



SPECIFICATION FOR PACKAGE UNIT INSTRUMENTATION & CONTROL

Company Doc No: E1150-TS-2000-J-0011

Rev.: C1

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Contractor/Eng Doc. No: 217601C-000-JSS-1580-0001

PROJECT No. E1150

ENGINEERING PROCUREMENT & CONSTRUCTION FOR 1.0 MMBD SUSTAIN PHASE 1 SURFACE FACILITIES PROJECT

Contract No. 4700022962

Contractor Project No. UZ1.0MMBD

SPECIFICATION FOR PACKAGE UNIT INSTRUMENTATION & CONTROL

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	SUMMARY OF DOCUMENT REVISIONS			
Rev. No.	Date Revised	Section Revised	Revision Description	
A1	20/06/2024	First Submission	Issued for Review	
B1	24/07/2024	As Marked	Issued for Approval	
C1	22/08/2024	As Marked	Issued for Design	







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HOLD LIST		
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1. <u>INTRODUCTION</u>

1.1 PROJECT OBJECTIVE

The objective is to deliver the incremental surface FACILITIES for "UPPER ZAKUM 1.0 MMBD Phase 1 PROJECT" required to sustain production through year-end 2029.

The SCOPE OF WORK shall include surface facilities adequate to meet production and injection forecast up to year-end 2029.

- Implementation of the system designed with additional capacity to sustain production beyond year-end 2029.
- Provision for Phase-2 and future facilities in terms of tie-ins and space reservation.

1.2 PROJECT SCOPE

SOW includes Engineering, Procurement, Fabrication, Testing, Transportation, Construction, Pre-Commissioning, Commissioning, Ready for Start-up, Assistance for Start-up, and completion of Performance Tests Works for the below mentioned Work Packages.

- WP A1 Al Ghallan Island (Central Island or CI)
 - WP A1.1 Water Injection Plant
 - WP A1.2 Produced Water Treatment and Disposal
 - WP A1.3 Pre-Assembled Well Manifold (PAM) and Local Equipment Room (LER)
 - WP A1.4 Integration of UZ Power System with Onshore Grid Power "Project Lightning"
- WP A2 Umm Al Anbar Island (West Island or WI)
 - WP A2.1 Oil Production Enhancement
- WP A3 Assefiya Island (South Island or SI)
 - WP A3.1 De-Bottlenecking of Existing PWT Plant
- WP A4 Ettouk Island (North Island or NI)
 - WP A4.1 Produced Water Treatment and Disposal
 - WP A 4.2 De-Bottlenecking of Existing PWT Plant
- WP A5 –Helipad on Al Ghallan Island, Assefiya Island, Ettouk Island & Umm Al Anbar Island
 - WP A5.1 Helipad (Construction & Demolition) on AGI, ETI & Upgrade of Existing Helipad on ASI,
 - o WP A5.2 -HEMS (Construction) on AGI, ETI & UAI.



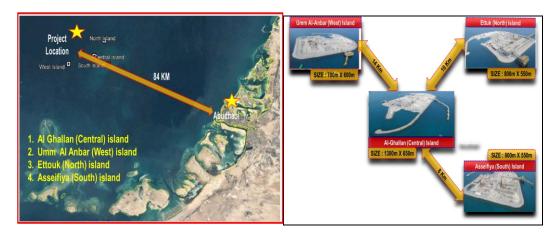


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2. PURPOSE OF THE DOCUMENT

This document is aimed to describe Specification for Package Units Instrumentation & Control on the Environmental Islands in Upper Zakum for the "1.0 MMBD Sustain Phase 1 - Surface Facilities" Project.

This Project is an extension of the UZ750 Project. Existing philosophy shall be followed, and any deviation shall be highlighted clearly for COMPANY review and approval.

3. ABBREVIATIONS & DEFINITIONS

3.1 **ABBREVIATIONS**

Acronym / Reference	Description
ADNOC Offshore	Abu Dhabi National Oil Company Offshore
Al	Analog Input
AGI	Al Ghallan Island
AO	Analog Output
API	American Petroleum Institute
ASI	Assefiya Island
ASME	American Society of Mechanical Engineers
ATEX	Atmospheres Explosives – European Union Directive 2014/34/EU
BASEEFA	British Approval Service for Electrical Equipment in Flammable Atmospheres
вом	Bill of Material







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Acronym / Reference	Description
BPCS	Basic Process Control System
BS (I)	British Standard (Institution)
ccs	Compressor Control System
CESI	Centro Elettrotecnico Sperimentale Italiano
CFF	Common File Format
CMRR	Common Rode Rejection Ratio
CPU	Central Processing Unit
CSA	Canadian Standards Association
DC	Direct Current
DD	Device Description
DI	Digital Input
DO	Digital Output
DP or D/P	Differential Pressure
EMI	Electro-Magnetic Interference
ESD	Emergency Shutdown
ETI	Ettouk Island
FAT	Factory Acceptance Test
FF	Foundation Fieldbus
F&G	Fire & Gas
FISCO	Fieldbus Intrinsically Safe Concept
FGS	Fire and Gas System
FM	Factory Mutual
FSD	Full Scale Deflection
GRP	Glass Reinforced Polyester
GWR	Guided Wave Radar
HART	Highway Addressable Remote Transducer
HEMS	Helicopter Emergency Medical Services







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Acronym / Reference	Description
HAZOP	Hazard and Operability
HPT	High Power Trunk
IEC	International Electro-technical Commission
INE or IE	Instrument Earth
I/O	Input/Output
IS	Intrinsic Safety
ISA	Instrument Society of America
ISE	Intrinsic Safety Earth
ISO	International Organization for Standardization
LOPA	Layer of Protection Analysis
LCIE	Laboratoire Central des Industries Electriques
LCR	Local Control Room
MAC	Main Automation Contractor
MCC	Motor Control Centre
MOC	Materials of Construction
MTR	Module Technical Room
NACE	National Association of Corrosion Engineers
NC	Normally Close
NDT	Non Destructive Testing
NO	Normally Open
NPT	Nominal Pipe Thread
OPC	OLE (Object Linking and Embedding) for Process Control
PC	Personnel Computer
P&ID	Piping & Instrumentation Diagram
PLC	Programmable Logic Controller
PRM	Plant Resource Management
PST	Partial Stroke Test





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Acronym / Reference	Description
PSU	Power Supply Unit
РО	Purchase Order
PVC	Poly Vinyl Chloride
QA/QC	Quality Assurance/Quality Control
RFI	Radio Frequency Interference
RMMS	Rotating Machine Monitoring System
RTD	Resistance Temperature Detector
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SE	Safety Earth
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SOV	Solenoid Operated Valve
SPDT	Single Pole Double Throw
SPIR	Spare Parts Inter-Changeability Record
TCP/IP	Transmission Control Protocol / Internet Protocol
TSO	Tight Shut-Off
TUV	Technischer Ueberwachungs Verein
UAAI	Umm Al Anbar Island
UCP	Unit Control Panel
UHF	Ultra High Frequency
UL	Underwriters Laboratories
UPS	Uninterrupted Power Supply
UV	Ultraviolet
VDRL	Vendor Document Requirement List
VHF	Very High Frequency





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3.2 **DEFINITIONS**

COMPANY	Abu Dhabi COMPANY for Offshore Petroleum Operations (COMPANY)
EPC CONTRACTOR	Target Engineering Construction Company – Sole Proprietorship L.L.C
ENGINEERING SUBCONTRACTOR	Technip Energies France – Abu Dhabi
PROJECT	Engineering, Procurement & Construction For 1.0 MMBD Sustain Phase 1 Surface Facilities Project
SUBCONTRACTOR	Is a CONTRACTOR's affiliated firm responsible for performing services related to project scope under a separate agreement.
VENDOR	Means any person supplying or arranging the supply of materials for the WORKS including related documentation and services, where necessary.
WORKS	Means any works and services performed under the AGREEMENT.

4. REFERENCES, CODES, AND STANDARDS

4.1 ORDER OF PRECEDENCE

- 1. Annexure 3E-1: Rely Upon Information
- 2. UAE Federal Laws and National Local Regulations
- 3. ADNOC HSE Standards and ADNOC Offshore Procedures
- 4. Project Philosophies
- 5. Design Basis
- 6. P & ID'S
- 7. Plot Plan
- 8. Project Specifications
- 9. Datasheets
- 10. COMPANY Specifications
- 11. All remaining Project Deliverables
- 12. COMPANY Standard Specification and Procedures
- 13. Applicable International Design Codes, Standards and Regulations

If there is any conflict among the documents included in the AGREEMENT, the most stringent requirement among them will prevail. CONTRACTOR shall promptly bring to the notice of COMPANY any such conflicts, and COMPANY shall determine the prevailing requirement and advise CONTRACTOR accordingly.





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4.2 REFERENCE CODE AND STANDARDS

4.2.1 International Standards Organization (ISO)

CODE	TITLE
ISO 5167	Measurement of fluid flow by means of Pressure Differential Devices inserted in circular cross section conduits running full
ISO-9001	Quality Management System - Requirements
ISO 15848	Industrial Valves- Measurement, test and qualification procedures for fugitive emissions.
ISO 5208	Industrial Valves- Pressure testing of metallic valves

4.2.2 International Society of Automation (ISA)

CODE	TITLE
ISA – S5 Series	Instrumentation Symbols and Identification, Binary Logic Diagrams for Process operations, Graphic symbols and Instrument Loop Diagrams.
ISA S 18.1	Standard for Annunciator Sequences and Specifications
ISA S20	Specification forms for Process Measurements & Control Instruments, Primary Elements & Control Valves
ISA 75 Series	Standards & Practices for Control Valves

4.2.3 American Petroleum Institute (API)

CODE	TITLE
API 520 Part - I	Sizing, Selection and Inst. of Pressure Relieving devices in Refineries – Sizing and Selection
API 520 Part-II	Sizing, Selection and Inst. of Pressure Relieving devices in Refineries – Installation
API STD 521	Guide to Pressure Relieving and Depressurization Systems
API STD 526	Flanged Steel Pressure Relief Valves
API STD 527	Seat tightness for Pressure Relief Valves
API RP-551	Process Measurement Instrumentation





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CODE	TITLE
API RP-552	Transmission Systems
API RP-555	Process Analyzers
API 578	Positive Material Identification (PMI)
API STD 607	Fire Test for Soft Seated Quarter Turn Valves
API STD 609	Butterfly Valve: Double Flanged, Lug and Wafer Type
API 6FA	Specification for Fire Test of Valves
API 670	Machinery Protection System
API 682	Pumps-Shaft sealing systems for Centrifugal & Rotary pumps
API 576	Inspection of Pressure relieving devices
API 598	Valve inspection & testing
API 6D	Specification for Valves (Gate, Ball, Check)

4.2.4 American Society of Mechanical Engineers (ASME)

CODE	TITLE
ASME B 1.20.1	Pipe Threads, General Purpose (Inch)
ASME B 16.5	Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard
ASME B16.36	Orifice Flanges
ASME B31.1/B31.3	Power and Process Piping Package
ASME B40.100	Pressure Gauges and Gauge Attachments
ASME B40.200	Thermometers, Direct Reading and Remote Reading
ASME PTC 19.3	Temperature Measurement Instruments and Apparatus (Performance Test Codes).
ASME PTC 25	Performance Test Codes-Pressure Relief Devices
ASME SEC VIII DIV 1	Boilers and Pressure Vessels Code – Rules for Construction of Pressure Vessels
FCI 70-2	Fluid controls Institute – Quality control standard for Control valve seat leakage





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CODE	TITLE
ASME MFC –3M	Measurement of Fluid Flow in Pipes using Orifice, Nozzle and Venturi tubes
ASME MFC –14M	Measurement of Fluid Flow using Small Bore Precision Orifice Meters
ASME MFC –18M	Measurement of Fluid Flow using Variable Area meters
ASME MFC -16	Measurement of Liquid Flow in closed conduits with Electromagnetic Flowmeters

4.2.5 International Electrotechnical Commission (IEC)

CODE	TITLE
IEC 60079	Electrical apparatus for Explosive gas atmospheres
IEC 60331	Test for Electric Cables Under Fire Conditions (Fire Resistant)
IEC 60332	Test on Electric Cables Under Fire Conditions (Flame Retardant)
IEC 60529	Degrees of Protection provided by Enclosures (IP Code)
IEC 60534	Industrial Process Control Valves
IEC 60584	Thermocouples
IEC 60751	Industrial Platinum Resistance Thermometer Sensors
IEC 61000	Electromagnetic Compatibility (EMC)
IEC 61508	Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems
IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry
IEC 61158	Digital Data Communications for measurement and Control –Field Bus for use in Industrial Control System.
IEC 61158-2	Industrial communication networks – Field bus specifications - Part 2: Physical layer specification and service definition Edition 4.0
IEC 61515	Mineral Insulated Thermocouple Cables and Thermocouples
IEC 61784-1-0	Industrial communication networks – Fieldbus Profiles General Concept





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CODE	TITLE
IEC 61784-1-1 to 6, 8,9,22	Industrial communication networks – Fieldbus Profiles communication profile family
IEC 62591	Industrial Networks- Wireless communication network and communication profiles- Wireless HART
IEC 62734	Industrial Networks- Wireless communication network and communication profiles- ISA 100.11a

4.2.6 British Standards

CODE	TITLE
BS 6739	Code of practice for instrumentation in process control systems: installation, design and practice.
BS EN 10204	Metallic Materials – Types of Inspection (Document on Material Testing & Certification)
BS EN 837-1	Pressure Gauges, Bourdon Type Pressure Gauges, Dimensions, Metrology, requirement and testing
BS 4800	Schedule of paint colours for building purposes

4.2.7 Foundation Fieldbus Specification and guidelines

CODE	TITLE
AG-163	Application Guide for 31.25 kbits/s IS systems
AG-181	Foundation Fieldbus System Engineering Guidelines
AG-140	Wiring and Installation
FF-103	Common File Format
FF-131	Standard Tables
FF-524	Device Descriptors File
FF-569	Host Interoperability Support Test (HIST)
FF-581	System Architecture
FF-586	HSE Ethernet Presence
FF-588	Field Device Access (FDA) Agent
FF-589	HSE System Management





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CODE	TITLE
FF-593	HSE Redundancy
FF-801	Network Management
FF-803	HSE Network Management
FF-816	31.25 kbit/s Physical Layer Profile Specification/FISCO
FF-831	Fieldbus Power Supply Test Specification
FF-844	H1 Cable Test Specification
FF-870	Fieldbus Message Specification
FF-880	H1 System Management
FF-890	Function Block Application Process Part 1
FF-891	Function Block Application Process Part 2 (10 Standard FBs)
FF-892	Function Block Application Process Part 3 (Advanced FBs)
FF-893	Function Block Application Process Part 4 (Multiple I/O FBs)
FF-894	Function Block Application Process Part 5 (Flexible FBs)
FF-900	Device Descriptor Language
FF-902	Transducer Block Common Structure
FF-903/904/906/908	Transducer Block Application Process Part 2 (Details Profile)
FF-940	Communication Profile
FF-941	HSE Profile
RELCOM	Foundation Fieldbus Wiring Design & Installation Guide

4.2.8 National Association of Corrosion Engineers (NACE)

CODE	TITLE
NACE MR-0175 / ISO 15156	Petroleum and Natural Gas industries- Materials for use in H2S containing environments in Oil and Gas Production.





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4.2.9 Other international Standards

CODE	TITLE
NAMUR NE 43	Standardization of the signal level for the breakdown information of digital transmitters
MSS-SP-72	Ball Valves with Flanged or Butt-Welding Ends for General Service

4.2.10 COMPANY Standards, Guidelines & Code of Practices

CODE	TITLE
A0-Q-PQ-GDL-001	Guideline for Project Quality Plan
AGES-SP-13-001	Criticality Rating Specification
AGES-SP-13-002	Procurement Inspection & Certification Requirement in Projects

4.3 PROJECT REFERENCE DOCUMENTS

DOCUMENT NUMBER	DOCUMENT TITLE
E1150-BD-2000-J-0002	Instrument & Control Philosophy
E1150-BD-2000-J-0001	Instrument & Control Design Basis
E1150-TS-2000-J-0033	Specification for Foundation Fieldbus Design
E1150-TS-2000-J-0012	Specification for Instruments and Controls Installation
E1150-TS-2000-J-0034	Specification for Integrated Control and Safety System (ICSS)
E1150-TS-2000-J-0035	Specification for Asset Management System (AMS)
E1150-TS-2000-J-0036	Specification for Alarm Management System (ALMS)
E1150-TS-2000-J-0031	Specification for Plant Information Management System (PIMS)
E1150-TS-2000-J-0037	Specification for Operator Training Simulator (OTS)
E1150-TS-2000-J-0038	Specification for Rotating Machine Monitoring System (RMMS)
E1150-TS-2000-J-0032	Specification for Network Interface and System Security Guidelines
E1150-TS-2000-J-0007	Specification for Wireless Network for Field Instruments
E1150-TS-2000-J-0013	Specification for Hydraulic Safety Shutdown System (HSSS)





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DOCUMENT NUMBER	DOCUMENT TITLE
E1150-TS-2000-J-0006	Specification for Control Valves
E1150-TS-2000-J-0001	Specification for Choke Valves
E1150-TS-2000-J-0002	Specification for Actuated On-Off Valves
E1150-TS-2000-J-0003	Specification for Safety Relief Valves
E1150-TS-2000-J-0042	Specification for Moisture Analyzer
E1150-TS-2000-J-0044	Specification for Basis Sediment & Water Analyzer
E1150-TS-2000-J-0045	Specification for Dissolved Oxygen Analyzer
E1150-TS-2000-J-0046	Specification for Turbidity Analyzer
E1150-TS-2000-J-0014	Specification for Multiphase Flowmeters
E1150-TS-2000-J-0040	Specification for System Cabinets
E1150-TS-2000-J-0015	Specification for Fire & Gas Detectors and Devices
E1150-TS-2000-J-0016	Specification for Instrument Cable, Cable Glands & Junction Boxes
E1150-TS-2000-J-0009	Specification for Instrument Interface requirements
E1150-TS-2000-J-0004	Specification for Differential Pressure Flow Elements
E1150-TS-2000-J-0021	Specification for Vortex Shedding Flow Meters
E1150-TS-2000-J-0022	Specification for Variable Area Flow Meters
E1150-TS-2000-J-0023	Specification for Electromagnetic Flow Meters
E1150-TS-2000-J-0025	Specification for Level Gauges
E1150-TS-2000-J-0026	Specification for Pressure Gauges
E1150-TS-2000-J-0027	Specification for Level Transmitters (Radar / Displacer)
E1150-TS-2000-J-0028	Specification for Pressure And Differential Pressure Transmitters
E1150-TS-2000-J-0029	Specification for Temperature Instruments With Thermowells
E1150-TS-2000-J-0010	Specification for Instrument Material Selection
E1150-TS-2000-J-0020	Specification for Instruments & Controls Testing & Commissioning
E1150-TS-2000-J-0018	Specification for Bulk Material
E1150-TS-2000-J-0017	Specification for Cable Tray







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DOCUMENT NUMBER	DOCUMENT TITLE
E1150-BD-2000-N-0001	HSE Philosophy
E1150-BD-2000-O-0001	Fire Protection Philosophy
E1150-BD-2000-O-0002	F & G Detection Philosophy
E1150-BD-2000-F-0003	Process Design Basis
E1150-GD-2000-G-0022	Specification for General Environmental Data and units of measurement
E1150-BD-2000-T-0001	Telecommunication Design Basis
E1150-TS-2000-O-0002	Specification For Fire Fighting & Safety Equipment
E1150-GD-2000-P-0001	Piping Material Specification
E1150-TS-2000-W-0004	Specification for External and Internal Coating

5. SCOPE

This document defines the general technical requirements for design, engineering, procurement, installation, interface, integration, testing, commissioning, QA/QC, site support and guidelines for all types of instruments and package control systems to be used for various types of the Package Units. This document shall be read together with other referenced specifications and relevant Project documents.

