طرح نگهداشت و افزایش تولید ۲۷ مخزن

SPECIFICATION FOR INSTRUMENTATION

نگهداشت و افزایش تولید میدان نفتی بینک

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IFC: Issued For Comment
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AFP: Approved For Purchase
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IFI: Issued For Information
AB-R: As-Built for CLIENT Review
AB-A: As-Built –Approved

REVISION RECORD SHEET

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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – General Facilities
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

2.0 SCOPE

This document together with the referred standards, specifications and project documents covers the minimum requirements for field mounted instruments to be used in construction of BINAK New facilities(Compressor station/ Extension of manifold and Gas-condensate Pipeline as project work packages). This basis shall be used to furnish the following instruments:

- Pressure instruments
- Temperature instruments
- Electronic transmitters
- Level instruments
- Switches
- Flow meter instruments
- Analyzer

It shall be used in conjunction with data/requisition sheet, prepared for each device.

3.0 NORMATIVE REFERENCES

3.1 LOCAL CODES AND STANDARDS

• IPS-E-IN-100	Engineering standards for general instrumentation
• IPS-E-IN-105	Instrument Workshop, Layouts, Test and Calibration Tools
• IPS-E-IN-110	Engineering standard for pressure instruments
• IPS-E-IN-120	Engineering standard for temperature instruments
• IPS-E-IN-130	Engineering standard for flow instruments
• IPS-E-IN-140	Engineering standard for level instruments
• IPS-E-IN-190	Engineering standard for transmission systems
• IPS-C-IN-100	Construction and inspection standard for general instrument field inspection, calibration and testing of instrument and instrument system
• IPS-C-IN-110	Construction standards for pressure instruments
• IPS-C-IN-120	Construction and installation standard for temperature instruments
• IPS-C-IN-130	Construction and installation standard for flow instruments
• IPS-C-IN-140	Construction and installation standard for level instruments
• IPS-C-IN-190	Construction Standard for Transmission Systems
• IPS-D-IN-101	Flanged & Screwed Thermowell Detail Selection Chart for Thermocouples, Rtd, Bi Metallic Thermometers & Test Wells Instruments Installation Standard
• IPS-G-IN-200	General Standard for Instruments Air System
• IPS-I-IN-100	Inspection Standard for General Instrument Systems

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- IPS-M-IN-110 Material and equipment standard for pressure instruments
- IPS-M-IN-120 Material and equipment standard for temperature instruments
- IPS-M-IN-130 Material and equipment standard for flow instruments
- IPS-M-IN-140 Material and quality control standard for level instruments
- IPS-M-IN-190 Material and equipment standard for transmission systems
- IPS-G-IN-210 General standard for instrument protection

3.2 INTERNATIONAL CODES AND STANDARDS

- AGA American Gas Association
- IEC-60584 Thermocouples
- IEC-60529 Classification of Degree of Protection Provided by Enclosures
- IEC-60751, BS1904 Industrial Platinum Resistance Thermometer Sensors
- ANSI-MC 96.1 Temperature Measurement Thermocouples
- BS EN 837 Specification for Bourdon Tube Pressure Vacuum Products
- IEC 60079 Electrical Apparatus for Explosive Gas Atmospheres
- IEC 60144 Ingress Protection for Dust and Water Jets
- IEC 60079 (Relevant Sections) Code of Practice for the Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres
- ASME VIII Unfired Pressure Vessels
- ANSI B1.20.1 Pipe Threads, General Purpose
- BS 1042 Measurement of fluid flow in closed conduits
- ISO 5167 Measurement of fluid flow by means of orifice plates, nozzles, and Venturi tubes inserted in circular cross-section, conduits running full
- NACE MR-0175 Sulfide stress cracking resistant metallic materials for oilfield equipment
- NACE RP-0775 Preparation, Installation, Analysis and Interpretation of Corrosion Coupons in oil field operation.
- ANSI B16.5 Pipe flanges and flanged fittings. inserted in circular cross

section conduits running full

- API RP-521 Guide for Pressure-Relieving and Depressuring Systems
- API RP 550 Part I Installation of Refinery Instruments and Control Systems
- ANSI/ASME B16.36 Orifice Flanges
- ASTM D3230 Standard Test Method for Salts in Crude Oil
- ISA S.5.1. Instrumentation symbols and identification
- ISA S.5.4 Instrument Loop Diagrams
- ISA RP7.3 Quality Standard for Instrument Air
- ISA S18.1 Annunciators - sequences and specification
- IEEE-C62 Guides and standards for surge protection.
- IEEE 802 Local area networks
- IEEE-830 Guide to software requirements specification.
- IEEE-1012 Standard for software verification and validation plans.
- IEEE-1016 Recommended practice for software design descriptions.
- European Codes (CENELEC) for electrical equipment in hazardous areas (for European Manufacturers only):
- EN 50.014 General Rules
- EN 50.018 Explosion-proof Equipment
- EN 50.020 Intrinsic Safety Equipment
- EN 50019, 50039 Electrical apparatus for potentially explosive atmospheres,

The latest published issue or amendment shall apply unless otherwise stated.

3.3 THE REFERENCE DOCUMENTS

- BK-SSGRL-PEDCO-110-IN-DC-0002 Instrument & Control System Design Criteria
- BK-PPL-PEDCO-320-IN-DC-0002 Instrument & Control System Design Criteria
- BK-GCS-PEDCO-120-IN-DC-0002 Instrument & Control System Design Criteria
- BK- GENRL-PEDCO-000-IN-SP-0001 Specification For Control System
- BK- GENRL-PEDCO-000-IN-SP-0012 Specification For F&G system
- BK- GENRL-PEDCO-000-IN-SP-0003 Specification For ESD System
- BK-GNRAL-PEDCO-000-PR-BD-0001 Process Basis of Design

- BK- GNRAL-PEDCO -000-PR-SP-0001 Piping & Pipeline Material Specification
- BK- GNRAL-PEDCO -000-SA-SP-0002 Spec. For Hazardous Area Classification
- BK- PPL-PEDCO-320-IN-BD-0001 Block Diagram Config. For Control/ESD/F&G Sys.
- BK- GCS-PEDCO-120-IN-BD-0001 Control/ESD/F&G Sys. Block Diagram Config.
- BK- W007S-PEDCO-110-IN-BD-0001 Block Diagram Config. For Control/ESD/F&G Sys. - Extension of Binak B/C Manifold.
- BK-W018S-PEDCO-110-SA-PY-0001 Hazardous Area Classification Layout - W018S
- BK-W028-PEDCO-110-SA-PY-0001 Hazardous Area Classification Layout - W028
- BK-W046S-PEDCO-110-SA-PY-0001 Hazardous Area Classification Layout - W046S
- BK-W035-PEDCO-110-SA-PY-0001 Hazardous Area Classification Layout - W035
- BK-W008N-PEDCO-110-SA-PY-0001 Hazardous Area Classification Layout - W008N
- BK-W007S-PEDCO-110-SA-PY-0001 Hazardous Area Classification Layout -Extension of Binak B/C Manifold
- BK-W007S-PEDCO-110-SA-PY-0004 Hazardous Area Classification Layout - W007S
- BK-PPL-PEDCO-320-SA-PY-0001 Hazardous Area Classification Layout
- BK-GCS-PEDCO-120-SA-PY-0002 Hazardous Area Classification Layout
- BK-SSGRL-PEDCO-110-PR-PI-0001 Symbol & Legend For PFD and P&ID
- BK-SSGRL-PEDCO-110-PI-SP-0001 Piping Material Specification
- BK-PPL-PEDCO-320-PI-SP-0001 Piping Material Specification
- BK-GCS-PEDCO-120-PI-SP-0001 Piping Material Specification

