be transmitted to DCS to identify initial cause of shutdown.

Event time stamps for each system shall be synchronized using Master Clock System for SOE reporting. All systems shall annunciate their alarms via DCS. This includes ESD, FGS, TAS, TGS etc. All alarms, trips and operator actions on all systems and subsystems shall be continuously and automatically downloaded to the Alarm and Event Management System for off-line analysis.

The alarm and event management system shall additionally maintain a Master Alarm Database of all configured alarms. The database shall contain trip points, priorities, justifications, and consequences.

5.11 Asset Management System

An Asset Management System shall be provided for managing maintenance of capital assets at the Terminal. Asset Management System shall gather and analyse data from equipment at the Terminal to provide maintenance alerts to maintenance personnel.

Asset Management System shall be capable of providing equipment maintenance scheduling. As a minimum the Asset Management System shall include applications for monitoring the following equipment at the Terminal;

- Rotating Machinery
- Electrical Equipment
- Static Equipment
- Process Instrumentation

Asset Management System shall be capable of interfacing to equipment condition monitoring subsystems (e.g. VMS, IPCS, MOVIC etc.) to provide an integrated maintenance management system for the Terminal.

5.12 Data Acquisition (Data Storage) and Historisation System (DAHS)

A Data Acquisition and Historisation System (DAHS) shall be provided to log key CCS parameters and events allowing historical and real time trending of data. The DAHS shall also log discrete events such as device state changes alarms etc.

The DAHS shall run on a dedicated server with sufficient storage capacity to meet the terminal archiving and reporting requirements. The DAHS shall make stored data available to higher level systems for analysis and enhanced reporting.

5.13 Machine / Vibration Monitoring System

Machinery/ Vibration monitoring and protection shall be carried out by dedicated DCS system (DCS-VMS) and marshalling cabinet located in 210-ISB-01. The DCS-VMS system shall provide automatic vibration, displacement and temperature monitoring and protection functions on applicable rotating machinery at the FACILITIES.

The following 4 nos. of Booster pumps shall be considered for machine/ vibration monitoring:

1. Booster Pump; 210-P-210A
2. Booster Pump; 210-P-210B
3. Booster Pump; 210-P-210C
4. Booster Pump; 210-P-210D

DCS-VMS shall be utilised to safeguard against excessive machinery stress, unplanned events, and abnormal operating conditions by initiating equipment shutdown.

DCS-VMS shall communicate via Terminal process control network for remote monitoring from CCR. Shutdown signals booster pumps shall be hardwired to ESD system via IRP.

Vendor shall consider all necessary interfaces, configurations, integration of temperature (RTD's), Vibration sensors/ transmitters, etc. related to the above mentioned booster pumps along with all necessary graphics, I/O racks, Modules, etc. as necessary for machine conditioning/ monitoring.

5.14 Manufacturing Execution Systems (MES)

The CCS shall have the capability/ provision to interface to business network (Level-4) /systems such as MES software (e.g. IBM Maximo, SAP PM, Oracle eAM, JD Edwards EnterpriseOne etc.) using bi-directional interfaces such as:

- OPC compliant applications
- Custom interfaces using XML, EDI, ODBC, OLEDB or Web Services
- File Transfer Protocol

The following functionality shall be supported:

- The receipt of order information from a business system
- The sending of order information for invoice generation to a business system
- Stock / inventory data reporting
- Planning and Scheduling Services
- Transaction Reporting

6 THIRD PARTY SYSTEMS PHILOSOPHY

6.1 Tank Gauging System (TGS)

The storage tanks 2 nos. of Slops Tanks (720-T-001 A/B) and 1 no. of Recovered Oil Tank (720-T-002), shall be provided with a radar based Tank Gauging System (TGS) at ISB-04 by DUQM Storage Tanks Facility EPC package for process measurement, including TGS field instruments shall be supplied by others. The tank inventory management software shall be capable of handling automatic overfill protection for crude oil tanks (by others).

TGS consists of radar type level instruments, multi-point temperature sensors, pressure sensors, etc. supplied by others.