This Project is an extension of the UZ750 Project. Existing philosophy shall be followed. Any deviation shall be highlighted clearly for COMPANY review.

This document shall always be read in conjunction with the Mechanical specifications of a particular Equipment package/s and/or Project requisitions / specifications associated with a supply of Equipment package, where the functional and operational requirements of Instruments and controls specific to the Package are detailed or elaborated.

Latest hardware and software version shall be provided for Package systems Various types of packages envisaged for the Upper Zakum for the "1 MMBD Expansion Phase 1 - Surface Facilities" Project are defined as below:

a) Package Type A

Type A Packages shall be fully implemented, monitored, operated and controlled from the Island BPCS, SIS and FGS, with no package control systems.

Function of the local panel, if any, shall be limited to local indicators and emergency push buttons without any logic units/devices installed in the field.





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In this type of Package, all the instruments and accessories within the package skid shall be supplied, installed, wired and terminated in the junction boxes supplied and mounted on the skid or local panel by the Package VENDOR. Multi pair/triad cables between the Package VENDOR supplied local panels/ junction boxes and the Island BPCS, SIS & FGS located in Local Control Room/Module Technical Room shall be by the EPC CONTRACTOR.

The Package VENDOR shall provide all the required information, detailed functional description, cause & effect diagrams etc., to implement their package control, monitoring and shutdown functions in the Island BPCS, SIS and FGS.

b) Package Type B

Type B Packages shall be fully implemented, monitored, operated and controlled from the Island BPCS, SIS and FGS. However, control systems required to perform package related special proprietary functions shall be stand-alone and dedicated systems. Redundant CPU with applicable redundant IO Modules need to be considered. Safety loops shall be redundant Safety IO modules. All these stand- alone systems shall be interfaced via redundant Modbus RTU TCP/IP (preferred) or Modbus RS485 or redundant OPC communications to the Island BPCS for monitoring/control and hardwired or connected via the VNET/IP control and safety network to the SIS (for trip and other SIS signals) and FGS. In this type of Package, all the instruments and accessories within the package skid shall be supplied, installed, wired and terminated in the junction boxes supplied and mounted on the skid by the Package VENDOR. Multi pair/triad cables between the Package VENDOR supplied junction boxes and the Island BPCS, SIS, FGS & Control Systems like Compressor Control System, Machine Monitoring System etc., located in Local Control Room/Module Technical Room shall be by the EPC CONTRACTOR.

The Package VENDOR shall provide all the required information and documentation (Detailed Functional Specifications, control logic (in the form of Instrument Function Diagrams) and narratives, Cause and Effect diagrams, P & I Diagrams, etc.) required to implement their package control, monitoring and shutdown functions in the Island BPCS, SIS and FGS to the EPC CONTRACTOR and the COMPANY for review and approval.

c) Package Type C

Type C Packages shall be fully implemented in the Package Unit Control Panel (UCP) located in LCR/MTR including proprietary functions with serial/hardwired link to the Island BPCS, hardwired link to the SIS and FGS. These Packages shall be monitored and operated from the Island BPCS. Redundant CPU with applicable redundant IO Modules need to be considered. Safety loops shall be redundant Safety IO modules.

The F&G detectors are supplied by EPC CONTRACTOR/Package Vendor (Except GTG) and connected to plant F&G System located in LER/LCR/MTR as applicable.

For the GTG package, GT enclosure detectors are connected to Vendor supplied UCP and GTG Module F&G detectors are connected to plant F&G system.





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Function of the local panel, if any, shall be limited to local indicators and emergency push buttons without any logic units/devices installed in the field.

In this type of Package, all the instruments and accessories within the package skid shall be supplied, installed, wired and terminated in the junction boxes supplied and mounted on the skid or local panel by the Package VENDOR. Multi pair/triad cables between the Package VENDOR supplied local panels/junction boxes and the Unit Control Panel located in the Local Control Room/Module Technical Room shall be by the EPC CONTRACTOR.

d) Package Type D

Type D Packages shall be fully operated by Local Control Panel in the field, with serial/hardwired link to the Island BPCS, hardwired link to SIS and FGS. Redundant CPU with applicable redundant IO Modules need to be considered. Safety loops shall be redundant Safety IO modules.

In this type of Package, all the instruments and accessories within the package skid shall be supplied, installed, wired and terminated in the Local Control Panel.

Multi pair/triad cables between the Package Vendor supplied Local Control Panel and the Island BPCS, SIS & FGS located in the Local Control Room/Module Technical Room shall be by the EPC CONTRACTOR.

As far as practical, package control systems shall be implemented in Yokogawa STARDOM PLC for non-SIL applications, in Yokogawa Prosafe RS PLC in case of SIL (SIS and FGS) applications or in Siemens make PLC for control and safely function (SIL) application of package.

The below table provides the list of the packages with Type for the "1 MMBD Expansion Phase 1 - Surface Facilities" project. This classification is in line with existing 750 philosophy and classification philosophy. Any deviation would need Company approval prior finalization.

Sr. No.	Package Description	Interface Type	Remarks
	Package Type A		
2	Chemical Injection Package	Not Applicable	
4	Deaerator Package	Not Applicable	
5	Sea Water Fine Filtration Package	Not Applicable	
6	Produced Water Treatment Package	Not Applicable	







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Sr. No.	Package Description	Interface Type	Remarks	
7	HP Water Injection Pumps, Produced Water Disposal Pumps, Crude Oil Transfer Pumps	Not Applicable (Refer Remark)	RMMS Cabinet is by Package Vendor and interface with ICSS.	
	Package Type B			
1	HP Water Injection Pumps, Produced Water Disposal Pumps, Crude Oil Transfer PumpsNot Applicable	From RMMS Cabinet: Redundant Modbus TCP/IP to BPCS ,and hardwired to SIS	RMMS Cabinet is by Package Vendor and interface with ICSS.	
	Package Type C			
	Package Type D			

The following packages are provided as standalone systems, with hardwired inter-trips to the Island BPCS, SIS and Fire and Gas System.

- Cathodic Protection System
- Electric Overhead Travelling Crane

6. **GENERAL REQUIREMENTS**

All package Instrumentation shall follow Instrument & Control Design Basis (Doc. No. E1150-BD-2000-J-0001), any deviation shall be pre-approved by COMPANY before implementation.

6.1 LANGUAGE AND UNITS OF MEASUREMENT

Unless otherwise stated, all drawings, documents, instruction books and manuals, engineering & maintenance manuals shall be in English language. Where a local statutory code approval is required, documents in bilingual (English or Arabic) or authorized translations in Arabic may be specifically requested.

PC software for documentation shall use the following commercially available software:

- Instrument Sizing: Intergraph SPI (INtools) Version 13.1
- Instrument Database: Intergraph (INTools) Version 13
- Instrument Drawings: Intergraph (INTools) Version 13 & AutoCAD latest Version
- Other Documents: Intergraph (INTools) Version 13, MS Office (Word, Excel)
- Modelling: Intergraph SP3D

The units of measurement shall be as per E1150-BD-2000-J-0001 "Instrument & Control Design Basis".







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6.2 **ENVIRONMENTAL CONDITIONS**

The environmental conditions shall be as per Instrument & Control Design Basis (Doc. No. E1150-BD-2000-J-0001)

All the Instruments and Control system equipment shall be designed suitable for installation under the above environmental conditions. Design considerations mentioned below shall also be followed.

Instrument and Control equipment shall be designed to operate for the applicable three types of location shown below:

	INDOOR AIRCONDITIONED (2)	OUTDOOR SHELTERED (1)(2)(3)	OUTDOOR UNSHELTERED (2)(3)
Maximum	35°C (95°F)	55°C (131°F)	65°C (149°F)
Minimum	10°C (50°F)	0°C (32°F)	0°C (32°F)

Notes:

- 1 "Sheltered" refers to permanent, ventilated enclosures or buildings or permanently fixed sunshades with a top and three sides.
- 2 For instruments which dissipate internal heat and are installed in custom engineered enclosures (e.g., enclosures not included in the original manufacturer's temperature certification), an additional 15°C shall be added to the above maximum temperatures. An example, for "indoor air conditioned" installation, the equipment must perform at 35 + 15 = 50°C. Similarly, for the "outdoor unsheltered" case, the equipment shall be designed for a maximum operating temperature of 65 + 15 = 80°C.
- 3 For the outdoor installations only, the designer can take credit for forced or passive cooling to eliminate or reduce the 15°C heat rise. For example, if vortex coolers are used, the heat removal capacity of the coolers may be subtracted from the generated heat. No more than 15°C reduction in temperature will be given as credit. The designer shall substantiate his claim by providing the support data and calculations.

6.3 SIGNAL STANDARDS AND TYPES

6.3.1 Pneumatic and Electronic Transmission Signals

Pneumatic and Electronic transmission signals shall be as follows:

- Pneumatic: 3-15 psig / 0.2-1.0 bar g
- Electronic
 - a) Foundation Fieldbus (FF) compatible instruments (connected to BPCS)
 - b) 2-wire, 4-20 mA, 24 V dc, with HART protocol (connected to Package Control Systems, SIS, CCS, RMMS etc.)







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Where Foundation Fieldbus compatible instruments are not available (e.g. speciality instruments like analysers), instruments with 4-20 mA, 24V DC, HART may be used. Local scales for Flow and Pressure shall be in engineering units and Level in "percent "units, unless otherwise specified.

Wireless device shall be provided for critical local gauges in field which are difficult to access. These devices shall use wireless network for communication with ICSS.

6.3.2 Contact signals

- a) Process Switch signals:
 "Fail safe" Closed for process on normal conditions, contact to open on alarm or abnormality.
- b) Alarm & Shutdown signals (from relay etc)
 "Fail safe"- Normally Energized system, with contact to open on alarm or abnormality.
- c) MCC commands: Start contact –Normally open; Stop contact – Normally closed
- d) MCC status: Normally open (NO)
- e) Selector switch signals: Contact closed on selection (open otherwise)
- f) Reset Signals: Rising pulse type normally open (NO)

6.3.3 Solenoid valve:

Normally energized.

6.3.4 Fire & Gas detector systems (from monitors, relays etc.):

Normally Energized system, with contact to open on alarm or abnormality.

6.3.5 Fire & Gas protection systems:

Digital input contacts to FGS shall be NO and line monitored.

Sounders, Beacons, Lamps, Digital Contact Outputs shall be energize to activate and Line Monitored.

Trip signal from FGS to other system is de-energize/open to trip.

The sounder and beacon colour within the package shall be in line with project approved specifications for Fire and Gas detectors and devices (E1150-TS-2000-J-0015).





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6.3.6 Digital communication:

Modbus RTU over TCP/IP or Modbus RS 485 or OPC.

6.4 SYMBOLS, TAGGING AND IDENTIFICATION

Symbols and Identification shall generally be as per ANSI/ISA-5.1-2009 and ISA S 5.2 to 5.5 for P & I D representation, Tagging, Logic diagrams, Graphic displays etc.

Sequence numbers of Instrument tagging is in the control of EPC CONTRACTOR/COMPANY registry. VENDOR shall request the same from EPC CONTRACTOR/COMPANY, as required. Document and Drawing numbers and their sequence numbers are also in the control of EPC CONTRACTOR / COMPANY registry. VENDOR may use his document and drawing number system but they shall additionally carry COMPANY's registry assigned numbers after PO on all submittals.

The electronic filing and numbering system shall be in relational one-to-one correspondence with the hard copy filing arrangement for drawing and document submittals.

6.5 UTILITIES

6.5.1 Electrical Power Supplies

Package VENDOR shall be supplied with single set of redundant feeder at one or two locations depending on the Package type:

- a) At the skid or package battery limit.
- b) At the Unit Control Panel / Power supply unit cabinet to be supplied by the VENDOR in the Local Control Rooms / MTRs.

The voltage levels shall be 230 V AC, 50 Hz \pm 5% non UPS for utilities like lighting, utility socket and 230 V AC, 50 Hz \pm 5% UPS for Systems and Instruments. VENDOR shall derive all necessary power requirements through power supply units and further distributions.

Generally, the following utilization voltages shall be adopted unless otherwise specified.

Instrument Panel Lighting: 230V, 50Hz, 1ph, non UPS.

Plant Instrumentation and control feeder: 230 V, 50Hz, 1ph UPS.

Control system voltage: 24V DC UPS.

Safety Instrumented System voltage: 24 DC UPS.

F&G System voltage: 24 DC UPS.

All power supplies shall be redundant as a minimum. Specific deviations shall be agreed with COMPANY before finalization.





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Optionally, Package VENDOR may be additionally supplied with redundant feeders of single phase UPS supply at a single point and further distributions shall be done by Package VENDOR.

6.5.2 Instrument Air (Motive Instrument Air)

Instrument air required for operation of pneumatic instrumentation on a single skid or geographically split multiple skid-based packages shall be provided on each skid at a single location with flanged ends by EPC CONTRACTOR. Further distribution shall be the responsibility of VENDOR.

For large skid requirements (air header size requirement higher than 2"), VENDOR shall install a secondary pressure control and a master filter system at the battery limit.

The valve actuators and the pneumatically powered valve accessories shall be sized using the minimum pressure but also shall be suitable for the design pressure as specified in the respective design document/ datasheet. Control Valve Actuators should be designed to operate on a range of 3 to 15 psig.

6.6 <u>INSTRUMENT CONNECTIONS</u>

All threads shall be to "NPT" (ASME B 1.20.1 taper). Where the instrument item is not available with NPT connections, suitable adapter to NPT shall be provided irrespective of the scope of installation. Electric connections shall be to "ISO metric". Parallel threads with washers are not acceptable.

Flanged ends shall be to ASME B16.5. Rating and Facing shall be as per approved Package piping specifications.

Orifice Flanges shall be to ASME B 16.36.

The table below lists the standard sizes and types for "Instrument Connections" and "Process Connections". "Process Connection" is the connection size at the first process isolation valve (defined by the Project Piping Specifications and Data Sheets) and "Instrument Connection" is the connection at the instrument.

INSTRUMENT TYPE	PROCESS / VESSEL CONNECTION	INSTRUMENT CONNECTION	
Flow Instruments			
D/P (Non-sour services)	½" flanged x ½"OD	½" NPT (F) x ½" OD	
D/P (Sour services)	1" flanged x ½" OD	½" NPT(F) x ½" OD	
Level Instruments			
External Displacer	2" flanged	2" flanged	
Internal Displacer	4" flanged	4" flanged	







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INSTRUMENT TYPE	PROCESS / VESSEL CONNECTION	INSTRUMENT CONNECTION
External Float	2" flanged	2" flanged
Internal Float	4" flanged	4" flanged
External Radar	2" flanged	2" flanged
Internal Radar	4" flanged	4" flanged
Level Gauge	2" flanged	2" flanged
DP type	2" flanged x ½" OD	½" NPT (F) x ½" OD
DP type with remote diaphragm seal	3" flanged	3" flanged
DP type direct vessel mounted (diaphragm seal)	3" flanged	3" flanged
Pressure Instruments		
Pressure gauge / DP gauge (on pipe, Non-sour services)	1" flanged x ½"NPT (F)	½" NPT(M)
Pressure gauge / DP gauge (on pipe, Sour services)	2" flanged x ½"NPT (F)	½" NPT(M)
Pressure transmitter / DP transmitter (on pipe, Non-sour services)	1" flanged x ½" OD	½" NPT(F) x ½" OD
Pressure transmitter / DP transmitter (on pipe, Sour services)	2" flanged x ½" OD	½" NPT(F) x ½" OD
Pressure gauge and DP gauge (on vessel)	2" flanged x ½"NPT (F)	½" NPT(M)
Pressure transmitter / DP transmitter (on vessel, Sour services)	2" flanged x ½" OD	½" NPT(F) x ½" OD
Inst. with diaphragm seal (pipe or vessel)	3" flanged	3" flanged
Temperature Instruments		
Thermowell on pipe	1 ½" flanged or 2" Flanged (Note 10)	1 ½" flanged or 2" flanged (Note 10)
Thermowell on vessel	2" flanged	2" flanged

Package VENDOR shall follow project instrument hook up drawings wherever possible and provide hook-up drawing for package instruments. Any deviations shall be highlighted for EPC CONTRACTOR/ COMPANY Review and Approval. Refer Instrument Process hook-up Drawing-AGI (E1150-A3-2000-J-2009), Instrument Process hook-up Drawing-ETI





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(E1150-A3-2100-J-2009), Instrument Process hook-up Drawing-UAAI (E1150-A3-2300-J-2009), Instrument Process hook-up Drawing-ASI (E1150-A3-2200-J-2009) for details.