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- BK-W018S-PEDCO-110-PR-PI-0001 P&ID - W018S
- BK-W028-PEDCO-110-PR-PI-0001 P&ID - W028
- BK-W046S-PEDCO-110-PR-PI-0001 P&ID - W0046S
- BK-W046S-PEDCO-110-PR-PI-0002 P&ID for Diesel Oil Drum- W0046S
- BK-W046S-PEDCO-110-PR-PI-0003 P&ID for Potable Water Tank - W0046S
- BK-W035-PEDCO-110-PR-PI-0001 P&ID - W035
- BK-W008N-PEDCO-110-PR-PI-0001 P&ID - W008N
- BK-W007S-PEDCO-110-PR-PI-0001 P&ID - Extension of Binak B/C Manifold
- BK-W007S-PEDCO-110-PR-PI-0002 P&ID - W007S
- BK-W007S-PEDCO-110-PR-PI-0003 P&ID for Diesel Oil Drum- W007S
- BK-W007S-PEDCO-110-PR-PI-0004 P&ID for Potable Water Tank - W007S
- BK-BK14-PEDCO-110-PR-PI-0001 P&ID for Diesel Oil Drum- BK14

- BK-BK14-PEDCO-110-PR-PI-0002 P&ID for Potable Water Tank - BK14
- BK-BK12-PEDCO-110-PR-PI-0001 P&ID for Diesel Oil Drum- BK12
- BK-BK12-PEDCO-110-PR-PI-0002 P&ID for Potable Water Tank - BK12
- BK-BK15-PEDCO-110-PR-PI-0001 P&ID for Diesel Oil Drum- BK15
- BK-BK15-PEDCO-110-PR-PI-0002 P&ID for Potable Water Tank - BK15
- BK-BK05-PEDCO-110-PR-PI-0001 P&ID for Diesel Oil Drum- BK05
- BK-BK05-PEDCO-110-PR-PI-0002 P&ID for Potable Water Tank - BK05
- BK-PPL-PEDCO-320-PR-PI-0003 Symbol & Legend For PFD and P&ID
- BK-PPL-PEDCO-320-PR-PI-0001 P&ID - Gas Pipeline (to Siahmakan G.I. ST.)
- BK-PPL-PEDCO-320-PR-PI-0002 P&ID - Condensate Pipeline (to Binak PU)
- BK-GCS-PEDCO-120-PR-PI-0001 Symbol & Legend For PFD and P&ID
- BK-GCS-PEDCO-120-PR-PI-0002 P&ID- Gas Comp. Inlet Gas Pipeline (Binak)
- BK-GCS-PEDCO-120-PR-PI-0003 P&ID-Gas Comp.Inlet Gas Pipeline(Golkhari)
- BK-GCS-PEDCO-120-PR-PI-0004 P&ID - Slug Catcher System
- BK-GCS-PEDCO-120-PR-PI-0005 P&ID - Gas Comp. Inlet Knock Out Drum
- BK-GCS-PEDCO-120-PR-PI-0006 P&ID - 1st Stage Gas Comp. Suction Drums
- BK-GCS-PEDCO-120-PR-PI-0007 P&ID - 1st Stage Gas Compression Comp.
- BK-GCS-PEDCO-120-PR-PI-0008 P&ID -1st Stage Gas Compression Air Coolers
- BK-GCS-PEDCO-120-PR-PI-0009 P&ID -2nd Stage Gas Compression Suction Drums
- BK-GCS-PEDCO-120-PR-PI-0010 P&ID - 2nd Stage Gas Compression Comp.
- BK-GCS-PEDCO-120-PR-PI-0011 P&ID - 2nd Stage Gas Compression Air Coolers
- BK-GCS-PEDCO-120-PR-PI-0012 P&ID - 2nd Stage Gas Compression Discharge Drum
- BK-GCS-PEDCO-120-PR-PI-0013 P&ID - Gas Compression Dehydration Package
- BK-GCS-PEDCO-120-PR-PI-0014 P&ID - Lean Glycol Storage Tank
- BK-GCS-PEDCO-120-PR-PI-0015 P&ID - Instrument & Plant Air System
- BK-GCS-PEDCO-120-PR-PI-0016 P&ID - Nitrogen Generation System
- BK-GCS-PEDCO-120-PR-PI-0017 P&ID - Close Drain System
- BK-GCS-PEDCO-120-PR-PI-0018 P&ID - Corrosion Inhibitor Package
- BK-GCS-PEDCO-120-PR-PI-0019 P&ID - Methanol Injection Package
- BK-GCS-PEDCO-120-PR-PI-0020 P&ID - LP Flare System
- BK-GCS-PEDCO-120-PR-PI-0021 P&ID - Oily Water Sewer
- BK-GCS-PEDCO-120-PR-PI-0022 P&ID - Fuel Gas System

- BK-GCS-PEDCO-120-PR-PI-0023 P&ID - Diesel Oil System
- BK-GCS-PEDCO-120-PR-PI-0024 P&ID - Potable Water System
- BK-GCS-PEDCO-120-PR-PI-0025 P&ID - Glycol Sump Drum

Note: This document shall be used in conjunction P&IDs and PFDs of each work packages of the Project .

3.4 ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No.BK-GNRAL-PEDCO-000-PR-BD-0001.

3.5 ORDER OF PRECEDENCE

In case of any conflict between the contents of this document or any discrepancy between this document and other project documents or reference standards, this issue must be reported to the CLIENT. The final decision in this situation will be made by CLIENT.

4.0 ABBREVIATIONS

FAT	Factory Acceptance Test
TRV	Temperature Relief Valve
PSV	Pressure Safety Valve
PRV	Pressure Relief Valve
QA	Quality Assurance
QC	Quality Control
UPS	Uninterrupted Power Supply
SAT	Site Acceptance Test
IPE	Instrument Protective Earth
IE	Instrument Earth
ISE	Intrinsically Safe Earth
ER	Electrical Resistance
LPR	Linear Polarization Resistance
ITR	Instrument Technical Room
CCR	Central Control Room
DCS	Distributed Control system
PCS	Process Control System
ESD	Emergency Control System

5.0 GENERAL REQUIREMENTS

5.1 UNITS OF MEASURMENT

For the whole project, engineering calculation results, instrument ranges and control settings shall be presented in SI units.