The TGS control systems such as application Servers, Engineering Work stations, digital communications bus, and tank inventory management software shall be provided at CCR by TGS Vendor as part of Onshore EPC package. The entire system shall be certified by an international accuracy approval body and approved for custody transfer.

TGS shall interface to CCS via Automation network to provide the following minimum data for control, logging, trending, alarm generation history and inventory reporting;

- Tank and Product Identification
- Level, Temperature and Density
- TGS communication status
- Total Observed Volume and Mass
- Gross Observed Volume and Mass
- Gross Standard Volume and Mass
- Rate of Import / Export
- Outage
- Monitor long term tank levels and provide indication of possible tank leakage

To alert the operators for problems with the tank floating roof its position and orientation shall be monitored by level sensors situated around the roof. The TGS shall generate alarms if there is a discrepancy between tank level and roof position. Refer doc. no. 9686-8550-SP-000-3015; Specification of TGS System for more details.

6.2 MOV Intelligent Control System (MOVIC / Master System)

Motor Operated Valve (MOV) shall be used to provide non-safety related isolation on large process lines where use of manually operated hand valves would be impractical. These shall be identified as Instrument Type "MOV". These valves are either controlled by DCS or locally operated manually by field operator.

All actuated valves used for On/Off operational line up shall be electric motor operated (except for FCV's used in booster pumps). It shall be possible to operate all motor operated valves remotely from DCS. The DCS shall receive the following feedback signals from each valve via MOVIC / Master system;

- Valve Opened

- Valve Closed
- Valve Fault
- Local / Remote Selected
- Position Feedback (% Open)

In order to reduce field cabling the DCS shall interface to motor operated valves using a Motor Operated Valve Intelligent Control system (MOVIC) at each ISB's.

The MOVIC System consists of smart actuators, a two-wire communication bus, redundant master control stations, and redundant communications link to the DCS.

MOV's shall be design with ring topology and interfaced to the master Motor Operated Valve Intelligent Control (MOVIC) System or Master System. MOV Control loop to be wired to field junction box and individually wired to each MOV. Overall loop to be created in junction box by jumper links on required terminals.

All MOV's shall meet requirements of Specification for Motor Operated Valve Control System and Actuator; doc. no. 9686-8550-SP-000-3008.

6.3 Custody Metering System

The Custody Metering System (CMS) comprises flow meters, reference (master) meters and flow computers for fiscal measurement and totalisation during oil movements.

A supervisory computer shall be provided for control of metering package including metering run selection, flow distribution and meter proving.

The supervisory computer shall also provide data archiving, report generation, system integrity checks and alarming for the metering system. The metering supervisory computer shall be located in ISB and interface to the DCS via the process control network for transmission of real time process data and alarms.

For Phase #1 (EPC Package 1.1.2) the custody metering skid; 410-A-410, SPM #1, Import/Export Line (bi-directional) is required at the Facility to be located at building (740-ISB-02).

The Custody metering skid shall include automatic, flow proportional line sampling facilities to gather representative samples of each crude oil transfer for laboratory analysis. The sampling system shall include online density measurement to provide live input to the metering flow computers and to detect grade changes during pipeline clearance.

A dedicated bi-directional ultrasonic crude oil import/export meter shall be provided for SPM.

The metering skid shall be used for fiscal metering of crude oil transfers to and from tankers and for monitoring the re-circulated crude oil flow during clearance / priming or pigging of the subsea pipelines.

Refer doc. no. 9686-8550-SP-000-3014; Specification for Custody Metering System (CMS) for more details.

6.4 SPM Control System

The RTU in SPM shall communicate to Master Telemetry Unit (MTU) via subsea Fibre Optic communication and radio. Further communication between facility CCS system shall be considered for SPM remote control & monitoring.

The Pipe Line End Manifold (PLEM) / Single Point Mooring (1 no. of 110-SPM-110) shall be controlled by a dedicated control system MTU located in CCB (Instrument Equipment room).

The MTU shall further interface with CCS via the process control network for berth, mooring and manifold monitoring, alarming and supervisory control of the PLEM valves from the CCR. The Facility ESD system shall be extended to the PLEM allowing remote actuation of the Sub Sea Isolation Valves (SSIV) via MTU.