Notes:

- 1) For diaphragm seal, the seal is the instrument connection
- 2) Instrument drain/vent shall be strictly connected as per Instrument hook-up drawings and Piping and Instrumentation Diagram (P&ID).
- 3) Flanged end connection rating shall be 300# RF, as a minimum for Instruments mounted on Process equipment.
- 4) For pipe class with higher ratings, instrument connection size shall be as per piping material specifications as applicable.
- 5) The stand pipe connections to the equipment will be 3".
- 6) The type of flange shall be in accordance to Piping Material Specifications (Doc. No. E1150-GD-2000-P-0001).
- 7) Threaded connections shall be avoided in sour service.
- 8) Threaded/ Welded connections shall be avoided in Lethal service
- 9) Instrument Impulse tubing shall be 12 mm O.D., 0.89 mm minimum wall thickness, SS-316L. However, selection of materials shall be chosen based on process condition. Material for sour service shall comply with applicable COMPANY & NACE standards MR0175/ ISO 15156. For lethal service and pipe class rating of 1500# and above, hard pipe (instead of impulse tubing) shall be used for hook-up of transmitters.
- 10) The Thermowell connection Size for line shall be 1 ½" NB OE 2" NB depending on the piping material specification for the line. Refer Piping design and construction standard (E1150-BD-2000-P-0002) and Piping Material specification (E1150-TS-2000-P-0001) for details.
- 11) Diaphragm seals are required for level instruments in lethal, severely dirty, corrosive, hazardous fluids, or fouling service. Pressure instruments for measurement in non-clean applications including slurry, dirty, highly viscous fluid will use diaphragm seal type transmitters with flushing ring.

6.7 HAZARDOUS AREA AND ELECTRICAL SAFETY

The protection for Classified Electrical Hazardous area shall be as per IEC-60079, unless Local Statutory Codes overrule. All the package unit field instruments shall be certified suitable for the hazardous area Zone 1, Gas Group IIB, Temperature Class T3, as a minimum at an ambient temperature of 55 °C. However, for packages with possible presence of Hydrogen, the field instruments shall be certified suitable for the hazardous area Zone 1, Gas Group IIC, Temperature Class T3 as a minimum at an ambient temperature of 55 °C.

The method of hazardous area protection for Instruments and Control Equipment located in the field shall be as below:







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INSTRUMENTS AND ACCESORIES	METHOD OF PROTECTION
Instruments and accessories (e.g.: Transmitters, Solenoid valves, Switches, Valve Positioners, F&G Detectors, etc.)	 a) Instruments and accessories used in Foundation Fieldbus BPCS circuits: FISCO as per IEC-60079-11 and 27:2008.
	 Instruments and accessories used in Non- Foundation Fieldbus BPCS and Other Systems circuits: Explosion Proof/Flameproof (Ex"d" as per IEC 60079-1).
Junction boxes	a) Foundation Fieldbus Circuits: Increased Safety (Ex"e" as per IEC 60079-7).(Note-2)
	 b) Non Foundation Fieldbus (i.e. Explosion Proof/Flameproof) Circuits: Explosion Proof/Flameproof (Ex"d" as per IEC 60079-1).
Cable Glands and Plugs	Ex"de" for Ex"e" certified Junction Boxes and Ex"d" for Ex"d" certified instruments and Junction boxes.
Field Mounted Local Panels and communication system (to be located only in Non- Hazardous Areas (preferably) or Zone 2 area only).	Increased Safety (Ex"e") as per IEC 60079-7 and/or Type "n" Protection (Ex"n" as per IEC 60079-15). (Note-1).

Notes:

- 1) Ex"d" to be used if Ex"n" type is not available.
- 2) The FF Junction boxes and all components inside the junction boxes including field barriers / segment protectors shall be suitable for installation in Zone 1 hazardous area. Channel field barriers shall be Ex"e"-Ex"i". The FF junction boxes will be installed in shaded area as far as practicable. All FF junction Boxes installed outdoor under direct sunlight shall be provided with Canopy/ Sunshades. Ex"!".

Where Ex"d" instruments are not available, Ex"i" shall be followed. Active barriers (Galvanic Isolator) shall be used for Ex"i" circuits.

Electrical Instruments and Enclosures shall not normally be installed in Zone 0 Hazardous Areas and shall only be done with written EPC CONTRACTOR / COMPANY approval.

All Local Panels on the Island facilities shall preferably be placed in non-hazardous areas. If the Panel is located in a Zone 2 classified area, a certificate of conformity to IEC 60079-15 shall be delivered for the complete panel from EPC CONTRACTOR / COMPANY approved recognized third-party authority.

It shall not be assumed that the packaging of individually certified components makes a certified system/unit/cabinet/panel. An appropriate third-party certification must be





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provided and shall be related to the complete assembled control system/unit/cabinet/panel. The third-party certifying authority shall be approved by the EPC CONTRACTOR / COMPANY.

All necessary Test Reports and Certificates shall be provided to the EPC CONTRACTOR / COMPANY. All the certificates shall be in English language.

All Control Rooms, Local Equipment Rooms and Modular Technical Rooms shall be air conditioned, positive pressure maintained and shall be classified as Safe (Non-Hazardous) Areas. All equipment within these Control Rooms shall be certified for non-hazardous area (General Purpose) installation unless specified otherwise in Project Specifications or Data Sheets.

Approved national authority (e.g. CSA, UL, BASEEFA, FM, CESI, LCIE) shall certify all Instruments, instrument equipment, devices or fittings installed in hazardous areas in which it will be used. All such equipment shall carry apparatus marking as per IEC.

Additional ATEX marking shall be applicable for equipment conforming to IEC / CENELEC as per EU Directive ATEX 2014/34/EU; whereas equipment conforming to North American Practices / NEMA shall carry AEx apparatus marking.

The EEx Certified enclosures shall be fitted with SS-Name Plates indicting the ratings and the certifying Body and their reference. An exact duplicate Name Plate shall be affixed inside the Box as well to serve as Long term reference and will not be damaged by salty environment, sand blasting or paint over coats and there shall be a Photographic document showing the details for EEX Certified enclosures Register for the whole Installation. Adequate clearances shall be maintained around the flame paths and the installation shall be independently audited and approved by a Third-Party EEx certifying authority.

Active barriers shall be provided for all Intrinsic Safety (I.S.) requirements.

All Ex certified equipment also requires an Emirates Conformity Assessment System (ECAS) Ex Certificate of Conformity (CoC) issued by a notified body. Requirement for the ECAS Ex programme utilizes IEC Standards, and qualification of conformity is met by meeting the requirements of the IECEx scheme in full.

6.8 WEATHER PROTECTION AND TROPICALIZATION

All hazardous area Instrument and accessories shall also be weather-proof.

All Instrument and Instrument items shall be tropicalized to meet the climatic conditions specified under environmental data by suitable epoxy and resin coating/s.

Instrument and Instrument item enclosures shall have Ingress Protection (IP) codes as per IEC 60529: Degrees of protection provided by Enclosures.

Unless otherwise specified, all outdoor located Instrument and Instrument item enclosures shall have an Ingress Protection of "IP 66".





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Unless otherwise specified, all outdoor cabinets/panels shall have an Ingress Protection of "IP 65". All indoor cabinets/panels shall have an Ingress Protection of "IP 54".

All the field instruments and cabinets/panels installed under/exposed to direct sun light shall be provided with sunshade or canopy, as applicable.

6.9 EARTHING / GROUNDING

All the Instruments and Control equipment including Junction Boxes, cable armours, cable screens and installation materials supplied as part of the Package Unit shall be earthed.

Instrument Earthing or grounding system for the Package Unit shall comprise of two or three levels as follows:

- a) Safety Earth (SE) also called as Plant Earth or Protective Earth or Electrical Earth.
- b) Instrument Earth (INE) also called Clean Earth or System Earth.
- c) Intrinsic Safety Earth (ISE) also called Barrier Earth or Zener Barrier Earth.

Package VENDOR shall plan for segregation of SE, INE and ISE as applicable in his scope of supply items but the tieback to Main Plant Earth system shall be by EPC CONTRACTOR.

Safety Earth cable shall have Green with Yellow stripes outer sheath, Instrument Earth cable shall have Green coloured outer sheath and Intrinsic Safe Earth shall have Green with Blue strips coloured outer sheath.

6.9.1 Cabinet, Cable Screen, Armour Earthing

The instrument cable screens shall be earthed at one end only and at the control room/centre marshalling or I/O interfaces cabinet, while the screens shall be left insulated at the field end of measuring element or transducer or transmitter.

The system and /or marshalling cabinets shall have the instrument earth bar insulated from the cabinet enclosures. The instrument earth bar inside the cabinet shall be connected to the external earth (via an IE grounding dispatcher), while the enclosure shall be connected to safety earth (via a SE grounding dispatcher).

Each screen shall be terminated at the marshalling cabinet in a bus bar or in a separate (but linked) terminal and then routed to the instrument bus bar.

IE from each cabinet shall be linked to the insulated grounding dispatcher/ bus bar within the control room by redundant link and shall be star connected.

Lead sheath (when provided), steel wire armouring and metal wire braiding of signal cables shall at each termination be connected to safety earth.





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Mounting bolts of instrument housings shall be fitted with two shark rings to ensure a very low resistance to structure.

Ungrounded Thermocouple screens shall be insulated in the thermocouple head and earthed at the instrument earth at marshalling cabinet.

Grounded thermocouple (e.g. skin thermocouples) when used, shall be provided with galvanic optical isolator at the control room end before the marshalling cabinet. The earthing of separate screened cable after the isolator shall be at the instrument earth at the marshalling cabinet.

Screened cables for Machinery Monitoring System (MMS) shall follow manufacturer's guidelines.

Cable armour shall be grounded to metallic enclosures by an earthing ring or bond leading to Safety Earth.

All cable glands shall be provided with earth tag. The cable armour shall be connected to gland for earthing purpose.

Metal Junction boxes or metallic sections of a Fibre re-enforced Polyester Junction box shall be earthed to their metallic support by earth wire specified.

Notes:

- 1) Most Field instruments do not have insulated connection facilities for the screen. The screen shall be insulated with a protective sleeve and left (open) unconnected and with the same offset length as the screen wires.
- 2) Lightning arresters (preferrably integral) for mounting in plant top structures or open space areas shall be provided. Lightning arrestors used for DC signals at transmitter end may also require field safety earthing of shield. Such transmitters shall also be provided with galvanic optical isolator at the control room end before the marshalling cabinet. The earthing of a separate screened cable after the isolator shall be at the instrument earth at the marshalling cabinet.

6.10 EMI/RFI NOISE IMMUNITY & ELECTRICAL DISCHARGE PROTECTION

The design of all electrical/instrument equipment and installations for the Package Unit shall meet the appropriate emission and immunity specifications for the intended operational environment, meeting the emission (IEC 61000-6-4) and immunity (IEC 61000-6-2) requirements for an industrial environment.

Circuits shall protect against and suppress electrical surges and transients of up to 1500V, 50-60 Hz that may be included in field wiring. Transient and surge protection on all input/output shall be designed as per API RP 552.





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6.11 CABLING, WIRING & TERMINATION

High Power Trunk (HPT) with Isolating Device Couplers (Intrinsically safe)" and FISCO Field Devices shall be used for FF Signals. This will provide high power (non-IS) power on the trunks, intrinsically safe (or energy limited) outputs on the spurs and H1 host controller and fieldbus power supply redundancy.

High Power Trunk (HPT) can use FF field instruments that are FISCO certified and utilize cables that meet the specified parameters for the interconnection of the equipment.

According to the FF specification (ISA S50.02) the maximum allowed length of a Fieldbus segment is limited to 1900 m. This total segment length is computed by adding the length of the main trunk line and all the spurs that extend from it.

Total Segment Length = Trunk + All Spurs

In order to eliminate the need to calculate the physical loading of each segment and to reduce the validation requirement, the following limits shall apply for this project:

- Trunk cable length ≤ 1500 meters
- Spur cable length ≤ 100 meters.

FF Segment device allocation for each Standard Size FF barrier junction box shall be governed by following factors while maintaining 20% installed spares in each FF junction box:

• FF Barrier Junction Box size

Number of FF Control Loops in one JB and FF loop Criticality of each loop Package VENDOR Shall liaise with MAC for Procurement of FF Junction box in co-ordination with EPC CONTRACTOR. The FF Junction box design shall be endorsed by MAC before installation.

FF Segment design shall comply with the Project "Specification for Foundation Fieldbus Design" (Doc. No. E1150-TS-2000-J-0033).

Non-FF signals segregation shall comply with the following segregation philosophy:

- Signal Destination (BPCS, SIS, FGS, etc.).
- Signal Type (AI / AO / DI / DO).
- Type of Protection (Intrinsically Safe / Non Intrinsically Safe).
- Instrument power supply (Voltage, AC/DC, etc.).

Analog input (AI) signals and Analog output (AO) signals may be connected to the same field mounted Junction box and run in the same Multi-conductor Cable.

24 V DC Digital Input (DI) signals and Digital Output (DO) signals may be connected to the same field mounted Junction box and run in the different Multi-pair Cable. The DI's & DO's shall be segregated in different terminal rows labelled appropriately.





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Proper segregation shall be provided in cable trays for different signal levels as per BS-6739 and API-RP-552.

Intrinsically safe circuits shall be correctly segregated throughout and all field Junction boxes shall on I.S. circuits shall be clearly identified and labelled in Blue.

Cables on I.S. circuit shall be sheathed or marked light blue (heat shrink sleeve is acceptable for up to 500 mm from the termination point), while non-I.S. cables shall be Grev.

The Instrument cable outer sheath colour shall be as accordance with "Specification for Instrument Cable, Cable Glands & Junction Boxes" (Doc No E1150-TS-2000-J-0016).

VENDOR shall design, engineer, supply and install all cables, wiring and termination complete with cable numbering and termination cross-ferrules from Instruments and accessories in his package to Field Junctions boxes, Local gauge board and Local control panels within skid / package battery limits.

All special interface and communication cables (e.g. optical fibre cables, system cables) complete with connectors are deemed to be in the scope of VENDOR and shall be supplied by him.

Cables and wiring shall be suitably segregated and terminated in Junction boxes on the skid edge or support structure at a single location & accessible.

Cable runs between Field Junction boxes and Field Instrument or control panel end shall be of single length without any transition fitting or transition boxes.

All cores of cables shall be terminated at Field Junction Boxes and at Marshalling panel in control/equipment rooms including the spare cores.

The use of metallic conduits requires specific approval. In case of vibrating or moving units, such as in machinery monitoring, flexible conduit with ground wire and certified suitable for the hazardous area specified may be laid for a maximum length of 1m from probe to nearest sensing/signal conditioning unit.

6.12 SPARING AND SPARE PARTS PHILOSOPHY

Each multi-pair/core cable run shall have a spare capacity of at least 30% subject to a minimum of 2 pairs or 4 cores.

Each junction box shall be designed to accommodate all terminations of pair or core cables and have a further additional termination of up to 20% unwired terminals, subject to a minimum of 4 terminals.

Minimum spare- wired windows on Alarm Annunciators should not be less than 20% subject to a minimum of 2 windows. Minimum one instrument of each type of standard panel receiver instrument.





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The guideline for spares for maintenance requirements (2 years operation) of various items is as follows:

- **Gauges & Switches**: At least one per type and range for each operating area. Accessories shall at least be one of each type.
- **Transmitters:** At least two transmitters per type and encompassing all ranges used for each operating area. Accessories shall at least be one of each type.
- **Control valves**: Spare trim for critical and high erosive service valve. Accessories shall at least be one of each type. Actuator for spring & diaphragm type only- one per each type in use per operating area.

Control System spares:

- 20% pre-wired I/O spares and 20% un-installed unwired free space including trunking for expansion at the end of FAT.
- Power and all auxiliary functions to include 20% spare for installed spare I/O and 20% for future I/O at the end of FAT.
- o CPU, memory and network utilization: no more than 50% at the end of FAT.

Spares for consumables shall be of at least 20% of annual requirements.

6.13 Instrument Data Sheets and Documents

All packages shall be integrated into Smart Plant data base (SPI). VENDOR shall provide instrument data sheets in the .isf format provided by EPC CONTRACTOR to integrate in SPI data base.

VENDOR shall provide Instrument index, IO list, Alarm & trip schedule, cable Schedule, JB schedule in predefined excel template provided by EPC CONTRACTOR for integration in Smart plant Instrument (SPI) database.

VENDOR shall provide Instrument Hook-up Drawings in predefined project template provided by EPC contractor.

7. DESIGN REQUIREMENTS

7.1 SKID AND PACKAGE LIMITS

For the purpose of this section of specification, the Skid may be defined as one main piece of equipment complete with all its auxiliary facilities (instrumentation, structural, piping, and electrical) installed and constructed as a full assembly within the VENDOR's premises.

For the purpose of this section of specification, the Package(s) unit (s) may be defined as a self-contained unit conforming to given performance specifications and requiring only utilities services for its function. A package is generally integrated within the VENDOR's premises.





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VENDOR shall therefore ensure that no free issue or loose items shall be left unassembled and items shall be removed only after a fitment test for packing and transportation.

Specific limits of supply and works are qualified under various sections of this specification on Process, Pneumatic, Hydraulic, Electrical, Electronic, Structural etc. interconnections and interfaces.

However, the VENDOR is required to delineate by block diagrams and in all applicable document/drawing submittals his understanding of the scope of supply and works.

7.2 GENERAL DESIGN CRITERIA

All items shall be as per Project Specifications listed under section 4.3 of this document. The following sections provide summary of requirements but don't override the project specifications. In case of a discrepancy, the more stringent requirement shall apply.

Project material shall have at least 30 years of support available from the start of operation. The design life of the instrumentation for new facilities shall be 30 years. Lifecycle of the equipment / system hardware and software shall be within the design life of the project.

All process variable and status indications shall be available at Local panel or Remote Control System as shown on the P&IDs.

Instrument performance characteristics:

- a) Unless otherwise specified, local gauges and switches shall be supplied with the following characteristics:
 - Accuracy: ± 0.1% for Local gauges
 - Repeatability for switches: ± 0.2% FSD
- b) Unless otherwise specified as a minimum, Transmitters and Machinery Monitoring detectors shall be supplied with the following characteristics:
 - Accuracy: ± 0.15% 0.25% FSD
 - Repeatability: ± 0.2% FSD
- c) As a minimum, closed (control) loops shall be supplied with the following characteristics:
 - Accuracy: ± 1.00%

Instrument and valve range selection shall be on following guidelines for operating at normal process conditions:

- Flow (d/p): 70 % of range.
- Pressure: 40-70 % of range.
- Temperature: 30-70 % of range.
- Level: 40-60 % of range.





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 Control valves: 40- 70 % for linear characteristics and 30- 70 % for equal percentage Characteristics.

All trips shall be alarmed. All trip alarms shall be preceded by a pre-alarm and shall be generated for operator intervention & remedial action.

Pre-alarm and Trip alarm signals shall not be derived from the same primary device or instrument and shall not share a common process tap/ connection/ thermowell.