The following metric units shall be used for process data and instrument scales:

Flow

Liquid (volume)	m3/h l/h (Litre per hour) GPM (Gallons per Minute)
Liquid (mass)	kg/h (kilograms per hour) or t/h (tonnes per hour)
Gas, Vapor	kg/h (kilograms per hour) or t/h (tonnes per hour)
Gas	*Nm3/h
Steam	kg/h (kilograms per hour) or t/h (tonnes per hour)

Level

General	%
Gauging	m, cm, mm
	Pressure
Gauge	barg, mbarg
Absolute	bara
Vacuum	barg, mbarg
Differential	bar, mbar, mm H2O
Temperature	°C
Viscosity	cP
Density	kg/m3
Velocity	m/s
Nominal pipe diameter	Inch
Rotation	rpm (rotation per minute)
Linear velocity	m/s (meter per second)
Power	kW or kVA
Voltage	V (volt)
Current	A (ampere)

Volume

Liquid	m3
Gas	*Nm3

5.2 INSTRUMENT POWER SUPPLY

- The instrumentation power except local control panels, level gauge illuminators shall be distributed from main Instrument power distribution panels located in auxiliary room.

- Main Instrument power distribution panels shall be fed from one dual redundant 110 VAC 50Hz UPS feeder and one single 110VAC 50Hz Non-UPS feeder for cabinet accessories/lighting, sockets…. UPS has battery for a period of 2 hours back-up.
- Solenoid valves shall be powered by 24 VDC generated by control system.
- F&G system components located in CR or cabinet room shall be powered from the 24 VDC power supply which is totally independent and provided by battery for a period of 24 hours back-up (24 hours back up for system normal operating without alarming devices and at the end of this time 5 minutes for activation of all alarming devices). Battery charging shall be automatic, with double battery chargers

5.3 INSTRUMENT EARTHING

For instrumentation, three (3) dedicated earthing network shall be used.

- Instrument Protective Earth (IPE) :
  Field instrument enclosures, cable armor, supporting arrangements, tray and junction boxes, cabinets shall be earthed to the IPE.
- Instrument Earth (IE) :
  It shall be used for earthing the screens of cables, except those carrying intrinsically safe signals.
- Intrinsically safe earth (ISE) :
  It shall be used for earthing the screens of cables carrying intrinsically safe signals through the galvanic isolated barriers bus bar.

Impedance of IE & ISE shall be less than 1 Ohm.

5.4 SIGNAL TRANSMISSION

- All analogue instrument devices shall be 4-20mA, HART Protocol type.
- Solenoid valves shall be 24 VDC.
- Multi-core cables shall be laid from each ITR to substation for hardwired signals connected to MCC through Electrical Marshalling cabinet installed in substation.
- Command signals shall be transferred from PCS/DCS/ESD to MCC via hardwired signals through Electrical Marshalling cabinet installed in substation. These signals shall be provided by dry contact of relays in PCS/DCS and ESD individual marshalling panels located in ITR.
- Status signals shall be transferred from MCC (Electrical Marshalling cabinet) to DCS/ESD. These signals shall be wetted by Electrical to drive relays in PCS/DCS and ESD individual marshalling panels located in ITR.
- Hardwired digital signals between PCS/DCS/ESD and PLCs shall be wetted (powered) by destination system.

- Major subsystems (such as ESD, FGS, UCPs, HVAC) shall be linked to the PCS/DCS via redundant serial link, generally with MODBUS RTU serial link for monitoring (command, shutdown , ... signals between subsystems and ESD shall be transmitted via hardwire).
- Instrumentation signals shall be segregated according to their nature (IS, NIS, Analogue, Digital, Solenoid, Power) and system (PCS/DCS, ESD, UCP) they belong to ,and separate Junction boxes shall be provided.

5.5 IDENTIFICATION & MARKING

- All instruments shall be identified by unique tag number. Format of this tag number is specified in “Piping and Instrumentation Diagram (P&ID) legend and symbol” .
- All instrumentation equipment shall be provided with permanent identification of instrument tag number. Nameplates for field-mounted instruments shall be stainless steel. Tags and nameplates shall be held in place with self-tapping stainless steel screws or rivets Instrument nameplate shall be stamped as follow:
  - Manufacturer’s Name
  - Model Number
  - Serial Number
  - Instrument Tag Number
  - Supply Voltage
  - Range
  - Output Signal
  - Hazardous Area Certification
- Terminal strips shall be furnished with the terminal makers. Wire markers shall be installed on the wires inside panels and junction boxes at their termination point. Cable markers shall be installed to identify field cables inside panels and junction boxes.

5.6 HAZARDOUS PROTECTION

Gas group and ignition level (temp class) will be in accordance with area classification according to IEC and CENELEC.

Classification of hazardous area shall be defined in accordance with API 500 & 505, while zone definition shall be based on IEC 60079.

All electrical or electronic instrumentation equipment shall confirm to electrical area classifications. The type of protection for electrical or electronic instruments or devices for use in hazardous area shall be as follows:

Equipment	Zone 0	Zone 1	Zone 2
General Instruments	EEx ia	EEx i	EEx i
Thermocouples/RTD	EEx ia	EEx i	EEx i
Switches	EEx d	EEx d	EEx d

Equipment	Zone 0	Zone 1	Zone 2
Valve Positioners	EEx ia	EEx i	EEx i
Lamps	Shall not install	EEx d or EEx e	EEx d or EEx e
Solenoid Valves	EEx d	EEx d	EEx d
Local Panels	Shall not install	EEx d or EEx p	EEx d or EEx p
Junction Boxes	Shall not install	EEx d or EEx e	EEx d or EEx e
Level Gauge Illuminator	EEx d	EEx d	EEx d
F&G Devices	EEx d	EEx d	EEx d

In case EExi apparatus is not available in the manufacturer's standard products, type EExd can be selected as an alternative for Zone 1 and 2 installations.

Industrial type non classified instruments could be utilized in non-hazardous safe area.

All electrical apparatus in hazardous area shall be certified to CENELEC for the European countries or the recognized authority in the manufacturer country i.e.:

PTB : For Germany
BASEEFA : For England
LCIE : For France
CESI : For Italy
CSA : For Canada
INIEX : For Belgium
F.M. : For USA
U.L. : For USA
J.I.S. : For Japan

5.7 INTERFERENCE PROTECTION

All instruments and micro-processor based system shall meet the following Radio Frequency Immunity (RFI) requirements that shall be tested at the acceptance test stage. Basic reference standard is IEC 60801 (part 3) for design and manufacturing considerations.

5.8 LIGHTNING PROTECTION

Transmitters should be equipped with suitable lightning protection.

Hazard due to the lightning shall be considered in the installation of instruments and cables.

5.9 INGRESS PROTECTION

Instrument enclosure's "degree of protection" shall be in accordance with IEC 60529. The degree of protection for junction boxes (containing terminals only) shall be IP 65.

For enclosures containing electronic components or coils (solenoid valves) the minimum degree of protection shall be IP 65. Large size outdoor local panels, for which IP 65 may not be applicable, shall be pressurized.