Interconnection between facility FGS and SPM FGS shall be interfaced via MTU (Fibre Optic network) based on F&G Cause & Effect Matrix of Offshore & Onshore.

6.5 Other Systems Interface

The Electrical System such as Integrated Protection and Control Systems (IPCS) shall be interfaced with both status and control signals transmitted over a redundant communication link to DCS (via OPC-UA protocol). Operator start and stop shall be soft linked or hardwired (where applicable) via interposing relays and diagnostic information shall be transmitted over this redundant communication links.

All safety related ESD trip signals between Electrical and Instrument Systems shall be hardwired through Interposing Relay Panels (IRP's). Any relays installed as part of a SIF are required to meet associated SIL targets.

All other pump status and control signals from the panels for enabling start-up of pumps or motors shall be transmitted to DCS where relevant permissive, interlocks and reset are checked prior to start up from the DCS. ESD and FGS system interface shall be hardwired.

The extent of control and indication of motors and switchgears shall be as per P&IDs.

Telecom system shall interface with Fire & Gas System via serial communication and capable of automatic control and directing Process CCTV PTZ Cameras towards pre-assigned location(s) as required.

Upon receipt of FGS alert or alarm condition, the System shall automatically initiate sequence of pre-assigned manoeuvres to point and focus pre-assigned PTZ Camera(s) towards the incident location and commence real-time Event mode recording and display associated video on pre-assigned Monitor(s).

FGS interface shall, as a minimum RS 232 or RS 485 serial link, however a Modbus over TCP/IP interface is preferable.

The interface details between Central Control Systems comprises of DCS, ESD System, FGS system, and TGS system, TAS, TMS, Wind monitoring system, Time synchronisation, etc., refer to doc. no. 9686-8550-SP-000-3016; Specification for Central Control Systems.

6.5.1 Integrated Protection & Control System (IPCS) Interface

Data from Integrated Protection & Control System (IPCS) regarding status and performance of connected loads shall be integrated into CCS for overall monitoring/display on operator graphics.

CCS shall include an application function which shall interface to IPCS Server in CCB to provide electrical data and status for use in control schemes and alarming. The communication protocol shall be OPC-UA. CCS shall integrate the information received from IPCS with hardwired commands via IRP and status information via serial communication shall provide the facility operator with an integrated view on electrical systems and motor control status.

CCS shall provide historian functions for all data received. The specific requirements for Instrument and Electrical Interface are detailed in doc. no. 9686-8550-SP-000-3016, Specification for Systems Interface.

6.5.2 HVAC Control System Interface

The Heating, Ventilation and Air Conditioning (HVAC) system shall be a standalone system with an interface to DCS to provide monitoring and alarming at CCR. The HVAC system shall be required for all Electrical substations, CCB, Guard house and messing facility, Main Gate/ Guard house, ISB's, Office buildings, Prayer hall, Fire station, workshop buildings.

The system shall generate alarms to warn of power loss (from the normal supply) and failure of any portion of HVAC system.

All HVAC systems shall be provided with standby units with auto changeover switches between the operating and standby units. These switches shall be capable of providing changeover and equal wear and tear between the operating and standby units.

HVAC units shall automatically shut down upon confirmed fire signal from F&G system/ Fire Alarm Panel as per doc. no. 9686-8150-24-000-2001; F&G Cause & Effect Charts.

HVAC control panel shall interface with DCS system via hardwired for signals such as high room temperature, Humidity monitoring, HVAC equipment/ unit failure and system common fault alarms.

In addition, for CCB, and all 4 nos. of ISB's, HVAC Control panel shall be serially linked (via RS485, Modbus TCP/IP protocol) to DCS system. All necessary graphics, I/O modules, termination, etc., in DCS system shall be provided by CCS Vendor. Refer doc. no. 9686-8340-SP-000-4007; 'Specification for HVAC Power & Control Panel' for more details.

6.5.3 Cathodic Protection – Remote Monitoring and Control System Interface

The Cathodic Protection-Remote Monitoring and Control System (CP-RMCS) shall be interfaced with the DCS system at each ISB's via serial interface (RS-485, Modbus TCP/IP). Further, communication to CCB via fibre optic network from each ISB's shall be provided.