Process control shall be derived from separate segregated instrumentation and process taps from trip signals.

Grouping of alarm contacts as a Common Fault alarm may be permitted only for non-process & off line non-critical utility alarms (e.g. panel ventilation fan failure).

IOP alarm shall be generated in the system in event of input open. The IOP settings for all analog transmitters shall be 3.8 mA (IOP-) and 20.5 mA (IOP+).

Switches shall not be used and Transmitters shall be used wherever practicable. Approval shall be sought for switches on a case-to-case basis.

All instruments shall be purchased from reputed manufacturers on the COMPANY approved Instrument & Telecom Vendor List with proven track record of installation in similar Oil & Gas industries.

Make and model of the Instrumentation and Control items supplied by Package VENDOR shall be same as that of main plant as far as is practicable to optimize COMPANY's Spares / inventory requirement and simplify maintenance operation. VENDOR shall obtain this information from the EPC CONTRACTOR. Any deviation from approved Vendor List shall be subject to COMPANY approval.

The DD & CFF revisions of Foundation Fieldbus instruments supplied by Package Vendor shall be compatible with the existing HOST system. Package vendor shall laise with MAC to collect information on DD & CFF revisions to be provided.

Control Instruments (i.e. connected to BPCS or Package Control System) shall not be used for SIS duties and vice versa. In case a particular process variable needs to be used both for control and protection functions, two separate transmitters shall be provided.

All the Safety Instrumented Functions (SIFs) part of the packages shall be subject to Safety Integrity Level assessment. All Instruments (including valves and actuators) used in safety applications (SIF) shall be SIL certified by a third-party like TUV, EXIDA, etc. All necessary data required for SIL verification shall be provided by package VENDOR.

All transmitters inside the package unit shall be HART or FF compatible and shall be connected to the AMS (PRM supplied by Yokogawa) for instrument asset health monitoring.

Transmitter calibrated ranges shall be selected so that Alarm and Trip points are above 10% and below 90 % of the calibrated range.





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All transmitters shall have an integral local indicator displaying the measured process variable (s) in Engineering Units. A separate loop powered/BPCS or Package Control System driven indicator shall be supplied (if specified on the Instrument Data Sheet) for applications requiring indication near the associated manually manipulated control device (e.g. control valve, damper, etc.).

All level instruments installed in the same Vessel (Level Gauge, BPCS Level and ESD Level) shall cover the same range.

Level measurements shall be indicated in both mm and percentage for both BPCS and SIS.

Primary level transmitter selection shall be GWR. Other types of transmitters can be used if required (with prior approval from the COMPANY).

Magneto restrictive type level transmitter shall not be used.

Diaphragm seals are required for Differential Pressure level instruments in lethal, severely dirty, corrosive, hazardous fluids, or fouling service.

Primary level transmitter selection for SIS system shall be GWR Type. GWR is not suitable for applications where the presence of emulsion is expected.

Vendor shall be responsible for implementing the level study workshop recommendations into the vendor design, if any.

Instruments shall not be shared for high-high and low-low trips. Separate instruments shall be designated for high-high and low-low trips.

For electronic transmitters installed in open spaces or on top modules, transient surge protectors shall be provided to protect against lightning.

All Control Valves connected to the BPCS shall be provided with FF compatible Smart Valve Positioners.

Partial Stroke Testing (PST) facilities shall be provided for all SIS and Blow Down valves and other SIS final elements to enable the performance of diagnostic testing without the need for full stroking of the device. PST shall be performed from BPCS with proper security access. Partial Stroke Positioner shall be DVC6200 make or equivalent.

Necessary valvelink software licenses shall be provided for valves in project scope. EPC Contractor shall arrange at site for the valve tuning / signature in valvelink software by Package vendor during commissioning.

Field instruments and/or devices shall have dedicated tappings and process isolation valves.

The first Isolation Valve on each tapping point shall be provided by Package Vendor as per the Piping Material Specification (Doc. No. E1150-TS-2000-P-0001).





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For lethal service and pipe class rating of 1500# and above, hard pipe (instead of impulse tubing) shall be used for hook-up of transmitters. Threaded/ welded connections shall be avoided in lethal service. For the Pressure, D/P transmitter with welded impulse lines - break flange to be provided closest to installed transmitter for maintenance. Double block and bleed to be provided for proper isolation & venting.

Pressure transmitters and pressure gauges shall have a 2-valve Instrument manifold for instrument isolation.

Differential pressure transmitters (Flow, Level and DP) shall have a 5-valve Instrument manifold for instrument isolation.

Instrument manifolds shall be integral and connected directly to the transmitter. Seal welded threaded connection shall be avoided

Pressure instruments for measurement in non-clean applications including slurry, dirty, highly viscous fluid will use diaphragm seal type transmitters with flushing ring. Flushing ring vent & drain shall be tube/pipe as per existing plant philosophy.

Instrument Process Wetted part materials shall be suitable for the process fluid operating and design conditions and shall conform to Specification for Instrument Material Selection (Doc. No. E1150-TS-2000-J-0010) and Piping Material Specification (Doc. No. E1150-TS-2000-P-0001).

Valve body and trim materials shall be suitable for the process fluid operating and design conditions and shall conform to Specification for Instrument Material Selection (Doc. No. E1150-TS-2000-J-0010) and Piping Material Specification (Doc. No. E1150-TS-2000-P-0001). Trim Material shall be SS316L (as a minimum) or as required for the application.

All the electronic instruments shall have two ISO M20 cable entries to accommodate certified (Ex "d") cable glands. Adapters shall not be used to convert NPT cable entries to Metric Parallel cable entries. Spare cable entries shall be plugged with certified SS316L plugs.

Instruments with flying leads are not acceptable and all leads shall be terminated on terminal blocks in an integral junction box with terminals to connect the incoming field cables.

All field Junction Boxes shall be provided with 20% Spare cable entries. All spare cable entries shall be fitted with certified blank plugs. Package VENDOR Shall liaise with MAC for Procurement of FF Junction box in co-ordination with EPC CONTRACTOR. The FF Junction box design shall be endorsed by MAC before installation. FF JB make & model, all internal components of FF JB make model supplied by package vendor shall be same as the ones supplied by MAC. For MAC vetting of FF design, Initial FF design documents (Like CBD etc.) shall be submitted by the package VENDOR at early stage and shall be shared for MAC review by EPC CONTRACTOR. Only after receiving confirmation from MAC on the proposed Package VENDOR FF JB design, the package VENDOR shall freeze the signal segregation into FF JBs.





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All temperature gauges and elements shall be provided with Thermo-wells. The Thermowell connection Size for line shall be 1 ½" NB OE 2" NB depending on the piping material specification for the line. Refer Piping design and construction standard (E1150-BD-2000-P-0002) and Piping Material specification (E1150-TS-2000-P-0001) for details.

The housing material of all the instruments shall be suitable for marine installation. As a minimum, housing material shall be Low Copper Die-Cast Aluminium with epoxy painting or SS 316L painted. SS304, cast Alumnium material shall not be used for any housing material. All parts shall be painted appropriately for installation in a highly corrosive, humid salt laden marine environment.

GRP sunshades shall be provided for all outdoor electronic/electric instruments including junction boxes exposed to direct sunlight (i.e. not sheltered). The material of construction shall be GRP.

Instruments shall withstand the maximum design conditions stated on the associated datasheet, as a minimum. Instruments exposed to vacuum shall have under range protection to full vacuum.

Instruments, which require hydro testing, shall be tested with a hydrostatic test pressure of 1.5 times the design pressure as specified in the Piping Material Specification.

Installation and hook-up of all instruments and devices shall be as per project specific documents, drawings and COMPANY standard practices.

Mono-flange assemblies shall be added at the impulse lines when the impulse pipes have welded connection. This will facilitate the removal of transmitter for maintenance.

For hard pipe hookup, the manifolds shall be provided with flange adapter/kidney flange with the nipple welded for process and vent connection. This will facilitate the removal of transmitter for maintenance.

When piping is used as an impulse line, pipe shall be minimum SS316L or higher grade based on service / piping class and instrument material selection specification (Doc. No. E1150-TS-2000-J-0010). The Rating , end connection and material shall be as per relevant pipe class. The compatibility of impulse piping with material specification shall be maintained to avoid dissimilar material contact. Insulating gaskets and bolting sleeves shall be considered as applicable. Supply of nuts, bolts, gaskets and other required bulk material for impulse piping shall be by Package VENDOR.

Field Instruments shall preferably be installed close coupled to minimize piping, tubing and fittings. If easy access cannot be assured using close coupled methodology, then instruments shall be mounted on 2" stand pipes/supports.

The mounting height of Field Instruments shall be 1.2 m to the centre line of the instrument from platform or grade level.

Instruments shall be easily accessible and readable from grade or platform.





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Instrument Stand pipes shall be fabricated from 2" Schedule 10S SS 316/316L. The stands shall be of welded and bolted construction and painted after welding. Stand Base Plates shall be fabricated from SS 316L of at least 5 mm thickness and shall be suitable for either welding or bolting to structural steel. Bolting shall be through Teflon inserts at least 3mm thick to avoid dissimilar metal contact. The Painting shall follow the Specification for Internal and External Coating (Doc. No. E1150-TS-2000-W-0004).

Over range protections for field instruments shall be at least 130% of full scale or the design whichever is the higher.

Wireless device shall be provided for critical local gauges which are difficult to access (physically or for safety reasons) and those that require regular monitoring. These devices shall be able to transfer all the readings electronically. These wireless devices shall be connected to BPCS through existing Wireless Gateway. The Wireless Gateway connects Wireless HART networks and communicates to the BPCS via modbus TCP/IP. Integration of wireless devices to wireless Gateway shall be by EPC CONTRACTOR. Package Vendor shall include all necessary provision in their design for critical local gauges if any identified as part of Package scope and provide complete support to EPC CONTRACTOR for integration of same with existing Wireless gateway.

Instrument materials of construction shall be suitable for the process fluid and conditions and shall be selected based on the applicable Pipe Class detailed under the Project Piping Material Specification document (E1150-TS-2000-P-0001) and Specification for Instrument Material Selection (Doc. No. E1150-TS-2000-J-0010). The Process wetted parts/Trim Material shall be SS316L as a minimum or superior, as required for the application.

All Field Instruments except in-line instruments shall be provided with the capability of being tested and calibrated In-Situ.

All the field instruments including valves and accessories in hydrocarbon services shall conform to the requirements of NACE Standards MR-0175/ISO15156 (latest edition).

7.3 INSTRUMENT SELECTION

Package VENDOR shall select all types of Instruments and valves for control application as per Instrument & Control Design Basis (Doc. No. E1150-BD-2000-J-0001), relevant Project specifications and warrantee/guarantees based on the minimum requirements indicated below.

Package VENDOR shall submit an individual data sheet for each instrument & valve by tag within his supply in a .isf data sheet format provided by EPC CONTRACTOR.

Separate instruments/sensors shall be provided for BPCS and SIS.

Package VENDOR shall submit all the instrument datasheets for EPC CONTRACTOR/COMPANY Review and Approval before PO placement to respective OEM. Any deviation from this specification and relevant project specifications shall be clearly highlighted for EPC CONTRATOR/COMPANY review and Approval.





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7.4 TRANSMITTERS

The primaries of transmitters shall be hermetically sealed and wiring rigidly encapsulated from the secondary of the transmitter within the housing.

SMART transmitters (FF and 4-20 mA, HART) shall meet the following features as a minimum:

- Retrofit type smart model shall not be supplied.
- Sensor shall incorporate a temperature sensor to compensate for temperature effect.
- Transmitters shall be microprocessor based and shall incorporate a non-volatile memory, which shall store complete configuration data of the transmitter.
- All necessary signal conversions and to produce output with required protocol shall also be carried out in transmitter electronics.
- Transmitter shall also run complete diagnostic routine. In the event of detection of failure, the output shall be driven to a predefined value.
- HART protocol shall allow for multi (two) masters a primary and a secondary for configuration, calibration, diagnosis & maintenance. The primary would be a control system or any other host system and the secondary would be a hand held communicator or a maintenance computer. It shall be capable of implementing universal commands.
- Hand-Held terminal for each type (FF and 4 -20 mA, HART) shall be supplied by the Package VENDOR suitable for the area classification and shall be complete with battery, carrying case, lead set with mini-grabbers and alligator clips and any other item necessary to complete the equipment.

Electronic 2-wire Transmitters shall be Loop-Powered from Local panel or Remote Control System, unless otherwise indicated. Transmitters shall be reverse- polarity protected.

Electronic transmitter shall provide EMI / RFI immunity by means of the circuit (and in particular to suppress RF signals from VHF/UHF sources) as per IEC.

The EMI / RFI effect shall be less than 0.1% of span when the instrument is subjected to an electromagnetic field strength of 30 V/m for frequency range 20 to 1000 MHz.

3-wire or 4-wire, 4-20mA dc Electronic transmitters shall be acceptable only for special measurements such as machinery monitors/ detectors, analyzers, storage tank level, magnetic flowmeters, etc. with prior approval, where a 2-wire transmitter may not be commercially available.

Repeat signals for 3 or 4-wire transmitter signals to EPC CONTRACTOR's control system shall be through I/I isolator, loop powered from BPCS, as a 2-wire system.





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All transmitters shall be compliant with NAMUR NE43. Transmitters over range current should be limited to 20.5 mA. Under range current should be 3.8 mA. In essence the transmitter output should be <20.5 mA &> 3.8 mA for any over range / under range process value. DP transmitters shall withstand pressure on one side in case of plugging of impulse lines and calibration should not drift.

7.5 PRESSURE AND DIFFERENTIAL PRESSURE INSTRUMENTS

7.5.1 Pressure & Differential Pressure transmitters

For Electronic Pressure and Differential pressure transmitters, the primary sensing shall be diaphragm with low displacement electronic type sensor- capacitance/inductance or piezoresistance.

7.5.2 Pressure Gauges

Pressure gauges shall be industrial solid front safety pattern type, designed to ASME B40.100 or to BS-EN-837-1.

The sensing element shall be bourdon tube, bellows or diaphragm type.

Primary elements shall withstand the specified overpressure for at least 30 minutes without having their elastic characteristics affected at specified process design temperature.

For pressures above 1000 psig, solid front with blow out back shall be provided. For lower ranges blow out disk/baffle is acceptable.

Movement shall be rotary-geared corrosion resistant SS 316 as a minimum. However, if the internals are not in direct contact with the atmosphere, liquid filled gauges with SS 304 Movements are acceptable when movement is not available in SS 316 variants.

The ranges and over-range protection shall be as specified in ASME B40.100 or to BS-EN-837-1.

The range shall be selected in such a manner that the normal operating zone falls in the middle 2/3rds of scale range for pulsating service and from 50 to 75 % of span for normal service. Scale graduations shall cover 270°.

For pressure gauges, the dial size shall be 150 mm nominal (6"), unless otherwise specified.

Micrometer pointer shall be provided in all Gauges, unless otherwise specified. External zero adjustment shall be possible but shall be rendered tamper proof.

The window glass shall be shatter proof.

All pressure Gauges shall be liquid- filled (glycerine, not oil) casing type, except for oxygen service.







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The accuracy of the gauges shall be to 2A ASME / Class 0.6 (BS-EN)Class 1A ASME / Class 1 EN-837-1.

7.5.3 Differential Pressure gauges

The differential pressure gauge shall be a balanced bellows type.

Accuracy of the gauge shall be to ± 1.5 % Full Scale. Dial size shall be 6".

The differential pressure gauge shall be provided with a suitable pressure equalising/ travel stop mechanism to ensure there is no loss of calibration or derangement on application of full static pressure in either of the legs.

Wherever the differential pressure gauge is used as local Flow Indicator across an orifice plate, the scale shall be square root and in the flow engineering units.

7.5.4 Pressure and Differential Pressure switches

In general transmitters shall be used for all applications. If unavoidable switches may be used with COMPANY/EPC CONTRACTOR approval.

Pressure switches shall be of Diaphragm and Piston assembly type.

Switches shall have set point adjustment mechanism with set point indicating scale.

The pressure differential switch for higher ranges (typically 1.0 bar) may be a balanced bellows type, if range is outside diaphragm use.

The switch housing shall be blind. The set point shall be adjustable internally. Manufacturer shall provide a locking and sealing mechanism for locking and sealing the set point adjuster. An indicating scale shall be provided for set point adjustment (accessible on opening the cover).

The switch shall be SPDT, snap acting dry contact micro-switch, hermetically sealed/encapsulated, in general. The contact rating shall be 2.0A at 24 V dc. All switch contacts shall be gold plated, as a minimum.

Flying leads are not acceptable. The lead wires from the switch shall be connected to an integral terminal block within the certified switch housing. All screw connection shall be vibration proof and captive.

Dead band of switch shall be set as specified on the Instrument Data Sheet.

7.5.5 Accessories for Pressure Instruments

Diaphragm Seal/ Chemical Seal

 Diaphragm seal shall be provided for congealing or plugging services (slurry, dirty, highly viscous fluids), corrosion or chemical resistance.





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- Diaphragm or Chemical seals shall be rated for continuous duty and of welded type construction.
- Filling connection between Diaphragm/ chemical seal shall be with a quick closing ball check and with 1/8" NPTF connection and protected by a plug.
- Flushing connection on the bottom flange of diaphragm seal shall be 1/4" NPTF with plug.
- Seals, flushing connection and plugs are wetted parts and hence shall have the same material.
- The Sealing fuid shall not degenerate, change state or react chemicallt with instrument internals under the specified operating and maximum design conditions. OEM shall highlight the temperature & vacuum conditions on use of diaphragm seals imposed by fill fluid.

Over range protector

The over-range protector shall be a pilot operated device with external adjustment for closing pressure. The closing pressure shall be the maximum of the gauge range and the reseating pressure shall be at 90% of the maximum gauge range. The proof pressure of overrange protector shall be twice the specified design pressure.

Over range protections shall be at least 130% of full scale or the design whichever is the higher.

Seal / Condensate pot

Seal pot shall be provided for congealing or plugging services, corrosion or chemical resistance. Seal and condensate pots shall be fabricated out of 4" Schedule 80 / 160 pipe and weld caps with welds complete with screwed or socket weld connections as specified. A minimum of four connections – process, vent, drain and overflow - shall be provided. Provision for mounting and clamping & support shall be provided.

Pulsation Dampener

Pulsation dampener shall be provided for pulsating service inclusive discharge of reciprocating pumps and compressors.

The detailed requirements for Pressure Instruments are stated in the below Project Specifications. Any deviation shall be clearly highlighted by Package VENDOR.