Minimum ingress protection for all indoor panels shall be IP 54. All field instruments shall be both operable and storable in site condition. Protection / heating box shall be supplied as far as required and sunshade for field instruments shall be considered if instruments are under direct sun light.

All instruments shall be suitable to utilize in tropical condition and must completely meet and comply with the environmental conditions of the site. In tropical condition all printed circuit cards shall be protected against corrosion and humidity by means of appropriate varnish coating and gold plated contacts on connectors (even for those located within control and technical rooms).

5.10 TROPICALISATION

Tropicalization shall be applied to protect electrical circuits and electronic cards from being degraded by corrosion and/or fungus growth.

All printed circuit boards shall be suitably coated with a coating, which has proven to be effective in the protecting of circuits and components.

All electric materials shall be designed and manufactured using non-hygroscopic, non-nutrient materials in order to reduce fungus growth susceptibility.

Wiring insulation materials shall be resistant to fungus growth.

5.11 NACE REQUIREMENT

All the wetted parts in sour service shall be in accordance with NACE MR-01-75/ISO 15156 standard as per “Piping Material Specification.

5.12 PAINTING

The paint system that is supplied on all instrumentation must be able to meet the harsh environmental conditions experienced at the plant site. Manufacturers’ standard finish that meet or exceed these requirements may be accepted upon customer approval.

6.0 FIELD SENSORS

- The same type of instruments shall be used for control of utilities and for process control.
- Safety components shall be completely independent from process control component.

- Instruments for subcontracted assemblies shall be of the same type and same supplier as those used for the process; in the negative, suppliers shall comply with the COMPANY VENDOR List.

The following requirements with respect of field instrumentation shall be implemented:

- Materials exposed to the process fluid shall be in accordance with the fluid conditions (pressure, temperature, corrosion, etc.) and with the relevant piping class
- For parts exposed to process fluid the following items shall be considered (unless other consideration specified):
  - Measuring element and other wetted parts of all field sensors/transmitters shall be 316 Stainless Steel as minimum.
  - For pressure and differential pressure transmitter, element material shall be AISI 316 as a minimum standard, where the nature of fluid requires a higher alloy or other material, the material shall be consistent with the piping or equipment specification.
  - All inserted instruments (e.g. thermowell) shall require the supply of wake frequency calculation according to ASME PTC 19.3
  - Moving parts for instruments (e.g. pressure, differential pressure, temperature gauges) shall be stainless steel or better when specified.
  - All inserted instruments (e.g. thermowells, sampling probes, pig detectors, etc.) shall be specified as per the process data sheet including all service conditions (pressure, velocity, temperature, density, fluid composition) which shall be provided by CONTRACTOR.

- NACE MR 01-75 or MR 01-03 Latest Edition requirements shall be applied in case of sour service.

6.1 CONNECTION ON PIPING AND EQUIPMENT

Specifications for instrument connection on piping and block valves, minimum flange rating for instrument connection = 300 lbs

INSTRUMENT			TYPE AND SIZE OF CONNECTION
To Piping	Orifice flange and nozzles		½ in.
	Annubar or pittot tube	Flanged	2in.
	Thermowells	Flanged	1 ½ in.
	Pressure Instrument and Bourdon tube pressure gauges		1/2 in. Flanged*[2]
To Equipment	Thermowells	Flanged	2in.
	Pressure instrument and Bourdon tube pressure gauges		2in. Flanged
	Displacer	External	2in. Flanged
		Internal	4in. Flanged
	level switch	External	2in. Flanged
		Internal	4in. Flanged
	Differential pressure		2in. Flanged*[3]
	Gauge Glasses		2in. Flanged
	Magnetic Level		2in. Flanged
STAND PIPE	Displacer	External	2 in. Flanged
	level switch	External	2 in. Flanged
	Differential pressure		2in. Flanged
	Gauge Glasses		2in. Flanged
	Magnetic Level		2 in. Flanged

Notes:

1. Valve type as per piping specification
2. Diaphragm seals on pipe and vessels for pressure/flow indicators/transmitter should be considered 2 in.
3. D/p cells for level with remote diaphragm seals dia. 3 in. Flanged connection and first block valve (except where not required by Licensors).
4. Standpipe dia. 3 in. With dia. 3 in. Vessels connection.

7.0 LOCAL SWITCHES

- Process variables used for initiating the shutdown systems shall be derived, as a general rule, from the electronic transmitter signals. The threshold function shall be achieved within safety systems logic.
- Local switch is forbidden for temperature, pressure and flow process alarm; local switches may only be used for mechanical equipment if required by VENDOR standard and will be subject to CLIENT approval.
- When switches are used as sensing devices, they shall have normally closed contact to open on trip condition.
- When they are provided for safety purpose, in non-fail-safe configuration, they shall include a resistor for line monitoring.

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- For other switches such as vibration switch,…., general requirement of below sections (for example: pressure switch) to be considered.

7.1 PRESSURE SWITCHES

- Pressure switches for direct connection normally shall be of the diaphragm type, diaphragm sealed piston type or bourdon tube type
- Switch element shall be of the micro switch snap action type and hermetically sealed. Micro-switches shall be two double pole double throw (DPDT) type
- The switch contact rating shall be 110VAC @10Amp.
- Repeatability shall be ±1% or better of full scale
- The pressure switch internals in contact with the process (wetted parts) shall be 316 stainless steel, unless different material is required due to process conditions.
- The pressure element shall be designed to have an over-range protection rating of at least the design pressure of the process line or vessels.
- The accuracy of the pressure switch assembly shall be at least 1% of the span
- The set point shall be field adjustable over the full range of the switch. The set point adjustment should be internal or enclosed.
- Pressure element connection shall be ½” NPT.
- Where differential pressure switches are required, they shall have fixed differential and adjustable set point.
- Over pressure shall be at least 30% of full scale.
- Dead band shall be less than 1% of span. The dead band shall be field adjustable.
- Switches sensors shall be operate at least 1.5 design pressure.
- The ambient Temp. effect should be ±0.2% URL (Upper range limit) and static pressure effect should be ±0.5% URL. Final values to be advised by vendor.
- The pressure switches shall meet the hazardous area explosion proof requirements of section 5.6 and the weatherproof requirements of IP-65 as per IEC-60529.

7.2 TEMPERATURE SWITCHES

- Temperature switches shall be direct mounted liquid filled or gas filled type. Switches shall be fully compensated against variations in the ambient temperature
- In general, the sensing element (bulb) and capillary material shall be 316 stainless steel, unless the process conditions dictate the use of other materials.
- The accuracy of temperature switches assembly shall be better than 1% of span.
- Unless stated otherwise, the bulb connection shall be 1/2” NPT male and the bulb diameter shall be 10 mm.
- Switch element shall be of the micro switch snap action type and shall be hermetically sealed. Micro-switches shall be two double pole double throw (DPDT) type.
- The switch contact rating shall be 110VAC @10AMP.
- Temperature switches shall be supplied with protection wells.
- Dead band shall be less than 1% of span. The dead band shall be field adjustable.
- The set point shall be field adjustable over the full range of the switch. The set point adjustment should be internal or enclosed.
- The temperature switches shall meet the hazardous area explosion proof requirements of section 5.6 and the weatherproof requirements of IP-65 as per IEC-60529.