The soft signals such as monitoring DC current output, DC voltage output, Reference Electrodes, Corrosion Probes, Temp., alarms and control such as T/R operation modes, etc. All necessary graphics, communication modules, ethernet switches, FO Converters, patch chords, termination, etc., at DCS system in each ISB's and CCR shall be provided by CCS Vendor.

The CP-RMCS at 810-ISB-04 shall be interfaced to DCS via serial communication and further communicated to DCS system at CCR. All necessary system cables, connectors, graphics, etc. shall be considered by MAC.

Refer to Specification for Cathodic Protection Materials & Equipment (Doc. No. 9686-8360-SP-000-2505) for further details.

6.5.4 Packaged Units Interface

The package unit shall comprise of a localized assembly, process section, or complete process unit. It is intended that engineering and design input is required to meet Project requirements.

Package instrumentation and controls shall comply with doc. no. 9686-8550-SP-000-3010; Specification for Instrumentation for Packaged Units, together with the related reference documents and technical description of the packaged equipment requisition.

Packages units are identified based on local control panels and Unit Control Panels and some packages without local control panels and directly hardwired to DCS & ESD systems via skid Junction boxes supplied by Package Vendor. The Unit control Panel shall be PLC based and for Local control Panels, the control shall be provided by the DCS.

For packages with unit control panels (PLC based), interfaces with CCS shall provide as a minimum, package status, and all key alarms/ variables, which shall be monitored from CCR. This communication may be undertaken via redundant RS-485 Modbus or TCP/IP serial links or OPC-UA or Ethernet and / or hardwired cabling. All critical signals to / from the unit shall be hardwired. All necessary graphics shall be provided by Package Vendor to DCS Vendor in order configure in the DCS system.

The following package units shall be controlled by a dedicated PLC based control system supplied by package Vendor. The control system shall interface to CCS via Terminal process control network for monitoring, alarming and supervisory control from the CCR.

- Desalination Package Unit
- Sanitary Treatment Package Unit
- Potable Water Hypochlorinator Package
- Sea Water Hypochlorinator Package

The following Mechanical packages which shall be controlled, monitored and tripped from Facility's CCS System (DCS, ESD & FGS Systems):

- Crude Oil Booster Pumps Package;
- Potable Water Mineralisation Package;
- Oily Water Treatment Package;
- Bio Filter Package;
- Coagulant Dosing Package;
- Flocculant Dosing Package;

- Iron Sulphate Dosing Package;
- Micronutrient Dosing Package;
- Sodium Hypochlorite Dosing Package
- Sump oil skimmer
- Aeration Blower Package

The following HSE Package Unit which has interfaces to facility CCS (DCS, ESD & FGS):

- Fire Water Pumps Package (Unit Control Panel or LCP)
- Emergency Diesel Generator Package

The following packages which no interface with facility CCS system are:

- Electric Overhead Travelling Crane package with Vendor specific design

The Emergency Diesel Generator package F&G devices and CO_2 control panel shall interface with FGS. Refer to doc. no. 9686-8550-SP-000-3010; Specification for Instruments for Package Units for more details.

6.5.5 Local Control Panels (LCP) & Unit Control Panels (UCP)

A local control panel (LCP) shall be provided where local monitoring during start-up/operation and shutdown or maintenance is required. However, control is preferred from CCS. The Unit Control Panel (UCP) are required where the signals shall normally be wired to Vendor supplied PLC located in ISB's.

The local control panel shall not contain any logic or control functions, these shall be located locally/ field. The panel shall be designed to allow easy and ready access for maintenance of equipment such as terminal blocks, test equipment and instruments.

Outdoor Local control panels shall be rated IP 65 as a minimum and certified for use in a hazardous area. Indoor Unit Control Panels shall be located inside the ISB's and shall be rated IP 42 as a minimum. The Local Control Panels shall be supplied with sun shades to prevent excessive heat build-up. Air conditioning units or vortex coolers shall be avoided if possible.