Specification for Pressure and Differential : E1150-TS-2000-J-0028

Pressure Transmitters

Specification for Pressure Gauges : E1150-TS-2000-J-0026





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7.6 <u>LEVEL INSTRUMENTS</u>

7.6.1 Selection of transmitters

The level transmitter type shall be selected based on appropriate services and they could be different from each other (flashing liquids, liquids with sediments, etc.). Hence the following criteria shall be followed:

Radar Type: Primary level transmitter selection shall be Guided Wave Radar (GWR) type. GWR shall be used for shut down application (i.e. HH or LL trip functions) and control & monitoring applications. All level transmitters used for SIS system shall be GWR type. Other types of transmitters can be used if required with prior approval from the COMPANY.

Non-contact type radar level instruments may be considered for toxic or hazardous service (H2S). Non-contact radar level transmitters shall be mounted on the top of the vessel or on an external chamber. Depending on the dielectric, frequency, antenna, design, etc, the maximum measuring range runs from 3 metres to 45 metres. Accuracy shall be 0.1% of span or better.

- DP Type: D/P types can be considered in clean non-viscous services for open and closed loop control and monitoring applications. DP types shall not be used in dirty or foam services or services with varying fluid densities, and GWR shall be used instead regardless SIS or BPCS.
- Alternatively, Displacer type Level Transmitters may be used for interface measurement and special applications where GWR or DP is not suitable.
- All Level Transmitters shall have an associated Level Gauge.
- Magnetostrictive type is not allowed.

For level switch application, external chamber with float type switch shall be used.

7.6.2 Level Gauges

In general, magnetic type level gauges are to be used wherever practical. If application warrants use of gage glass, then Armoured-type Transparent or Reflex gauges shall be used for services with rating below ASME Class 900 and for design temperatures below 482 °F.

If two or more gauge glasses are used to cover the range required, the visible glass section overlap of at least 25 mm ±5 mm.

Gauge glasses shall be toughened thermal resistant borosilicate glass. Gauge chambers and covers shall be in carbon steel. Gauges shall have corrosion resistant stainless steel hardware (nuts, bolts and washer).





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Gauge Glasses shall preferably be Top-Top and Bottom-Bottom connection type with Offset gauge cocks to facilitate easy cleaning of the gauge chamber and viewing glass internal surface.

Gauge Glasses with Topside and Bottom-Side connection type shall be with Straight type gauge cocks. For such Side and Side connections, the gauge chamber shall have two entries, 180°- phase apart with one set plugged.

The gauge cocks shall have self-closing feature to safeguard against possible breakage of glass and escape of process fluids. All level gauges shall have integral isolation protection and a check valve device to protect from glass breakage etc.

A graduated scale in SS material shall be provided with 0 to 100% marking. Scale shall be welded to the gauge. Clamped type is not acceptable.

All gauge cocks shall be provided with spherical union connection to facilitate minor field alignment at the time of mounting.

The valves shall be Outside Screw & Yoke (OS & Y) bolted bonnet construction.

The following accessories may be used with the Level Gauges.

- Illuminator: Power supply for Illuminators shall be 220 240 V, 50 Hz, 1ph, unless otherwise specified.
- Heat Shield: For steam condensate service (ASME B31.3 process piping) and where
 materials are corrosive to Glass, Level Gauge with suitable heat shield made of mica
 or Kel-F shall be provided internally for shielding borosilicate glass.
- Non Frost Extension: For Level Gauges in low temperature or cryogenic service, nonfrost extension shall be provided to ensure clear visibility under lowest possible ambient temperature and highest possible humidity.

7.6.3 Level Instrument – Displacer or Float

All level instruments to this specification shall be of glandless (pack-less) type.

Minimum Body rating shall be ASME 300 class.

Internal trim shall be of 316L SS, unless otherwise specified.

Displacer type Level Transmitter

The Displacer type Level Transmitter shall be force balanced torque tube type. Suspended conventional spring buoyant/ balanced instrument is not acceptable for process services.

Range of Displacer Level Transmitter shall not exceed 72" or 1829 mm.

Accessories for Displacer Level Transmitter:





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- Cooling air fins, for non-condensable vapour services with service temperature above 392 °F and all condensable vapour services above 248 °F, shall be provided.
- Plain frost extensions below 32 °F shall be provided.
- Test connection box for in-situ calibration and maintenance.

Radar type Level Transmitter

Guided Wave Radar (GWR) shall be the first choice and it shall be of external chamber mounted type.

Cone type Radar Level Transmitter may be used for applications requiring non-contact type level measurement (or) application where Guided wave type and DP type is not suitable. Cone type shall be installed on top of the vessel and shall be installed with slotted still well.

Level switches -Float type

- Separate switches shall be used for alarm and shutdown.
- Preferred type is External float Chamber construction.
- Switch shall be hermetically sealed Snap acting micro- switch, SPDT type, unless otherwise specified.
- Switch contact shall be heavy-duty type for continuous duty and rating shall be 2A at 24 V dc. minimum.
- Switch shall have fixed minimum differential with automatic reset.

The detailed requirements for Level Instruments are stated in the below Project Specifications. Any deviation shall be clearly highlighted by Package VENDOR.

Specification for Level Transmitters (Radar / : E1150-TS-2000-J-0027

Displacer)

Specification for Pressure and Differential

Pressure Transmitters : E1150-TS-2000-J-0028

Specification for Level Gauges : E1150-TS-2000-J-0025

7.7 FLOW INSTRUMENTS

7.7.1 Selection

Square edge Orifice with flange taps from 2" to 12" or Square edge Orifice with D & D/2 taps from 12" and above is the preferred choice. Use of other orifices such as segmental or quadrant shall be a special application. For line size 1" and below, Integral Orifice meter with block and bypass valve shall be used. Orifice plate with single transmitter shall be used for the maximum rangeability of 4:1. For rangeability greater than 4:1 either orifice plate with multiple transmitters or other type of flow meter shall be used.

Annubar or Special Pitot with averaging velocity measurement with differential pressure transmitters for single-phase air or steam may be used.





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Venturi or Vortex flow meters may be used when orifice measurement is not feasible due to permanent pressure loss requirements.

Ultrasonic flow meters (time of flight) for very low permanent loss measurements may be considered.

Coriolis flow meters may be used instead of orifice plate with DP transmitter for 2" and smaller piping. Coriolis mass flow, Turbine meters and P.D. meters shall be used for fiscal-transfer or material balance measurements.

For water, seawater, effluents etc. with trace suspensions, Electromagnetic flow meter (Mag flow meter) may be used.

For Local direct reading non-critical low liquid flows (such as measurement of cooling or sealing fluids, sample for in-line process stream analysers) for sizes up to 2" (inclusive) and wide turndowns, Metal tube, armoured, Rotameter may be used.

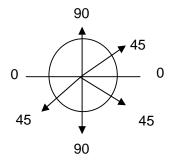
For Purge flow measurements, Purge glass tube Rotameter with flow control (needle) valve and regulator shall be used.

Locally mounted flow switches (paddle type) shall be used for non-critical utility systems for ensuring flow-no flow situations only.

7.7.2 Measurement Orifice

Sizing and selection shall be based on ISO 5167 standard. Correction for vent and drain holes shall be applied as per Miller's Flow measurement handbook or BS 1042 – 1981.

Preferred run and Tap detail for orifice, listed for each fluid in order of preference:



Liquids: Horizontal runs - all downward:

- 1) 45°
- 2) 0-45°

Dry and non-condensable Gases: Horizontal runs-all upward:

- 1) 45°
- 2) 90°







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3) 45-90°

Vapours: Horizontal runs - all upward

- 1) 45°
- 2) 80°
- 3) 45-80°

Steam: Horizontal runs - all upward

- 1) 45°
- 2) 0-45°

Downward vertical runs for gas/vapour service and upward vertical runs for liquids for metering may also be provided.

Close coupled differential pressure transmitters shall be avoided, wherever possible. Location of remote coupled Differential pressure measurement for orifice measurements shall be as follows:

- Dry and non-condensable gas: Above taps
- Condensable gases and Liquids: Below taps
- Steam: Below taps

Minimum straight length requirements shall be as per API RP 551/ISO 5167.

The detailed requirements for Flow Instruments are stated in the below Project Specifications Any deviation shall be clearly highlighted by Package VENDOR.

Specification for Differential Pressure Flow : E1150-TS-2000-J-0004

Elements

Specification for Vortex Shedding Flow Meters : E1150-TS-2000-J-0021

Specification for Variable Area Flow Meters : E1150-TS-2000-J-0022

Specification for Electromagnetic Flow Meters : E1150-TS-2000-J-0023

Specification for Multiphase Flowmeters : E1150-TS-2000-J-0014

7.8 <u>TEMPERATURE INSTRUMENTS</u>

7.8.1 Selection

For local indication from 32 °F up to 752 °F, Bimetal thermometer (gauge) shall be used.

Temperature sensing element for temperatures below 1202 °F shall be Class A (IEC 60751), PT-100 (100 Ohm at 32 °F) Resistance Temperature Detector (RTD). RTD element shall be of 3 wire, Duplex configuration. 4 Wire RTD for machine monitoring (MMS) applications, when required by package VENDOR shall be used.





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For temperature above 1202 °F, Duplex, Type 'K' and for temperature above 1832 °F Type R, thermocouple (Ungrounded type) shall be used. Thermocouple shall conform to IEC 60584.

All temperature measurements for control, alarm and trip shall be with duplex type Thermocouples or RTDs, unless otherwise specified.

All elements shall be installed in thermowells. Direct insertion of sheathed elements into fluid is not acceptable.

Locally mounted temperature switch is not acceptable. All switch actions shall be derived from transmitters.

7.8.2 Local Gauges

Local gauges shall comply with ASME B40.200.

Bi-metal thermometer shall be every-angle type only and with SS 316L stem, as a minimum.

Gauge dial shall be 150 mm nominal.

Mercury filled system thermometers shall not be used.

The gauges shall have tamper proof external zero adjustment.

Scale shall be white laminated phenol with black graduations for all gauges. The temperature scale shall be in °C unless otherwise specified.

The window material shall be shatterproof laminated glass.

All gauges shall have tamperproof external zero adjustment.

Over range protections shall be at least 125% of Full Scale.

The range shall be selected in such a manner that the normal operating zone falls between 50 to 75% of span. Scale graduations shall cover 270°.

7.8.3 Transmitters

Field mounted temperature transmitters shall be used for all temperature elements. Direct run of elements to control panel/ room is not acceptable.

The transmitters shall be Head mounted type with spring loaded nipple-union-nipple arrangement. Transmitters shall be provided with remote local indicators, as required.

"Burn-out" Protection shall be provided with upscale or downscale output drive and shall respond to both circuit and sensor fault.





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7.8.4 Thermocouple

Thermocouple (T/C) designations shall be as per IEC 60584-1: Thermocouple, Part1-Reference tables.

Accuracy shall be to tolerance Class 1 as per IEC-60584-2.

Reference junction compensation for Thermo-couples shall be automatic.

The transmitter output shall be linear with measured temperature.

Thermocouples shall be ungrounded type. For machine, monitoring applications, it may be grounded type. A transformer coupled certified output isolator should be provided in safe area prior to connection to plant control system for grounded system.

Thermocouple burnout shall be upscale, unless otherwise specified.

Mineral insulated (compacted MgO with purity at least 96%) thermocouples with SS sheath (preferably SS 316L) shall be used.

Thermocouple extension cables shall be as per Project Specification for Instrument Cable Document No. E1150-TS-2000-J-0016.

7.8.5 Resistance Temperature Detectors (RTD)

Calibration shall be to IEC 60751: Industrial platinum resistance thermometer sensors.

RTD accuracy class shall be Class A only with Pt-100 element.

3-wire RTD for process measurement and 4-wire RTD for machinery monitoring (RMMS) applications, when required by Package VENDOR, shall be provided.

7.8.6 Thermowells

Thermowells shall be of machined bar stock from 316L SS material, as a minimum.

Minimum Body rating of thermowell shall be ASME 300 class.

Unless otherwise specified, all thermowells shall be flanged.

Thermowell wake frequency and mechanical stress calculation as per latest ASME PTC 19.3 shall be provided for COMPANY/EPC CONTRACTOR review and approval.

The detailed requirements for Temperature Instruments are stated in the below Project Specifications. Any deviation shall be clearly highlighted by Package VENDOR.

Specification for Temperature Instruments with : E1150-TS-2000-J-0029 Thermowell





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7.9 VALVES (FOR CONTROL APPLICATIONS)

7.9.1 Selection

For clean liquids, gases or steam, Globe body single ported valve is the preferred choice.

The use of double port valves would require specific approval from COMPANY.

For highly viscous and suspended solids in liquid service, Globe body valve with Non-cage trim may be used.

For flashing and /or cavitations application, Globe or Cage valve with anti-cavitation trim shall be used.

Balanced cage-guided globe valves shall be used in severe services for gas and clean liquid service (free of solid particles) and higher pressure drops.

High performance butterfly valves and Eccentric disc valves for low pressure drop applications requiring moderate modulating characteristics may be used. High performance butterfly valves may be offered when high temperature with shut off leakage class-IV or better is required. High performance butterfly valves shall be double or triple offset type. Wafer or lug style is not acceptable. They shall be double-flanged type, as a minimum.

Standard Butterfly valves shall not be used for services requiring Class-IV or better shutoff. The travel of Standard butterfly valves shall be restricted to 60° without loss in flow capacity. High performance butterfly valves, however, can have travel rate up to 90°

For choke valves, erosive, steam service with excessive noise & /or cavitations and High pressure drop applications, Angle body valves may be used. Angle valve used in high pressure drop application shall be provided with multistage pressure reduction trim as a standard.

Self-actuated Pressure and Temperature regulators with internal sensing or external sensing shall be Globe valves for low accuracy regulation for utility services below 2".

The minimum body size for valves in lines of 1" and larger shall be 1".

Valve sizes shall in no case be less than half the line size.

Minimum body & flange rating shall be ASME 300 Class for carbon steel control valves with sizes up to 8". For higher sizes or for other body materials, it shall follow Piping Material Class Requirements.

SS 316L is the standard minimum trim material to be used. Special Stainless steel or alloy steel or other material bodied valves for control applications shall follow the appropriate Piping material specifications (Doc. No. E1150-TS-2000-P-0001) & Specification for Instrument material Selection (Doc No. E1150-TS-2000-J-0010) (valve material) for body and trim.





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All Valves in hydrocarbon service shall meet NACE MR 0175/ISO 15156.

Unless otherwise specified all valves shall have ANSI valve seat leakage class-IV as a minimum.

Sandwich type flangeless valve body suitable for use between pipe flanges with long bolts shall not be used.

Split body valves shall not be used.

The direction of flow shall be clearly marked on valve body.

Ball valves shall not be used for process control applications unless globe valves would not be suitable (e.g. throttling valves on very low ΔP applications or on fast acting on-off service). Camflex type valves (or equivalent design) are a good choice for zero leakage instead of butterfly types especially for relieving pressure to flare header applications. This has got a special design to get tight shutoff compared to other types of valves.

All Isolation valves shall be Bi-directional and Tight Shut-Off / Zero leakage as indicated in respective valve datasheet.

7.9.2 Sizing, standards, and regulations

The sizing for valves for control applications shall be traceable to ISA S75.01.01: Flow equations for sizing control valves or IEC 60534-2-1.

Face to face details shall be to ISA S75.08 or API 609 based on type of valve.

Aerodynamic noise prediction shall be traceable to ISA S75.17.

Hydro-test of control valves shall be traceable to ISA S75.19.01.

Leakage class shall be as per ANSI/FCI 70.2.

For all valves in hydrocarbon services, low leakage loaded packing systems designed to reduce fugitive emissions shall be provided.

All Valves in hydrocarbon service (Sour service) shall be certified for Fugitive Emission Certification as per ISO 15848 Part 1 & Part 2. External leakage of valve stem seals (or shaft) and body joints of Valves in the HC service (sour service) shall be covered. The applicable tightness class for the stem shall be as per Table-1 of ISO 15848 Part-2 based on packing and sealing materials.

The acceptance criteria shall be as follows:

Production testing shall be done for valves sizes 16" above for all pressure rating -1 valve for every lot of 15 valves – minimum 1 per size.







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- For sizes less than 16" and pressure rating up to 600#, prototype test certificates
 qualifying the size range is acceptable if the qualification had been carried out on
 valves of similar design with packing and sealing materials same as per valve
 datasheet.
- For sizes less than 16" and pressure rating above 600#, production testing 1 valve for every lot of 15 valves minimum 1 per size.

All valves shall be furnished with Fugitive Emission compliance certification as per above requirement.

Predicted sound pressure level should not exceed 85 dBA for all valves.

Split range control may be specified to achieve turndown or to meet a particular control requirement.

7.9.3 Control valves

For temperature above 400 °F, the bonnet shall be radiation finned and for temperature below 32 °F it shall be extended type.Bellow seal bonnet shall be specified ply when no stem leakage can be tolerated for corrosive service and for ASME class 300 or lower.

Double packing for valves in vacuum service shall be provided. Main control valve parts and assembly shall be designed for life expectancy of thirty years.

The detailed requirements for Control Valves are stated in the Project Specifications for Control Valves (Doc. No. E1150-TS-2000-J-0006). Any deviation shall be clearly highlighted by Package VENDOR.

7.9.4 Shutdown and ESD valves

Fire Safe Quarter Turn Trunnion mounted Full-Bore valves with dual seat seal shall be provided for Shutdown valves. Fire Safe Quarter Turn Trunnion mounted Full-Bore or Reduced Bore valves with double block and bleed shall be provided for process isolation valves.

Valves for Emergency Shutdown service shall be checked for fail-safe operation under following conditions:

- Failure or Loss of air supply.
- Failure or Loss of Electrical supply.
- Failure of input signal.
- Mechanical failure in valve actuator.

Valves for ESD and shutdown service shall be certified for required speed of operation to safeguard process and equipment.

Unless otherwise specified, all ESD and shutdown valves shall have TSO and it shall mean class VI leakage class shutoff.





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Shutdown valves shall also comply with MSS-SP-72.

All the Shutdown and Blowdown Valves shall be provided with Partial Stroke Testing devices to meet the target Safety Integrity Level as per Safety Integrity Level Study recommendation.

All ESD shutdown valves shall be provided with isolation valves for ESD integrity testing.

The detailed requirements for Actuated on-off Valves are stated in the Project Specifications for Actuated On-Off Valves (Doc. No. E1150-TS-2000-J-0002). Any deviation shall be clearly highlighted by Package VENDOR.