7.3 LEVEL SWITCHES

- The External float-type level switches shall be supplied with float chambers, having a flanged closure for easy internal inspection. The material for the float chamber and the float depends on the process condition. However, the minimum requirement for the float material shall be 316 stainless steel.
- The switch element shall be of the micro switch snap action type and shall be hermetically sealed. Micro-switches shall be two double pole double throw (DPDT) type.
- The switch contact rating shall be 110VAC @10AMP.
- Unless stated otherwise, process connections shall be 1” or 2” flanged and electrical connections shall be ISO M20.
- Internal displacer or float-type level switches shall have 4” steel flanges for top mounting on pits and miscellaneous vessels. Flange rating shall be minimum 300# RF.
- Internal stilling well should be supplied by the Vendor, and should have an inside diameter of at least 25mm larger than the displacer or float diameter.
- The stilling well shall be open at the bottom end, and should have a vent hole located above the maximum level.
- The level switches shall meet the hazardous area explosion proof requirements of section 5.6 and the weatherproof requirements of IP-65 as per IEC-529.

8.0 TRANSMITTERS

- Transmitters shall be of the smart transmitter type with HART communication protocol, except those connected to the ESD/HIPPS/FGS system that will be preferably of conventional electronic type. If smart type transmitters are selected for ESD application they shall be configured as “write protected”.
- If control and safety transmitters are provided at the same location the ranges for both transmitters should be the same. Saturated signals under normal operating conditions shall be avoided (e.g. a small range transmitter signal for Low Low level detection).
- The design of pressure parts shall be based on the allowable stresses of the ASME.
- All components, particularly if containing electric contacts, shall be vibration resistant.
- In-line instruments shall have flanged connections.
- All instruments shall have an over-range protection up to the maximum design static pressure indicated on the instrument data sheet.
- Instrument exposed to vacuum shall have under-range protection to full vacuum.
- Integral digital indicators (local LCD indication) shall be supplied for each transmitter.
- All transmitters (pressure, flow, temperature etc.) shall be provided with burnt-out protection.
- Transmitters shall be provided with test terminal and bypass diode to facilitate field testing without disconnecting or connection of field mounted signal indicator, either integral with or remote from its transmitter. Transmitters shall be reverse polarity protected.
- All Transmitters in general should be supplied as a head mounted or integral part of the instrument.
- As the minimum, for all transmitters, two sets of hand held communicator is required.
- Circuits shall ensure system continuity, in case of local indicator failure or removal.
- Square root extraction shall be included in the Differential Pressure Flow Transmitter.
- The transmitter span shall be adjustable over the entire range of the measuring element and shall be provided with positive locking device
- The Differential Pressure Transmitters shall be able to withstand the application of the maximum service static pressure to the "low" pressure side, with the "high" side at atmospheric pressure, without any adverse effect or requiring recalibration.
- Where remote transmitters or electronics is required suitable cabling to interconnect sensor to the transmitter, is part of the Instrument Supplier’s supply.
- Pressure and differential pressure transmitters’ sensors shall be able to withstand a minimum of 1.3 times the system design static pressure.
- Transmitters shall operate from a remote power supply of 24VDC.
- Electronic field sensors shall be based on Intrinsically Safe EExi sensors and the weatherproof requirements of IP-65 as per IEC-60529.
- Electrical connections shall be ISO M20.
- Gas group and temperature class shall be in accordance with the area classification as defined by IEC codes.

- All unused instrument connections shall be plugged with a plastic plug for protection prior to Installation.
- Span and zero adjustment on transmitter shall not interact.
- Transmitters shall be installed on a 2” vertical pipe. All mounting accessories to achieve this mounting shall be provided with the instrument.

8.1 HOUSING/ WETTED PART MATERIAL OF TRANSMITTERS:

- Unless otherwise specified, enclosure material of transmitters shall be low copper die-cast aluminum.
- Measuring element and other Wetted parts including sensing elements shall be of AISI 316 stainless steel except where the process condition requires other materials.
- Where the nature of fluid requires a higher alloy or other material, the materials shall be selected according to the application from: S.S 316 L, Tantalum, Monel, Hastelloy C, etc., according to NACE MR-01-75 and piping or equipment specification.
- Local receiver shall be purchase by Transmitters if it is required based on reference PID, Local receiver shall wired in series loop with transmitters, the LCD shall have minimum 15 digits.

8.2 ACCURACY OF TRANSMITTERS:

Accuracy of Electronic transmitters: ±0.1% of calibrated span or better.

8.3 MANIFOLD:

- If there is no any Diaphragm seal type transmitters, In addition to the process (or piping) isolation valve at the measurement take-off point, each pressure Transmitters shall be provided with a dedicated manifold valve to enable maintenance, in-situ calibration, venting and draining. The manifold valves shall be provided as follows:
  - 2-valve for pressure transmitters
  - 5-valve for Differential Pressure transmitters
    If Diaphragm sealed is used for transmitters, so Flushing or drip ring shall be used.
- Process connection of the manifold valves shall be ½ inch NPTF.
- The manifold valves on Pressure and differential transmitters shall be bracket mounted type with the base bracket mounting holes such that the instruments can be directly connected to the manifold valves, and the assembly can be installed and supported on 2" stanchions by bracket mounted manifolds.
- As a minimum, material of the manifold valves shall be AISI 316 stainless steel.

8.4 DIAPHRAGM SEAL AND CAPILLARY SEALS:

- Diaphragm seal shall normally be integral with the instrument and material shall be minimum SS316.

- For remote seal applications, capillaries shall be kept as short as possible (at least 1 meter) and shall not exceed 6m. For differential pressure applications the capillary shall be of the same length.(For diff pressure transmitter with Diaphragm seal located on column or reactor , it is better to consider the height of column/reactor and location of DPT for capillary , if the length will be more than 6m so the selection of DPT shall be changed to Two PT and the differential will consider in control system) .
- The capillary tubing material shall be of AISI type 316 type stainless steel as a minimum and be shielded by flexible stainless steel tubing with PVC cover, according manufacturer's standard.
- When H2 penetration exist in gas services with diaphragm seal, the gold plated shall be used on 316SS except for ceramic type diaphragm seal which gold plate is not required. Ceramic type diaphragm seal is not tolerable for suddenly change in temperature.
- Diaphragm seal elements may be used to eliminate purging, winterizing and corrosion except for vacuum services.
- For measurement of viscous fluids, fluids containing solids, highly corrosive fluids or where temperature changes may influence the fluid conditions, the use of remote diaphragm seals and capillaries may be considered

8.5 SWITCHES

- Process variables used for initiating the shutdown systems shall be derived, as a general rule, from the electronic transmitter signals. The threshold function shall be achieved within safety systems logic.
- Local switch is avoided for temperature, pressure and flow process alarm; local switches may only be used for mechanical equipment if required by Supplier standard and will be subject to purchaser approval.

8.6 GLAND CONNECTION

Cable entry to instruments shall be M20 *1.5 for single pair cable connection with the appropriate cable gland.

9.0 FLOW INSTRUMENTS

- The flow measuring devices shall preferably be square edge concentric plates flange taps connection. Other type of flow measuring devices as described below may be considered depending on process parameters, accuracy and range-ability points of view.

9.1 ORIFICE PLATE

- Orifice plates shall be used for liquid, vapor and gas services.
- Manufacturing of orifice plates shall be generally in accordance with ISO 5167 standard or AGA Report No 3 for Natural Gas metering and BS 1042.

- According to IPS-E-IN-130, page 13 of 83, clause 5.1.2 d/D (β) Ratio:
- Orifice diameters should be selected so that the ratio of orifice diameter to actual internal pipe diameter, d/D, does not exceed the limits as shown on MPMS 14.3, as follows:

  1) With meters using flange taps, β shall be between 0.15 and 0.70.

  2) With meters using pipe taps, β shall be between 0.20 and 0.67.

- With either type of pressure taps, diameter ratios as low as 0.10 may be used while ratios as high as 0.75 may be used with flange taps and as high as 0.70 may be used with pipe taps. The flow constants, Fb, for these extreme values of β are subject to higher tolerances, and it is recommended that the use of these extreme ratios be avoided (see MPMS 14.3).
- When using small bores, care should be exercised to prevent plugging by pipe scale or other foreign material.
- Concentric, sharp edged orifice plates with flange taps shall be used in most applications. The use of eccentric orifices shall be limited to gases containing liquid, liquids containing solid particles, or liquids containing gas.
- Orifice plate material shall generally be Min SS 316/316L. Orifice tag number, material, direction of flow, nominal diameter and bore diameter shall be
- The preferred differential pressures for sizing purposes shall be zero to 12.5, 25, 50, 125, 250, 500, 1000, and 2000 mbar. The desired range is 0 to 250 mbar whilst ranges of 2000 mbar and above should be avoided wherever possible. Where the range ability does not exceed 3:1, a single transmitter shall be used.
- Meter range shall be selected in accordance with the following:

  a) For orifice meters, normal flow rate shall be between 70% and 80% of capacity, provided anticipated minimum and maximum flow rates will be between 30% and 95% of capacity;

  b) If rangeability larger than 30% to 95% is required, two differential pressure transmitters connected to the same orifice taps shall be used.

- Only for quadrant edge corner taps, BS 1042 should be used instead of ISO 5167. The correction of the calculation due to presence of a drain or vent shall be in accordance with BS 1042.
- Orifice plate thickness:

Pipe size Nominal diameter (inch)	Plate Thickness (mm)
d ≤ 8″	3.2
8"< d ≤ 14″	6.5
14" < d ≤ 24″	10
24″ < d ≤ 30″	15

- Orifice plates shall be used only for line sizes 2” up to 30” (if the line size is less than 2” an integral meter run shall be used). Drain hole for vapor service and vent hole for liquid service shall be provided for the orifices in horizontal runs, as specified on the individual data sheets.
- The minimum orifice flange rating shall be ANSI 300 # RF.
- The orifice flange shall be weld neck type as per ANSI B 16.36.The threaded connections for the pressure taps on the orifice flanges shall be ½” NPT. The tap sizes will be specified on the individual data sheets. Four (4) hex head plugs (Two (2) per flange) shall be provided into the pressure taps. The plugs shall be of the same materials as that of the flanges. Two (2) jackscrews shall be provided for one pair of the orifice flanges. The materials shall be the same as the flanges. The orifice flange materials will be specified on the individual datasheet as per piping classes. Gasket contact surface finishes shall be as follows:

    a) For Raised Face (RF): Flange raised face shall be smooth finish, 125 to 250 Ra in accordance with ANSI B 46.1 regardless of gasket type, flange rating and/or handling services.
    b) For Ring Type Joint (RTJ): Side wall surface of gasket groove shall not exceed 63 micro inch (1.6 micron) roughness.

- Finishes shall be judged by visual comparison with surface finish roughness standard confirming to ANSI B 46.1. Flanges shall be protected over the entire gasket surfaces adequately for shipping. Bolts and nuts for the orifice flanges shall be supplied by VENDOR.
- On the handle of Orifice, these data shall be engraved by vendor:

    Tag Number
    Material
    Direction of Flow
    Inside Pipe Diameter
    Bore Diameter

9.1.1 Restriction Orifice Plate

- Multi holes Restriction orifice shall be used when Noise will be more than 85 dBA.
- Restriction orifice plates shall be constructed with a thickness specified at full rating. The thickness will be indicated on the individual VENDOR data sheets.
- Restriction orifice plate material shall generally be stainless steel AISI 316
- Other suitable materials shall be selected depending on the process fluid and as specified on individual data sheets.
- Drain/weep holes shall not be provided on the restriction orifice plates.
    - Orifice bore shall not be beveled for the restriction orifice plates.

- Each restriction orifice plate shall be provided with a corrosion resistant tag that projects beyond the flange. The tag shall be stamped with the material, bore diameter, thickness, I. D. of the pipe and identifying tag number.

9.1.2 Retractable Orifice

- Retractable orifices shall have the following characteristics:
  - Carbon steel flanged body with flanges according to classes of piping specification,
  - Plates retractable while process is operating,

- Plate shall be fitted with :
  - Mechanical lifting system allowing easy lifting operation even in the case of large pressure drops and large sized orifices.
  - Suitable safe isolation from process (double seals).
  - Due consideration shall be given to retractable orifice seals in term of gas composition and risk of explosive decompression of the seal.
  - Venting and/or draining facilities if needed.

- The required number of plates to permit flow measurement over the range stated on the datasheet.
- The size of each plate on the basis of approx. 3:1 flow turndown with overlap of flow ranges between plates as necessary.
- The selected differential pressure span shall be fixed for all plates.
- Each plate shall show the instrument tag number suffixed by a unique letter of the alphabet and its bore diameter.
- Pressure taps for retractable orifices shall be sized 1/2" NPTF.

9.1.3 Calculation

- The calculation of orifice plates shall be in accordance with ISO-5167/5168 standard.
- Flow rate to be measured shall be kept between 30% and 90% of the design flow.

9.1.4 Major features for Orifice Plates:

- Orifice plates shall be calculated at 110% of the design process maximum flow rate.
- Square root extraction shall be carried out within the control system.
- The primary elements shall be sized for use with differential pressure transmitters having a range of 0-250 mbar.
- Other ranges: 0-12.5, 0-25, 0-50, 0-125, 0-500, 0-1000, may be used if required by process conditions.
- The preferred range is 0-250 mbar; the range 0-1000 mbar should be avoided where possible. In case of compressible fluids, the selected differential pressure shall preferable not exceed 3.6% of the upstream static absolute pressure.

- The d/D ratio shall normally be between 0.25 and 0.75.
- The correction factor for viscosity and Reynolds numbers shall be taken as 1.0 for orifice bore calculations unless an estimated viscosity is shown on the individual data sheets.