7.9.5 Actuators

The actuator design shall be such that it shall be possible to operate the valve under the maximum condition of ΔP shutoff in specified maximum stroking time at minimum air supply pressure.

The actuator shall be spring and diaphragm type, unless otherwise specified.

The stroking range of the spring and diaphragm actuator shall be 0.2 to 1.0 barg, unless otherwise specified.

The spring and diaphragm actuator action shall be field reversible if required.

Piston actuators shall be normally specified for on-off valves and large size valves.

Piston actuators shall be provided with mechanical adjustable travel stops to ensure protection against seat / plug damage.

Piston actuators shall be provided with lockable travel speed adjustment.

Piston actuator when specified without return spring shall be provided with a volume tank and necessary fail safe hardware to achieve fail safe position of the valve. The volume tank shall be designed to ensure minimum three open-Close cycles and shall be equipped with necessary safety devices. The volume tank design shall be as per ASME section-VIII and stamped/ certified to "ASME-U". Volume tank shall be Carbon Steel and painted as minimum and provided with pressure gauge. It should be installed as close as possible to the valve.

Relief valves on Volume Tank shall be listed in the Safety valve register and complete specification shall be provided.

Material of construction of actuator shall be electro-chemically compatible with valve body.

A rubber boot or gaiter shall be provided for stem protection against fine sand and dust.All outdoor electronics shall be protected by GRP Sunshade.





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7.9.6 Accessories

7.9.6.1 Positioners

Valve positioners shall be specified for all the applications excluding on\ off service.

All positioners shall be provided with three pressure indicators one at supply pressure, one at input pressure and one at output.

Positioners shall be provided with integral bypass switch when actuator signal and input signal match.

7.9.6.2 Positioners shall be smart-type with SS 316L painted housing. Positioners connected to BPCS shall be Smart FF type and positioners connected to other systems (e.g. package control system, SIS, UCP etc) shall be Smart, 4-20 mA, HART type. Solenoid valves

All Solenoid valves shall be designed for use in direct (not pilot operated) continuous duty. The solenoid valves shall be in packless construction. The solenoid valve shall be 3/2 way universal, unless otherwise specified.

DC operated solenoid shall have polarity well marked on the terminals and there shall be a freewheeling diode across it, suitably encapsulated.

Auto reset shall be provided for all solenoid valves, unless otherwise specified.

Solenoid valves shall have integral terminal box (flying leads shall not be acceptable).

The vent port of the solenoid valve shall be fitted with bug screen.

For the solenoid valves used in shutdown service to process shutdown valves, solenoid valve flow coefficient shall be chosen to ensure the required stroking/ closing time.

Insulation class shall be Class 180 (formerly Class H), with temperature rise to class F.

SOV power consumption shall be < 4 W.

7.9.6.3 Hand Wheel

Hand wheel shall not be provided as a replacement for block and bypass valve manifold. Hand wheels shall only be supplied if shown on P&ID and stated on the Valve Data Sheet.

The torque required to operate the hand wheel at hand wheel rim shall not exceed 350 Nm at specified maximum ΔP shutoff.

The hand wheel shall be provided with an easy declutching mechanism and instruction plate mounted on hand wheel itself.

Open and close directions shall be clearly marked on the hand wheel.





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7.9.6.4 Volume Boosters

Volume boosters shall be provided to reduce the stroking time of the valve in some control loops. However, Pressure boosters shall not be used to adjust pressure to get the same effect.

7.9.6.5 Lock-up Relays

Air lock-up relay shall be provided at the inlet of the actuator to ensure the air lock to keep the valve in stay-put position on air failure. In case solenoid valve is also used for controlling shutdown action of the valve, the SOV shall be provided between air lock relay and input to actuator.

7.9.6.6 Limit Switches

Two limit switches shall be provided for all Shutdown and Blowdown valves, Limit switches shall be hermetically sealed, proximity type sensors.

Limit switches connected to BPCS shall be FF type. All others shall provide 2A, 24 V DC SPDT Contacts.

7.9.6.7 Air Filter Regulators

Separate Air filter regulators (with integral pressure gauge) shall be used at the air supply inlet of the positioner.

The air filter regulator shall be capable of supplying the required flow rate to the actuator without any droop.

Air filter regulators shall maintain the pressure without any pressure fluctuations. Air filter regulators shall be SS 316L.

Plastic indicators at filter body shall be avoided.

7.10 PRESSURE RELIEF DEVICES

7.10.1 Selection

Package VENDOR shall determine type of relieving devices. However, the following may be used as a brief guideline basis for common package application requirements.

- For Gas or Vapour service as a single valve protection with fixed back pressure below 10% of set pressure, Full Nozzle, Full Lift, spring-loaded Conventional Safety valve with accumulation of 10% shall be used.
- For Gas or Vapour service, as part of multiple valve protection with fixed back pressure below 10% of set pressure, Full Nozzle, Full Lift, spring-loaded Conventional Safety valve with accumulation of 16 % shall be used.





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- Steam service on boiler code applications shall be "ASME" stamped/ certified Conventional Safety valve and open bonnet but with accumulation as per code details. Steam service with accumulation as 10% for non-ASME applications may be used.
- For Fire exposure relief on Un-fired pressure vessels, Full Nozzle, Full Lift, spring-loaded Conventional Safety valve with accumulation of 21 % shall be used.
- Liquid relief valve shall be reduced bore, modified lift, Spring loaded Relief valve with accumulation of 25 %.
- Gas or Vapour service; for varying backpressure or corrosive service and back pressure above 10 % of set pressure but below critical or 55% of Relieving pressure, Full Nozzle, full Lift, Spring loaded, Bellows sealed (pressure balanced with vented bonnet) Safety valve shall be used.
- Liquid service; for varying back pressure (typically at more than 10% of set pressure) or corrosive service, Reduced bore, Modified lift, Spring loaded, Bellows seal bonnet Relief valve shall be used.
- Liquid relief for Liquid in blocked condition shall use Thermal relief valves with minimum orifice of 0.71 cm2. The standard size shall be 1D2 flanged, as a minimum.
- Gas or vapour service with suspended particles and /or corrosive applications, Full Nozzle, Full Lift, Spring loaded Conventional Safety valve with rupture disk with combination capacity factor of 0.9 shall be used.
- Low-pressure H.C. storage tanks with non-freezing or non-fouling control medium and for Pressure relief with very small margins between set pressure and operating pressure, Pilot operated Relief valves may be used.

7.10.2 Sizing and Standards

Safety-Relief valves: API 520, API 521, API 526, API 527 and ASME 31.1.

Rupture Disks: API 520, API 521, API 526 and API 527.

7.10.3 Construction

Flanged Safety-Relief valves shall have enclosed spring (except for air and Steam) with bolted bonnet, screwed cap, and shall be with stainless steel nozzle, disc, guide & spindle with forged carbon steel bodies, as a minimum.

Body pressure ratings for all flanged valves shall be the same rating as valve inlet flange.

Carbon steel (coated for corrosion prevention) spring for valves in service temperature of 450 °F & below and Tungsten steel springs for valves in service temperature above 450 °F shall be provided, as a minimum. Inconel springs for H2S service.





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Open lifting levers shall be supplied on all valves used in piping and unfired pressure vessel valves for steam and air service. No lifting levers are required for process valves, unless otherwise specified.

Metal-metal seats with "commercial" seat tightness shall be normally specified. Bubble tightness permitting no leakage may be specified under special (below 450 °F and 105 kg/cm2 pressure typically to avoid O-ring failure) conditions to avoid unacceptable fugitive emissions.

7.10.4 Installation

Multiple valves shall not be installed on a common tee-type header nozzle without specific COMPANY approval. Valves shall be directly mounted on Vessel or Pipeline to avoid support problems, line losses and "chatter" problems and discharge reactions.

The detailed requirements for Safety Relief Valves are stated in the Project Specifications for Safety Relief Valves (Doc. No. E1150-TS-2000-J-0003). Any deviation shall be clearly highlighted by Package VENDOR.

7.11 MISCELLANEOUS FIELD INSTRUMENTS

Mechanical vibration switch may be provided for air fin-fan coolers for alarms.

Pneumatic actuators shall operate dampers, Louvers or fan blade pitch control with electropneumatic positioners.

7.12 CONTROL PANELS & ASSOCIATED INSTRUMENTATION

7.12.1 Design basis

Indoor panels shall be RITTAL or Approved equal make. Panels shall be 2 or 4-doors (door width -400 mm max.) based on size with front and / or back access.

Standard size of each panel shall be 800 mm wide, 800 mm depth and 2000 mm in height with a plinth beam of 100 mm. However, shipping splits shall be finalized by EPC CONTRACTOR. In between panel-section partition plates are required for each 800 mm panel section, even for contiguous mounting.

Control panels shall be delivered complete with the following, as applicable:

- Anti-vibration pad.
- Key lock.
- Internal door pocket for drawings.
- Filters, Louvers and fans (with wired failure contact).
- Lamp test facilities.
- Internal lighting with door switch.
- Removable lifting lugs.
- Three layer strip labelling with laminated Traffolyte engraving. (White/Black/White).





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Test / Maintenance utility socket.

Outdoor panels may be custom engineered to meet other requirements for weatherproofing and with rain/sunshade hood section (with a gutter) and outer lighting.

Panels such as Marshalling, System, Network, PC/Server, Power Supply Distribution, UCP and Interface panels shall be designed and constructed in accordance with Specification for System Cabinets (Doc. No. E1150-TS-2000-J-0040).

Certified Panels required in hazardous area may be designed to have two vertical sections:

- A metallically segregated lower part, rated to "Ex e" class where only incoming and outgoing signal terminations shall be located and
- An upper metal enclosure, rated to "Ex d" class where the control and power components may be located.
- The interface shall be through certified glands with secondary seal.

7.12.2 Panel instruments and systems

Systems and Panel receiver instruments make and type shall be from the approved manufacturer and model series specified in Project specifications.

7.12.3 Alarm Annunciators

Alarm Annunciators shall be generally as per ISA S18.1: Annunciator Sequences and Specifications.

Alarm Annunciators shall have First-out alarms with Manual reset (ISA sequence F3M1) for trip alarms, unless otherwise specific sequence to be followed is issued with project specifications. Standard alarms shall be with automatic reset (ISA sequence A1), unless otherwise specified.

VENDOR shall submit detailed fabrication specification complete with BOM for panel within his supply for approval prior to fabrication.

VENDOR shall meet the architectural requirements of COMPANY/EPC CONTRACTOR to provide visually aesthetic and matching panel exteriors to existing panels or to those supplied by others.

7.12.4 Wiring & Termination

All internal panel wiring and trunking shall be flame retardant.

Separate trunking for IS, Non-IS and Power and for different signal levels shall be provided.





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Signals shall be wired to single deck terminal strips suitable for minimum stranded conductor size of 2.5 mm2.

For cabinet internal wiring (cross wiring) the conductor cross sectional area shall be 1.0 mm2 and for FF signals wire size can be 0.75 mm2. All wiring shall be one continuous length from terminal to terminal.

Unless otherwise specified, Wiring insulation colours shall be as follows:

Power

- Single phase AC: Phase Brown / Neutral Blue.
- DC Power: Positive Red / Negative Black.

Signal

- FF Signal (+ve): Blue.
- FF Signal (-ve): Orange.
- Analog (+ve) (IS & NON-IS): Light Blue.
- Analog (-ve) (IS & NON-IS): Light Blue.

Earthing

- Safety: Green with Yellow stripes outer sheath.
- Instrument: Green coloured outer sheath.
- Intrinsically Safe: Green coloured outer sheath with blue strips.

Cores shall be identified with heat shrinkable cross-ferrules at each termination. Cables shall have PVC cable markers.

Terminations shall be segregated according to signal levels and also as per IS & Non-IS requirements.

The Cabinet wiring and termination shall be as per Specification for Cabinets (Doc. No. E1150-TS-2000-J-0040).

7.13 ANALYTICAL INSTRUMENTS

7.13.1 Design basis

Analytical Instruments complete with sampling and on-line calibration systems shall be engineered and supplied.

The design and installation of on-line analyser systems shall comply with the Engineering as per API RP 555: Process Analysers.

As a minimum, the analyser system to be supplied shall include the following and designed for unattended continuous operation:

Sample take-off, which may be a fixed probe or retractable probe or a process tap.







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- Sample transport and disposal system consisting of a sample conditioning system and a closed fast loop with all / some of the following items according to type of analyser.
 - Differential pressure for velocity measurement.
 - Sample-pump/aspirators and aspirator.
 - Filters.
 - Variable Area meters, metal tube type.
 - Relief valves.
 - Multi-stream switching valves.
 - Excess flow valves.
 - Coolers.
 - Heaters.
 - Pressure, temperature and density measurements for correlations /corrections /compensations.
 - Tubing and compression fittings.
- A calibration by-pass system.
- A utility conditioning system.
- An analyser house or analyser Electronics enclosure shall include, as applicable, signal converter/ amplifier system, signal linearization electronics, power distribution, signal output & conditioning electronics, testing & calibration electronics and diagnostics.

The electronics shall preferably be a solid-state microprocessor based device to control the operation of the sensor, compute the analysis in engineering units, provide output signals and monitor the complete system for correct operation. Automatic zero and calibration shall be possible.

On-line type analysers shall be FF or (if FF is not available) 24 V dc, 4 to 20 mA with added HART protocol. Complex analysers (provided with sample conditioning system, analyser unit etc) shall provide serial link as well as hardwired signals (4 – 20 mA, HART) to Package Control System/BPCS.

On-line Analyser for use as part shut down system shall have traceability to primary standards, a laboratory means to verify calibration and have fallback mode to manual input based on lab results. Inputs shall be hard wired.

Vents or drain emissions shall specifically consider all local environmental legislation and shall be kept to the practicable minimum.

All other lines after the fast loop sample system shall be installed using UNS N08904 to ASTM B 677 (904 L SS) stainless steel tube with 6Mo double ferrule compression fittings. All materials used as part of the sample system shall be 316L stainless steel, as a minimum.

An alarm indication of analyser failure (or out of service) should be provided direct wired to the main control system or area. An alarm indication of low analyser sample flow should be provided direct wired to the main control system or area.





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The detailed requirements for Analyzers are stated in the associated Project Specifications. Any deviation shall be clearly highlighted by Package VENDOR.

Specification for Moisture Analyzers : E1150-TS-2000-J-0042

Specification for Basic Sediment & Water

Specification for Dissolved Oxygen Analyzers

: E1150-TS-2000-J-0044

(BS&W) Analyzers

Specification for Turbidity Analyzers

E1150-TS-2000-J-0045 E1150-TS-2000-J-0046

7.14 PACKAGE CONTROL SYSTEM

The requirement of the package control system shall be as indicated in the respective package unit specification. Where required, it shall be stand alone and dedicated to perform the control of the package unit. It shall be designed meeting the below:

- The package control systems shall be either PLC based or Microprocessor based as stated in the package unit specification. Generally, the PLC based systems shall be located inside the Local Control Room/Module Technical Room. However, if specified in the equipment package specification, it may be located in the field provided it is suitable for the environmental conditions and protection method as specified in section 6.2 of this document. The Microprocessor based systems may be located in the field near the package unit.
- Each package control system shall have redundant processor, power supply (power module), redundant communication cards and redundant I/O cards.

Each package unit shall have redundancy for power supply. 2 x 100% PSU shall be provided & each PSU shall not be loaded more than 60%. Each PSU shall be supplied from independent AC 230 V UPS DB.

Any deviations shall be approved by COMPANY before finalization of the order.

All package system PLCs and controllers shall have data base memory retention facility with a battery backup for at least 72 hrs.

The availability of the package control system shall be greater than 99.9%, considering 16 hours as the Mean Time To Repair.

The Package control systems shall be interfaced with the BPCS using redundant Modbus over RS 485 or TCP/IP protocol or OPC.

The Package control systems shall include HART Multiplexer Master with RS-485 port for interfacing HART instruments with the PRM supplied by MAC.

One no. of laptop for each island, loaded with engineering Software (Engineering and configuration) for Packages PLC shall be provided.





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All Package Control System shall be provided with HMI (touch screen facilities). HMI philosophy shall be as per described in the Specification for Human Machine Interface (HMI) (Doc. No. E1150-TS-2000-J-0047).

Package Unit HMI system displays shall be designed using the same design philosophies as the ICSS, so that they "look and feel" like the ICSS displays. All necessary package unit data shall be transmitted to the ICSS for display on the BPCS HMI and on OTS simulator for Operator training. The HMI graphics shall be developed as per Specification for Human Machine Interface (HMI) (Doc. No.E1150-TS-2000-J-0047). Mirroring of package unit HMI to MAC HMI shall be established and implemented.

The graphics shall include system alarm page indicating status of the healthiness of the system components.

All package Control Systems shall be provided with output overrides for all outputs to external equipment and systems for isolation and major OI of packages.

The package vendor shall configure the start permissive flow chart graphics to verify individual permissive for ready to start.

The first up alarm to identify the first trip initiator out of a set of input causes shall be configured in the package control system.

Shutdown signals requiring target SIL shall be implemented in a SIL certified PLC by VENDOR.

Any Inter-Trips between the package VENDOR SIS and the main Island SIS (as defined on the Cause and Effect Diagrams) shall be transmitted on Hardwired links.

7.15 ROTATING MACHINE MONITORING SYSTEM (RMMS)

Rotating Machinery Monitoring System (RMMS) shall be provided to monitor and protect the critical rotating equipment in compliance to API 670. Refer to "Specification Machine Monitoring System (Doc. No. E1150-TS-2000-J-0038)" for the requirements.

7.16 FIRE AND GAS SYSTEMS (INCLUDING F&G DETECTORS)

The Package Unit VENDOR shall supply and install Fire and Gas Detection Systems as defined in Fire and Gas Philosophies and Specifications.

The Package Unit VENDOR shall submit data sheets for each type of detector and signaling device within his supply complete with location diagrams and all other relevant drawings and documentation to the EPC CONTRACTOR/COMPANY for review and approval.

The EPC CONTRACTOR and the Package Unit VENDOR shall perform SIL assessment as per IEC 61508 & 61511 and based on the SIL assigned shall design the F & G Detection system accordingly and verify that all assigned SIL and Risk Reduction targets are





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achieved. Refer to "Specification for the Fire & Gas Detectors and Devices (Doc. No. E1150-TS-2000-J-0015)" for the requirements.

7.17 CONSTRUCTION DESIGN

7.17.1 Accessibility

Field instruments shall be accessible and ergonomically located within 1.2m height and 500 mm arm sweep from a fixed platform, grating or specially constructed step.