9.1.5 Integral Orifice Transmitter

- The use of integral orifice transmitter, which may be required for flow metering in small lines shall be used only when plugging is not expected and if a bypass line is provided. Orifice meter runs are considered to be “in-line” instruments and will preferably be fabricated with flanged end connections. Integral orifice flow meters shall be used if the line is less than 2 inches in diameter.

9.2 VENTURI

- Venturi tubes may be selected for non-viscous fluids when relatively high accuracy is required with a low pressure drop in the system. Rectangular types will be considered for application in air ducting systems.
- Sizes can range from 2” diameter to 40” diameter.
- Venturi tubes and flow nozzles of circular cross section shall be sized and constructed in accordance with the requirements of ISO 5167.
- Venturi or low loss flow tubes shall be used where good pressure recovery is essential. Applications are on liquids, gases and steam.
- Flow range is limited only by minimum and maximum beta ratios.
- The upstream and throat pressure tappings shall be made in the form of separate pipe wall
- pressure tapping interconnected by annular chambers, where the services are dry gases or liquids.
- Minimum of four Pressure tappings on each annular chamber for Venturi tube shall be provided for the entrance section and the throat section.
- Pressure tapping for Venturi tubes shall be ¾” NPT threaded as shown on the individual data sheets in accordance with each line class.
- Venturi tubes shall have flange type of connection; the minimum rating shall be 300#.
- Gasket contact surface finishes shall be as follows:
  - Flange Face Finish
- Surface roughness shall be in accordance with ASME 16.5;
  - 125 to 250 AARH for raised Face Flanges and Flat Face Flanges
  - 63 AARH for Ring Joint Flanges

9.3 VORTEX

- Vortex meter may be considered for clean liquids, gases and steam measuring application with higher turndown ratio.
- vortex flow meters shall not be used in the following applications:

- Wet steam,
- Liquids with high vapour pressures,
- Viscous fluids,
- When the fluid of a control valve mounted upstream or downstream of the vortex flow Meter is flashing or cavitation,
- Pulsating flow (e.g. downstream reciprocating compressors),
- When the pipeline in which the vortex flow meter is installed is subject to vibration.

- Vortex meters are particularly useful where the installation of orifice plate and d/p transmitter(s) becomes too complex due to turndown ratio.(Turndown ratio of a vortex is around 20:1 for liquids and 15:1 for gases)
- The points shall be taken into consideration are:
  - The maximum allowable operating temperature,
  - The maximum allowable line size (8" typical),
  - The minimum allowable pipe Reynolds number (20 000 typical).

- The use of vortex meters may be considered for liquid flows containing neither vapors, nor dust, nor solid particles. Vortex meter application may also be considered for dry gas flows.
- Vortex meter body shall be Flanged and made of ANSI 316 stainless steel unless the operating conditions require a more adequate material.
- Where no restriction or a range-ability of more than 3:1 is required, Vortex Flow Meters shall be utilized, where the required flow meter ranges are very wide and the orifice-type flow meters cannot be applied.
- The performance of the instrument shall have repeatability ± 0.25% of flow rate.
- Vortex meters shall be avoided on services that are dirty, abrasive, viscous, or mixed flow (gas with liquid droplets, liquid with vapour bubbles).
- Vortex meters shall have ASME flange process connections to ASME B16.5 .
- Flanges shall be protected over the entire gasket surfaces adequately for shipping.
- NACE material requirements shall be in accordance NACE MR 01-75.
- Vortex Flow Meters shall have HART Smart 4 to 20 mA analogue outputs with 24 V DC two-wire systems, derived from Control System.
- The VENDOR shall inform the EPC CONTRACTOR of the minimum working voltage of the Vortex Flow Meter.
- Vortex Flow Meters shall meet electrical certification requirements as indicated on the individual data sheets. Hazardous area applications shall meet Explosion Proof EExd or Exi requirements.
- Ingress protection and weatherproof requirements shall be IP65 as a minimum.
- All electrical or electronic connections shall be supplied with the threaded electrical connection to
- ISO M20x1.5.

- Flow direction shall be clearly and permanently stamped on the meter body.
- The accuracy of the meter shall be ± 0.5% of F.S for liquid service and ± 1% of F.S for gas service
- Gasket contact surface finishes shall be as follows:
  - Flange Face Finish
- Surface roughness shall be in accordance with ASME 16.5;
  - 125 to 250 AARH for raised Face Flanges and Flat Face Flanges
  - 63 AARH for Ring Joint Flanges

9.4 PITOT TUBE (ANNUBARS)

- For low differential pressure drops averaging type Pitot-tubes can also be used.
- Pitot elements shall be provided if accuracy below 1.0% range is not required or if the pipe diameter is too large for an acceptable orifice design based on price and accuracy required.
- Annubars shall be utilized in large pipe diameters and where accuracy is not a critical factor. Same accuracies as orifice plates can be achieved with careful installation.
- Annubar tube length and active length shall be designed to suit the pipe diameter, and in cases where deflection or oscillation may occur, it shall be supported or secured at the opposite side.
- Annubars shall have minimum 3” flanged connections. Flange rating and material shall be as per the pipe specification.
- Tube material shall be AISI 316 stainless steel as a minimum.
- The head shall have 316 stainless steel connection block with ½” NPT(F) ports.
- Instrument connections shall be supplied complete with ½” NPT stainless steel valve and nipple.
- The DP flow transmitter shall be supplied separately.
- Annubars can be used on liquid, gas, and steam services.
- Annubar shall be retractable while process is in operation.

9.5 VARIABLE AREA FLOW METERS (ROTAMETER)

- The use of variable-area flow meters shall be restricted to simple local indication applications, such as measurement of purge, cooling or sealing fluids, or in sample loops for on-line process stream analyzers, Variable Area flow meters may be used for small flow rates or where reading with low accuracy or where local indications.
- They may also be used where rangeability, non-linearity, viscosity or the hazardous nature of fluid makes the differential pressure-type instrument unsuitable.
- Variable Area flow meters shall normally be the armoured type with magnetic pick-up. ANSI 316 stainless steel tube is preferred unless the operating conditions require a more adequate material.