In general, Instruments may be mounted on pipe stands, building walls, steel columns, masonry structures of non-load bearing (of main structure) and offset from the surface to avoid collection of debris & water. They shall be located so that they will not interfere with aisle, space on platforms, or catwalks or tube bundle removal areas, overhead crane passage path etc.

Local readouts shall be at eye-level.

Impulse or lead lines shall be designed to isolate the transmitter from piping vibration.

Instrument removal and reconnection shall be possible without disconnecting other fixtures and connections etc.

Field drive selections (start, stop, Hand-Off-Auto etc.) shall be located close to equipment for functional operation check and at 1.0m height from fixed platform, grating or specially constructed access step.

Facilities for in-situ calibration or frequent withdrawals of probe or frequent "rodding" requirements shall be accessible from fixed platform or grating

Heavy instrument items such as Control valves and Relief valves shall access space to use hoists, cranes etc. for lifting and moving to workshops for maintenance or testing.

Local panels shall have instruments mounted at eye-level but in any case not less than 750 mm from base. Local panels shall be located away from process heat (steam outlets, steam traps etc.) and water sprays.

All instruments except in-line instruments shall be provided with in-situ calibration and relevant vents & drains connected to a closed vent/drain system.

Refer to "Design Specifications for Instruments & Controls – Installation" (Doc. No. E1150-TS-2000-J-0012) for detailed requirements.

7.17.2 Cabling and wiring

Cables shall be located at least 300 mm away from hot spots and hot surfaces.

Instrument wiring and cabling passing through interstices of platforms or gratings shall be protected on either side for a distance of up to 75 mm.





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Instrument wiring and cabling separation distances from Electrical cabling and wiring of different voltage levels shall generally follow guidelines in "Design Specifications for Instruments & Controls – Installation" (Doc. No. E1150-TS-2000-J-0012).

The following describes the cross-ferruling philosophy to be used for instrument cable cores:

- At instrument side: Instrument Terminal details + Field JB and its terminal number if no markings exist at Instrument terminals, the cores are identified by "+" and "-", except in the case of switches when "C" and "NO" or "NC" shall be used.
- At JB side for instrument cable: JB TB (Terminal block) number + Instrument Tag number
- At JB side for main cable: JB TB number + Marshalling cabinet tag and its TB number.
- At Marshalling cabinet side: TB number of marshalling cabinet + Field JB number and its Terminal number
- All cables shall be tagged at both ends and on both sides of the terminal block. Tagging
 of cables shall indicate the instrument tag to which it is related. When cables / wires
 are used for interconnection, wire ferruling at each end shall have source / destination
 reference and terminal no, where it is to be terminated.

7.17.3 Tubing

Impulse Tubing shall be supported by tube support, protected & guided by Unistruts or channel and attached by stainless steel straps, when required along the complete length of its run. Tubing runs shall be of minimum bends and sloped according to installation and vent & drain requirements. Tube to tube contact shall be avoided and when necessary separated by insulating cement.

Pneumatic Tubing shall be supported by tube support at regular intervals of 1.5 metre span, protected by angle /channel/tray and attached by plastic coated metallic straps along the complete length of its run. Tubing runs shall be of minimum bends and sloped according to drain requirements.

The supplied Tubing shall comply with detailed requirement specified in "Design Specifications for Instruments & Controls – Installation" (Doc. No. E1150-TS-2000-J-0012)

7.18 INSTRUMENT BULK MATERIAL REQUIREMENTS

7.18.1 Instrument signal cables

Cables shall comply with IEC standards. All cables shall be Flame retardant to IEC –60332 part3, Category C. In addition, cables used for SIS and F&G System shall be Fire-resistant to IEC-60331 (1382 °F for three hours) and low-smoke zero-halogen type. Signal cables shall have individual and overall screen. Control cables shall have overall screen only.







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Instrument Power cable shall not be screened. All cables shall be with wire braid armour. Lead sheathed cables shall be used for laying as direct buried cable in onshore to avoid hydrocarbon seepage.

Note: Instrument power cable requirement for sizes above 16 mm2 shall follow Electrical specification for L.V. cables.

The supplied Cables shall comply with detailed requirement specified in "Specification for Instrument Cable, Cable Glands and Junction Boxes" Doc. No. E1150-TS-2000-J-0016".

7.18.2 Instrument Junction boxes

All Junction boxes used for Non-Foundation Fieldbus circuits shall be SS 316L and Flameproof Ex (d) Certified.

All the Junction boxes used for Foundation Fieldbus circuits shall be of SS 316L material flame retardant, anti-static, UV resistant, Glass Reinforced Polyester (GRP) material and Certified to Ex(e) Increased Safety.

Indoor safe area Termination boxes shall be made of Sheet Steel.

The supplied Junction Boxes shall comply with detailed requirement specified in "Specification for Instrument Cable, Cable Glands and Junction Boxes" Doc. No. E1150-TS-2000-J-0016".

7.18.3 Cable trays

Perforated Main Cable tray/ladder system shall be made of heavy duty, flame retardant Glass Reinforced Polyester (GRP) with SS 316 fastenings. The tray/ladder material shall be UV resistant, non-magnetic and anti-static without electrical conductivity. The materials shall be treated by means of additives to avoid the accumulation of static electricity.

The supplied Cable Trays shall comply with detailed requirement specified in "Specification for Cable Trays" Doc. No. E1150-TS-2000-J-0017".

7.18.4 Electrical cable glands & miscellaneous fittings

As a minimum, all the electrical cable glands shall be of double-compression type with a separate provision to clamp armour and/or Outer lead sheath. The cable glands used near the splash zone should be of triple compression type. Material shall be SS 316L with PVC shroud; and suitably certified for hazardous area & ingress protection.

All cable glands shall be with earth studs.

All Miscellaneous Electrical fittings required such as cable transits, cable markers, earthing bus bars shall be provided as per package VENDOR's standard.







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The supplied Cable gland shall comply with detailed requirement specified in "Specification for Instrument Cable, Cable Glands and Junction Boxes" Doc. No. E1150-TS-2000-J-0016".

7.18.5 Impulse tubing and Tube fittings

Tubing with double compression fittings up to ASME 900 rating. Piping (not tubing) shall be provided up to the instrument manifold for Lethal Service and class ASME 1500 and above ratings.

Tube size shall be ½" O.D. * 0.065" wall thickness.

Tubing fittings shall be double compression double-ferruled type of Inconel 625 or 6MO or UNS S31803 or Titanium based on application/service, except for sea water/fire water service. For sea water/fire water service, Monel 400 shall be used.

All tubing, fittings, Instrument Valve and Instrument Manifold shall be compliant to NACE MR0175/ISO 15156 as a default unless otherwise specified in specified in package specification.

The supplied Impulse tubing and tube fitting shall comply with detailed requirement specified in "Specification for Instrument Bulk Materials (Doc. No. E1150-TS-2000-J-0018).

7.18.6 Pneumatic Tubing and Tube fittings:

Pneumatic tubing shall be UNS N08904 (904 L SS) as per ASTM B 677-9.

Tubing fittings shall be double compression double-ferruled type of 6MO in accordance with ASTM A182 and ASTM A479. Tube size will be specified as follows:

- ¼ O.D. * 0.035" wall thickness for small pilots (e.g. Transmitters).
- 3/8 "O.D. * 0.035" wall thickness for medium pilots (e.g. Control valves).
- ½" O.D. * 0.049" wall thickness for large pilots (e.g. Positioners).

The supplied pneumatic tubing and tube fittings shall comply with detailed requirement specified in "Specification for Instrument Bulk Materials (Doc. No. E1150-TS-2000-J-0018)".

7.18.7 Instrument Air Supply Sets

Instrument Air Supply Air sets (1/4" or ½") shall be provided with integral filter, regulator and gauges.

The Filter shall be of SS 316L to 40 micron as standard, unless otherwise specified.

Instrument air take off points from plant instrument header shall be provided with isolation valves and spare ones shall be plugged. Instrument air up to instrument air manifold shall be supplied through SS 316L piping as per pipe class A51E of "Piping Material Specification" (Doc. No. E1150-GD-2000-P-0001).





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The supplied Instrument air tubing, fitting, regulator and other accessories shall comply with detailed requirement specified in "Specification for Instrument Bulk Materials (Doc. No. E1150-TS-2000-J-0018)".

7.18.8 Instrument Valves

All Instrument Valves and Manifolds MOC shall be as per Specification for Instrument Bulk Materials "Specification for Instrument Bulk Materials" (Doc. No. E1150-TS-2000-J-0018).

The supplied Instrument valves and manifold shall comply with detailed requirement specified in "Specification for Instrument Bulk Materials" (Doc. No. E1150-TS-2000-J-0018).

7.18.9 Instrument Valve Manifolds

Instrument Valves and Manifolds MOC shall be as per "Specification for Instrument Bulk Materials" (Doc. No. E1150-TS-2000-J-0018). The valve manifolds shall be selected as follows, unless otherwise specified:

- Flow Instrument -differential pressure instruments: 5-valve manifold.
- Level Instrument -differential pressure instruments: 5-valve manifold type.
- Secondary isolation at instrument end for remote mounted devices: 2-valve manifold block.
- Pressure Transmitters: 2-valve manifold.
- Pressure Differential Transmitters: 5-valve manifold.
- Pressure gauges: 2-valve manifold.
- Pressure Differential gauges: 5-valve manifold.
- Pressure switch: Block, Bleed and in situ calibration port valve manifold.

7.18.10 Instrument sunshades

Instrument sunshades shall be solar heat insulating UV resistant electrostatic-free fibre reenforced polyester with 316 SS fastenings. Sunshades shall not interfere with normal calibration access to Transmitters.

Sunshades shall be provided whenever the transmitter / sensor / Junction box is exposed to direct sunlight.

7.18.11 Insulation Requirements

Insulation requirements shall be as shown in P & IDs for impulse lines heat tracers & bodies of instruments and provided accordingly.

Refer to "Specification for Instrument Bulk Materials" (Doc. No. E1150-TS-2000-J-0018) for detailed requirements.





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8. MATERIAL OF CONSTRUCTION (MOC) REQUIREMENTS

Material selection for Instrumentation shall be as follows:

The selection of wetted parts and body material for in-line and on-line instrumentation and valves shall be in accordance with the "Piping Material Specification" (Doc. No. E1150-TS-2000-P-0001) and Specification for Instrument Material Selection (Doc. No. E1150-TS-2000-J-0010).

The following shall apply for Material Selection for Instrumentation, as a minimum, unless otherwise specified.

All wetted parts shall be to SS 316L for process and utility services, as a minimum.
 This shall apply to all accessories too.

Note: Monel wetted parts shall be used for seawater/fire water applications.

- Capillary tubing shall be 316 L SS with protective armour in SS, as a minimum.
- All wetted parts material of instruments in sour service shall comply with NACE MR 0175/ISO 15156.
- Instrument Housing material shall be Low Copper Di-Cast Aluminium with epoxy painting or SS 316L, painted.
- Use of SS 304 or lower grade and Aluminum is not permitted in any form.

The sub-vendors, sub-suppliers and sub-contractors shall be selected from an Approved vendor list issued along with Project Requisition.

9. INSTALLATION / COMMISSIONING REQUIREMENTS

The pre-commissioning and commissioning shall form part of site support services and the spares & consumables used during this stage by VENDOR shall be replenished free-of-cost to EPC CONTRACTOR/COMPANY, at the successful conclusion of commissioning services.

9.1 SPECIAL TOOLS

SUPPLIER shall furnish, all special tools required for installation, commissioning, disassembly, and re-assembly of their equipment. These shall include but not limited to the following per equipment package.

- Software (including any third-party software) configuration devices for all controllers, I/O modules.
- Software (including any third-party software) for reconfiguration of operator interface.





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- Diagnostic software and hardware for all electronics.
- EPC CONTRACTOR as well as technician level diagnostic software for all machine condition / performance
- Monitoring, machine condition / performance evaluation.
- Any special instrument tools to dismantle impeded instrument items.
- Special test clamps or leads for electronic/instrument checks, if any

9.2 START-UP & COMMISSIONING SPARES

- SUPPLIER shall supply start-up and commissioning spares, as required in order to avoid using any of the recommended spares. The cost of start-up spares shall be quoted separately in advance for review.
- The time scales and procedure for repair and/or replacement of parts shall be stated in the SUPPLIER's bid.

9.3 OPERATIONAL SPARES

 The SUPPLIER shall review the equipment (including tools, testing and calibration equipment) offered in their proposal and shall include a comprehensive recommended spare parts list enough for two (2) years continuous operation of the equipment and one-year consumable spares

10. SURFACE PROTECTIVE COATING/ PAINTING

External Painting and coating shall comply with the Coating and Lining Specification (Doc No. E1150-TS-2000-W-0004).

Painting shall be to manufacturer's standard for items not addressed in the Coating and Lining Specification (Doc. No. E1150-TS-2000-W-0004) or undefined within this specification. But VENDOR shall furnish his standard painting procedure for approval prior to shipment for approval. Colour and finish shall be to manufacturer's standard for items not addressed and shall be subject to EPC CONTRACTOR/COMPANY approval.

Instrument cases shall be preferably corrosion resistant Stainless steel. Non-stainless steel metallic cases shall have marine painting. Marine coating finish is required on both materials.

Colour Finish Schedule (to BS 4800 or approved equal by COMPANY)

Instrument Panels - Exterior

- Control System panels: Pale Grey (RAL 7035).
- System consoles: Manufacturer's finish.







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- SIS panels: Signal Blue (RAL 5005).
- FGS Panels: Signal Red (RAL 3001).
- Power supply: Admiralty Grey to 18 B 21.
- Communication panels: Light Blue.
- Other panels: Light Grey to 10 A 03.

Instrument Panels – Interior: Dip coat primed (to RAL 7044).

ESD devices and Fire Detectors: Safety Red.

Gas Detectors: Safety Amber / Orange.

Local Gauge panels: Green to 14 E 53.

Instrument cable trays (pre-fabricated): Aluminium Grey / Medium Grey.

<u>Junction boxes – Outdoor.</u>

- I.S and Non- I.S (for all except Fire & Gas): Pale Grey (RAL 7035).
- Fire & Gas: Signal Red (RAL 3001).
- Power: Natural black to 00-E-53 (or RAL 9011).
- Termination Box Indoor: Self coloured black to 00-E-53 (or RAL 9011) h) In-line meters.
- On Insulated lines: Manufacturer's standard.

Control valves

- Body: Light Grey to 10 A 03.
- Actuator -Fail close: Green to 14 E 53.
- Actuator- Fail Open: Yellow to 08 E 51.

Shutdown Valves

- Body: Colour of adjacent piping if specified in data.
- Sheet or Mfr's standard or Delivered for Onsite painting with Primer when so specified.
- Actuator:
 - o Fail Close: Green to 14-E-53 as per BS-4800 or equal.
 - o Fail Open: Yellow to 08-E-51 as per BS-4800 or equal.
 - Fail Lock: Light Grey 10-A-03.

Relief valves (all types): Orange to 06 E 51

Instrument Fireproofing

If fireproofing is specified by EPC CONTRACTOR for the packaged equipment instrumentation, SUPPLIER shall install any fireproofing materials supplied with the valves and ensure the following:

- Fireproofing is installed with access for maintenance
- Fireproofing covers cable and tube entries.





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 Fireproofing shall be removal box type design considering removal and re fixing of all associated equipment during maintenance

11. QUALITY ASSURANCE/ QUALITY CONTROL REQUIREMENTS

The product supplier shall maintain an effective Quality Management System and certified to latest edition of ISO 9001 Quality Management Systems – Requirements and ISO 9004 - Quality management — Quality of an organization — Guidance to achieve sustained success.

The system in place must cover the full scope of supply and works associated with Equipment packages. The quality certificates shall be from an accredited society, subject to approval on submission.

The VENDOR shall submit his QA/ QC procedure for Instrumentation and Control separately for approval of EPC CONTRACTOR/COMPANY, clearly indicating the test to be conducted, Instrument items to be used, detailed procedure and expected performance levels; and Control of non-conformity, corrective action and its long term effects if any. All the events and results shall be recorded.

It would be VENDOR's responsibility to ensure the entire test and calibration equipment is capable of meeting desired accuracy, precision and repeatability criteria. VENDOR shall provide Calibration Certificate Records from local recognized and certified laboratory for at least five calibration points. (Certified copy of Calibration procedure for each type of instrument shall be furnished for EPC CONTRACTOR's/COMPANY's approval and use.

All items shall be warranted against defective materials as required by Purchase Requisitions. Defective parts found within the guarantee period shall be replaced / repaired to permit the units to perform to design conditions.

12. <u>INSPECTION AND TESTING REQUIREMENTS</u>

The testing requirements shall include all aspects such as Functional, Performance and Interface tests as per the Inspection and Test Plan, this specification and other specifications attached with the requisition.

The Documents & Drawings required for Approval at various stages by EPC CONTRACTOR shall be as specified in VDRL under Mechanical specifications or bid documents.

VENDOR shall have conducted his own tests and recorded the results. The results shall be submitted to EPC CONTRACTOR prior to any inspection by him or inspection waiver or before Dispatch.

Factory testing and Staging shall be done at a single location and all testing/-staging facilities and equipment to test shall be in the scope of VENDOR. Prior to this Factory Acceptance Test (FAT), VENDOR shall submit for approval written FAT procedures.







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A means to record/approve various stages of tests which shall allow testing from card/component/module level to total integration.

As a minimum, the tests shall include the following activities or checks for Instruments or systems, as applicable.

- Visual & Dimensional check.
- Bill of material check.
- Assembly checks.
- Approved material for installation check.
- Accessories completeness checks.
- Mounting detail checks.
- Material Test Certificates
- Ratings check.
- Leak checks.
- NDT certificates check, when applicable.
- NACE certificates check, when applicable.
- Bench Calibration check.
- Cabinets, wiring, trunking, termination, earthing etc. checks.
- Electrical checks.
- End connection checks.
- Enclosure certification checks.
- EMC certificate check.
- Functional/ Performance / Operational check.
- Input / Output (I/O) check including point / channel / module / system cable failure and reinstatement.
- I/O points check for all types analogue, contact, pulse, digital / discrete status flags etc.
- Redundancy checks Processor, Communication, Memory, Power supply and I/O, as applicable.
- SWC test.
- Common mode rejection ratio (CMRR) test for modules, when requested.
- Time synchronization checks.
- System Initialization checks.
- Console checks and/or display checks for control loop configuration.
- Software loading.
- Logic checks with authorized issue of Cause and Effect or binary Logic diagrams.
- Graphics check Static and Dynamic.
- Serial mapping check.
- Auxiliary systems check Maintenance PC etc.
- Master Slave controls check.
- Supervisory system upload/download check.
- Tagging, Cable numbering, termination ferruling and nameplate check.





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12.1 INTEGRATED TEST WITH ICSS SYSTEM

The Package Unit shall be Interface Tested with the ICSS (if applicable) after successful completion of the Package Unit FAT.

The Package Unit VENDOR shall ship the necessary Hardware and Software (that required for Integration Testing with the ICSS) to the MAC Integration Facility located in Abu Dhabi.

The Package Unit VENDOR and his representative(s) shall be available at the MAC Integration Facility (with the necessary Software, Hardware and Testing and Tool kits) throughout Interface Testing period.

The Package Unit VENDOR shall submit his proposed Site Acceptance Testing (SAT) Procedure to the EPC CONTRACTOR/COMPANY for review and approval. The SAT shall include tests to verify that all tests done at the FAT stage are valid and, in addition, shall include tests to verify any changes completed after the FAT and to test for any outstanding FAT punch-list items.

Any necessary special test equipment and any test equipment requested by the EPC CONTRACTOR shall be provided by the Package Unit VENDOR and identified as required in the SAT procedure.

12.2 INSTRUMENTATION AND CONTROL SYSTEM TESTING

Testing and Inspection shall be as per Specification for Instruments & Controls Testing and Commissioning (Doc. No. E1150-TS-2000-J-0020).

13. MARKING AND TRACEABILITY REQUIREMENTS

For all pressure retaining parts of the Instruments, Type 3.1 Inspection certificates as per BS EN 10204 shall be submitted for verification of chemical composition / mechanical properties, as a minimum.

For all other critical non-pressure retaining parts of the Instruments, Type 2.2 Inspection certificates as per BS EN 10204 shall be submitted for verification of chemical composition / mechanical properties, as a minimum.

Instrument Nameplate details shall be provided in corrosion resistant SS 316L. The nameplate as a minimum shall contain the following information. Name Plate records (hardcopies of drawings) to be supplied.

- Tag Number.
- Manufacturer.
- Model No. And Serial number along with date of manufacture.
- Range & Contractor specific characteristics.
- Material details.

Additional tags on installation in the form of plate riveted on stand or fixed by stainless steel wire shall indicate the tag no. and service as per P & ID.





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14. HANDLING, STORAGE, PRESERVATION AND PACKING REQUIREMENTS

In General, the following guidelines apply.

All threaded and flanged openings shall be suitably protected to prevent ingress of foreign matter.

Packing shall be road-worthy, sea-worthy (open deck storage) and air-worthy as per transportation basis.

Cabinet and instrumentation shall be packed separately; other loose or small parts shall be properly packed and protected to prevent loss or damage to equipment. The cabinet shall be braced or strengthened to avoid distortion. The VENDOR shall be liable to make good any damage during transit.

Heavy-duty plastic foil and silica gel for safeguarding and sealing of all parts sensitive to moisture. Additional external reinforcing against mechanical damage shall be provided as necessary.

Each consignment shall be clearly marked with the complete PO, requisition number, description of its contents and its intended project name.

Construction site and EPC CONTRACTOR shall be notified in advance of despatch and expected delivery dates.

The Package Unit VENDOR shall be fully responsible for supplying all necessary documentation to ensure smooth and rapid transportation/customs clearance of the equipment.

Package Unit VENDOR shall provide clear instructions for the type of storage required at site after receipt of the material.

15. VENDOR DESIGN DATA

The Package Unit VENDOR shall be responsible for supplying all of the documentation, drawings and data specified in the EPC CONTRACTOR/COMPANY approved VDRS.All Package VENDOR documentation shall be in project template provided by EPC CONTRACTOR. The data shall be preferably on CD, properly indexed and readable like an e-Book. In such cases only one set of hardcopy of documentation would be needed.

As a minimum, the following information shall be included, for Instrumentation:

- Inst list, index and schedules.
- Data sheets.
- Cause and Effect matrix.
- Loop, Logic and Ladder Diagrams.
- Cable Block diagrams.
- Control narratives for complex controls and interlocks.
- Cabinet Power & Heat Calculations.





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- Reliability and Availability Calculations.
- System Architecture Diagram.
- Hook-ups Process, Electrical, Pneumatic, Hydraulic.
- Wiring & Termination diagrams Panel, Junction boxes and Termination boxes.
- Interface diagrams.
- Cable schedules.
- Layouts Process, Electrical, Pneumatic, Hydraulic.
- Alarm and Trip settings list.
- Modbus mapping and / or Serial link bit map.
- I.S. Calculations.
- Foundation Fieldbus Segment Design Calculations.
- Certificates of conformity.
- Enclosure certification including name plate drawing complete with Tag nos. and descriptions.
- Electrical, Instrument air, instrument gas and analyzer calibration fluid consumption calculations, as applicable.
- SPIR forms with Spares for commissioning and two-year Operational spares.
- FAT and SAT procedures & Reports.
- Application software for the equipment with licenses as required for use, including program and source codes as applicable.
- Operating and Maintenance plans and manuals.
- Sizing & Calculation books
- Pre-commissioning procedures.
- List of sub-orders /subcontracts from Package VENDOR.
- At least Five- calibration points certificates for all instruments.

16. HAZOP AND SIL PARTICIPATION REQUIREMENTS:

16.1 HAZOP:

Package VENDOR shall participate and assist EPC CONTRACTOR in HAZOP review meetings. Package VENDOR shall implement any HAZOP decisions and associated Package VENDOR design / documentation shall be revised accordingly.

16.2 SIL / LOPA

SIL Assessments and LOPA reviews shall be carried out by EPC CONTRACTOR in compliance with the requirements of IEC 61511. Package VENDOR shall participate in LOPA / SIL Study .

17. TRAINING

Package VENDOR shall quote for training of various categories of instrument personnel necessary to maintain and troubleshoot Instruments and Control systems supplied by him. Such training shall preferably be imparted at site subsequent to installation of equipment at site and prior to commissioning. Trainings shall be in person at OEM's facility or at Site







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actual conditions (not virtual) in minimum two batches of the site personal. Training agenda , materials, schedule shall be shared by VENDOR in advance and agreed with COMPANY Site Maintenance team.

18. <u>ATTACHMENTS</u>







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18.1 ATTACHMENT 1: MAC INTERFACE TEMPLATES







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Check List for Subsys	stem Interface to Yokogawa DCS (Modbus RS 485)								
PROJECT NAME									
SUB-SYSTEM MANUFACTURER:	To be filled by Subsystem Vendor								
SUB-SYSTEM MODEL:	To be filled by Subsystem Vendor								
COMMUNICATION INTERFACE (RS-485 / RS-422):	Serial RS-485								
INTERFACE CONNECTION (2-Wire / 4-Wire):	2-Wire / 4- Wire								
DUAL-REDUNDANT COMMUNICATION:	Yes								
DISTANCE BETWEEN THE COMMUNICATION MODULE AND THE PLC:	To be filled by EPC								
COMMUNICATION PROTOCOL:	Modbus RTU								
COMMUNICATION MODE:	SLAVE								
MODBUS SLAVE ADDRESS (01 - 255):	To be filled by Subsystem Vendor								
TRANSMISSION SPEED:	19200 BPS								
DATA BIT (7,8):	8								
STOP BIT:	1								
PARITY (Even, Odd, None):	None								
NUMBER OF ANALOG INPUTS FROM SUB-SYSTEM TO DCS:	To be filled by Subsystem Vendor								
NUMBER OF ANALOG OUTPUTS FROM DCS TO SUB-SYSTEM:	To be filled by Subsystem Vendor								
NUMBER OF DIGITAL INPUTS FROM SUB-SYSTEM TO DCS:	To be filled by Subsystem Vendor								
NUMBER OFDIGITAL OUTPUTS FROM DCS TO SUB-SYSTEM:	To be filled by Subsystem Vendor								

Speed 1200,2400,4800,9600,19200 bps is supported, 38400 bps or faster is not supported







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ANALOG INPUT	TS FROM	SUB-SYSTEM TO DCS:													
INA	Modbus Address	Tag Name	Tag Description	Min. Value	Max. Value	Engg. Unit	Alarm LL	Alarm L	Alarm H	Alarm HH	MB Raw Data count Min Value.	MB Raw Data count Max Value	Data Size	Data Type	Remarks
1 Eg : 4	30001	As per Project Tag naming Philosophy	12 x 12 Characters (Maximum 24 Characters)								Eg: 0 to 655	35 / 0 to 4095	16/32-bit	Eg: Signed / Unsigned / Floating	
2 Eg:4	30002												16/32-bit	Eg: Signed / Unsigned / Floating	
3 Eg:4	30003												16/32-bit	Eg: Signed / Unsigned / Floating	
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															







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ANA	ALOG OUTP	UTS FROM DCS TO) SUB-SYSTEM:									
No.	Modbus Func.Code	Modbus Address	Tag Name	Tag Description	Min. Value	Max. Value	Engg. Unit	MB Raw Data count Min.	MB Raw Data count Max.	Data Size	Data Type	Remarks
1	Eg:3	40101	As per Project Tag naming Philosophy	12 x 12 Characters (Maximum 24 Characters)				Eg : 0 to 655	535 / 0 to 4095	16/32-bit	Eg : Signed / Unsigned / Floating	
2	Eg:3	40102								16/32-bit	Eg : Signed / Unsigned / Floating	
3	B Eg:3	40103								16/32-bit	Eg : Signed / Unsigned / Floating	
4												
5												
6												
7	,											
8	3											
9												
10												
11												







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DIGITA	AL INPUTS FR	ROM SUB-SYS	TEM TO DCS	:					
No.	Modbus Func.Code	Modbus Address	Bit No.	Tag Name	Tag Description	Signal State"1" (*)	Signal State"0" (*)	Data Type	Remarks
1	Eg : 2	10001	0	As per Project Tag naming Philosophy	12 x 12 Characters (Maximum 24 Characters)	On	Off	DI	
2	Eg : 2	10001	1			Alarm	Normal	DI	
3	Eg : 2	10001	2			Open	Close	DI	
4	Eg : 2	10001	3			Open(**)	Not Open	DI	
5	Eg : 2	10001	4			Close(**)	Not Close	DI	
6	Eg : 2	10001	5					DI	
7	Eg : 2	10001	6					DI	
8	Eg : 2	10001	7					DI	
9	Eg : 2	10001	8					DI	
10	Eg : 2	10001	9					DI	
11	Eg : 2	10001	10					DI	
12	Eg : 2	10001	11					DI	
13	Eg : 2	10001	12					DI	
14	Eg : 2	10001	13					DI	

(*) Maximum 8 characters in DCS

^(**) For the perticular equipment, If Open/Close feedback tags to DCS are seperate then request to map "OPEN" feedback tag first & "CLOSE" feedback tag in next "Consecutive" address. Example: In Modbus Address 10001, If "OPEN" Feedback Tag is assigned for Bit "3", then assign "CLOSE" Feedback tag in Bit "4".







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DIGI	TAL OUTP	UTS FROM DCS	TO SUB-SY	STEM:					
No.	Modbus Func.Code	Modbus Address	Bit No.	Tag Name	Tag Description	Signal State"1" (*)	Signal State"0" (*)	Data Type	Remarks
1	Eg : 1	00001	0	As per Project Tag naming Philosophy	12 x 12 Characters (Maximum 24 Characters)	On	Off	DO	
2	Eg : 1	00001	1			Alarm	Normal	DO	
3	Eg : 1	00001	2			Open	Close	DO	
4	Eg : 1	00001	3			Open(**)	Not Open	DO	
5	Eg : 1	00001	4			Close(**)	Not Close	DO	
6	Eg : 1	00001	5					DO	
7	Eg : 1	00001	6					DO	
8	Eg : 1	00001	7					DO	
9	Eg : 1	00001	8					DO	
10	Eg : 1	00001	9					DO	

^{*)} Maximum 8 characters in DCS

^{**)} For the perticular equipment, If Open/Close Command tags from DCS are seperate then request to map "OPEN" command tag first & "CLOSE" command tag in next "Consecutive" address. Example: In Modbus Address 00001, If "OPEN" Command Tag is assigned in Bit "3", then assign "CLOSE" Command tag in Bit "4".







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Check List for Subsys	tem Interface to Yokogawa DCS (Modbus TCP/IP)						
PROJECT NAME							
SUB-SYSTEM MANUFACTURER:	To be filled by Subsystem Vendor						
SUB-SYSTEM MODEL:	To be filled by Subsystem Vendor						
PROTOCAL:	Modbus TCP/IP						
INTERFACE CONNECTION:	RJ-45						
DUAL-REDUNDANT COMMUNICATION:	Yes						
PRIMARY IP ADDRESS	Will be provided by Yokogawa						
SECONDARY IP ADDRESS	Will be provided by Yokogawa						
SUBNET MASK	255.255.25.0						
DISTANCE BETWEEN THE COMMUNICATION MODULE AND THE PLC:	To be filled by Subsystem Vendor/EPC						
COMMUNICATION PROTOCOL:	Modbus TCP/IP						
COMMUNICATION MODE:	SLAVE						
MODBUS SLAVE ADDRESS (01 - 255):	To be filled by Subsystem Vendor						
TRANSMISSION SPEED:	10 Mbps						
NUMBER OF ANALOG INPUTS FROM SUB-SYSTEM TO DCS:	To be filled by Subsystem Vendor						
NUMBER OF ANALOG OUTPUTS FROM DCS TO SUB-SYSTEM:	To be filled by Subsystem Vendor						
NUMBER OF DIGITAL INPUTS FROM SUB-SYSTEM TO DCS:	To be filled by Subsystem Vendor						
NUMBER OFDIGITAL OUTPUTS FROM DCS TO SUB-SYSTEM:	To be filled by Subsystem Vendor						







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AN	AL	og inpu	TS FROM	SUB-SYSTEM TO DCS:													
No		Modbus unc.Code	Modbus Address	Tag Name	Tag Description	Min. Value	Max. Value	Engg. Unit	Alarm LL	Alarm L	Alarm H	Alarm HH	MB Raw Data count Min Value.	MB Raw Data count Max Value	Data Size	Data Type	Remarks
	1	Eg : 4	30001	As per Project Tag naming Philosophy	12 x 12 Characters (Maximum 24 Characters)								Eg : 0 to 655	35 / 0 to 4095	16/32-bit	Eg: Signed / Unsigned / Floating	
	2	Eg : 4	30002												16/32-bit	Eg: Signed / Unsigned / Floating	
	3	Eg : 4	30003												16/32-bit	Eg: Signed / Unsigned / Floating	
	4																
	5																
	6																
	7																
	8																
	9																
1	0																
1	1																
1	2																
1	3																
1	4																
1	5																
1	6																
1	7																







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No.	Modbus	Modbus Address	Tag Name	Tag Description	Min.	Max.	Engg.	MB Raw Data	MB Raw Data	Data Size	Data Type	Remarks
	Func.Code			12 x 12 Characters	Value	Value	Unit	count Min.	count Max.			
1	Eg: 3	40101	As per Project Tag naming Philosophy	(Maximum 24 Characters)				Eg : 0 to 655	535 / 0 to 4095	16/32-bit	Eg : Signed / Unsigned / Floating	
2	Eg:3	40102								16/32-bit	Eg: Signed / Unsigned / Floating	
3	Eg: 3	40103								16/32-bit	Eg: Signed / Unsigned / Floating	
4												
5												
6												
7	,											
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12												
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14												
15												
16												
17												







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DIGIT	AL INPUTS FR	ROM SUB-SYS	TEM TO DCS	:					
No.	Modbus Func.Code	Modbus Address	Bit No.	Tag Name	Tag Description	Signal State"1" (*)	Signal State"0" (*)	Data Type	Remarks
1	Eg : 2	10001	0	As per Project Tag naming Philosophy	12 x 12 Characters (Maximum 24 Characters)	On	Off	DI	
2	Eg : 2	10001	1			Alarm	Normal	DI	
3	Eg : 2	10001	2			Open	Close	DI	
4	Eg : 2	10001	3			Open(**)	Not Open	DI	
5	Eg : 2	10001	4			Close(**)	Not Close	DI	
6	Eg : 2	10001	5					DI	
7	Eg : 2	10001	6					DI	
8	Eg : 2	10001	7					DI	
9	Eg : 2	10001	8					DI	
10	Eg : 2	10001	9					DI	
11	Eg : 2	10001	10					DI	
12	Eg : 2	10001	11					DI	
13	Eg : 2	10001	12					DI	
14	Eg : 2	10001	13					DI	

^(*) Maximum 8 characters in DCS

^(**) For the perticular equipment, If Open/Close feedback tags to DCS are seperate then request to map "OPEN" feedback tag first & "CLOSE" feedback tag in next "Consecutive" address.

Example: In Modbus Address 10001, If "OPEN" Feedback Tag is assigned for Bit "3", then assign "CLOSE" Feedback tag in Bit "4".







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DIGI	TAL OUTP	UTS FROM DCS	TO SUB-SY	STEM:					
No.	Modbus Func.Code	Modbus Address	Bit No.	Tag Name	Tag Description	Signal State"1" (*)	Signal State"0" (*)	Data Type	Remarks
1	Eg : 1	00001	0	As per Project Tag naming Philosophy	12 x 12 Characters (Maximum 24 Characters)	On	Off	DO	
2	Eg : 1	00001	1			Alarm	Normal	DO	
3	Eg : 1	00001	2			Open	Close	DO	
4	Eg : 1	00001	3			Open(**)	Not Open	DO	
5	Eg : 1	00001	4			Close(**)	Not Close	DO	
6	Eg : 1	00001	5					DO	
7	Eg : 1	00001	6					DO	
8	Eg : 1	00001	7					DO	
9	Eg : 1	00001	8					DO	
10	Eg : 1	00001	9					DO	
11	Eg : 1	00001	10					DO	
12	Eg : 1	00001	11					DO	
13	Eg : 1	00001	12					DO	
14	Eg : 1	00001	13					DO	
15	Eg : 1	00001	14					DO	
16	Eg : 1	00001	15					DO	

(*) Maximum 8 characters in DCS

(**) For the perticular equipment, If Open/Close Command tags from DCS are seperate then request to map "OPEN" command tag first & "CLOSE" command tag in next "Consecutive" address. Example: In Modbus Address 00001, If "OPEN" Command Tag is assigned in Bit "3", then assign "CLOSE" Command tag in Bit "4".