- Rotameters may be used on liquids, gases and vapour services in vertical pipes. Several designs
- exist which are commonly used as purge meters. Rotameters are normally used in small pipe sizes.
- Meter bodies shall be equipped with inlet and outlet float stops, and where feasible, clean out plugs, which may be utilized as connection taps.
- Indicating scales shall have full length safety glass shielding which has gasket in both sides and should be approximately 125mm in length for extension meters used for transmitting service or for armoured meters, and 25mm in length for local indicators not of the armoured type.
- The armoured variable area flow meter shall have a metal metering tube with a magnetic type extension attached to the float; the pressure rating shall be compatible with the maximum process conditions.
- Rotameters used for flushing of instrument lines or dip-tube level measurement may be of the glass type tube if the two following conditions are present:
  - The flushing fluid is non-hazardous, i.e. instrument air, nitrogen ect.
  - Operating pressure is low

- Gland assemblies shall be of “O” ring construction, unless process conditions noted on the individual data sheet require otherwise.
- Tube construction shall be beaded, ribbed or flat except for the plain tapered tubes used for armoured type. Plain tapped tubes shall have internal guiding.
- Floats shall be self-cleaning and shall be designed for maximum immunity to viscosity variations and dimensional stability.
- Rotameters shall be completely assembled with all accessories before shipping with the orientation of connections as noted on the individual data sheet.
- Accuracy shall be within 2% of full scale.
- Flanged Rotameters shall comply with ASME B16.5 requirements. Flanges shall be protected over the entire gasket surfaces adequately for shipping.
- When any transmitters are specified on the individual data sheet, Rotameters shall be supplied with their associated transmitters.
- The type of protection for the electrical components shall be as specified on the individual datasheet. Hazardous area applications shall meet Explosion Proof EExd or Exi requirements. Ingress protection and weatherproof requirements shall be IP 65 as a minimum.
- All electrical connections shall be supplied with the threaded connection ISO M20x 1.5.
- The flow direction shall be clearly and permanently stamped on the meter body.
- Local indicator can be of mechanical pointer or digital LCD type.
- Unit for Rotameter shall be GPM (Gallons per Minute) or l/hr (Litre per hour) for liquid, and SCFM for air/gas.
- Gasket contact surface finishes shall be as follows:

Flange Face Finish

Surface roughness shall be in accordance with ASME 16.5;

- 125 to 250 AARH for raised Face Flanges and Flat Face Flanges
- 63 AARH for Ring Joint Flanges

9.6 POSITIVE DISPLACEMENT METER

- Positive Displacement meter may be used to measure the flow where integrated flowing quantity and high accuracy is required.
- Inlet piping to the positive displacement meter shall be equipped with a strainer.
- All P.D. meters shall be stainless steel double case type.
- Body material shall be carbon steel of the pressure rating as specified on the data sheets.
- The meter body configuration shall be constructed in order to minimize the pressure drop through the meter.
- Reset type counters with calibration adjustments shall be provided. Counters shall be equipped with shutter proof front glass.
- Straight through strainers with mesh size, material and rating, as noted on the data sheet, shall be installed preceding each meter. The Vendor shall quote suitable mesh sizes for the P.D. meter.
- According to IPS-E-In-130, Positive displacement meters have the following characteristics:

a) Typical accuracies are 0.2 percent of actual flow. Highest accuracy requires some form of meter proving. Typical repeatabilities are: 0.05 percent.

b) Rangeability is typically 10:1 or more. Positive displacement meters have good rangeability and accuracy, particularly with heavy or viscous fluids.

c) Positive displacement meters come in a range of sizes from 0.38 liter per minute (0.1 gallon per minute) to 34000 liters per minute (9000 gallons per minute) or better.

- Careful consideration shall be given to bearing type, lubrication and protection against abrasive materials.
- P.D. meters shall be monitored from the relevant control room.
- If necessary, P.D. meters shall be equipped with a local automatic temperature compensator.
- P.D. meter and their associated strainers, air-eliminators, and flow regulators shall have ANSI raised face flange process connections. Rating shall be in accordance with piping specification.
- P.D. meters and their housing shall meet the hazardous area requirements of section 5.6 and the weatherproof requirements of IP-65 as per IEC-60529.
- Electrical connections shall be supplied with the threaded connection, ISO M20x1.5mm.

9.7 CORIOLIS

- Coriolis flow meter shall be used only when flow measurement cannot be obtained by measuring differential pressure, for large rangeability, in applications where accurate measurement of mass flow or density is required or corrosive services (titanium or hastelloy internal tubes).
- Coriolis meters are not suitable on liquid services containing significant gas content, or on gas services with low in-line pressure, also slurries, compressed gases, and liquefied gases in line.
- Coriolis flow meters should be installed on line size 1/4" up to 8".
- Coriolis meters shall be used to measure liquids.
- Gas/liquid mixtures shall be avoided.
- According to IPS-E-IN-130, in Coriolis instruments, mass rate is measured at accuracies as high as Â±0.15% of full scale, and the repeatability shall be 0.25%.
- The range-ability of Coriolis meters is typically 20:1.
- Coriolis meters are capable of measuring mass flow rate, volumetric flow rate, fluid density and temperature from the same sensor.
- General installation shall ensure that the sensor is full of process fluid. When measuring liquids, the sensor must not be installed at a high point, as gas may accumulate in the sensor. Similarly, when measuring gases, the sensor must not be installed at a low point in the system, as condensation may accumulate in the sensor. If the meter is installed in a vertical line, the fluid flow shall be upwards through the sensor. Upstream and downstream straight run requirements and flow conditioning are not necessary, due to independent flow characteristics.
- The body and sensor materials shall be AISI 316 stainless steel as a minimum. Other alloys shall be used as per process fluid requirements.
- Coriolis meters shall have ASME flange process connections to ASME B16.5 in line with the pipe specification.
- Coriolis meters and associated electronic housing shall meet electrical certification requirements as stated on the data sheets. Hazardous area applications shall meet Explosion Proof EExd or Exi requirements. Ingress protection and weatherproof requirements shall be IP65 as a minimum.
- Electrical connections shall be supplied with the threaded connection ISO M20x1.5mm.
- Any special cabling between the sensor head and the electronic housing shall be supplied by the meter VENDOR. The maximum distance between the two units shall be clearly stated by the VENDOR at the enquiry stage.
- Flow direction shall be clearly and permanently stamped on the meter body.

9.8 TURBINE FLOW METER

- Turbine meter may be used for process flow measurement where highly accurate, wide range measurement of very small flow rates is required, or on clean low viscosity liquids with high range-ability requirements.
- Turbine meters shall not be installed on lines prone to vibration or close to equipment that emits electromagnetic fields
- Turbine meters shall be used in relatively clean liquids. Turbine meters shall not be used for
- viscosities higher than 10 cP.
- Turbine meters can provide range-ability of 10:1 and can be used for operational as well as custody transfer applications.
- Wetted parts shall be constructed from stainless steel (except for magnetic parts) unless otherwise specified on the data sheets.
- According to IPS-E-IN-130, Turbine meters have the following characteristics (for process flow measurement):

a) Accuracy of 0.25 percent of rate with repeatability of 0.10 percent is typical. To obtain the highest possible accuracies, some form of meter proving is required.

b) Rangeability typically varies from 7:1 to 75:1, depending on meter design, fluid viscosity, and meter size.

c) A high flow rate for a given line size is obtainable. Line velocity may be as high as 8 to 9 meters (25 to 30 feet) per second.

d) Very low flow rate designs, as low as 0.02 liters (0.005 gallons) per minute (although normally nonlinear in these ranges) are available.

e) Availability of very wide temperature ranges and pressure ratings.

f) Turbine meters are available for bi-directional flow (as a special design).

- It is preferred to use turbine meters for non-lubricating liquid services such as LPG.
- Turbine Meters shall be designed with hydraulic balance to keep the rotor in place and shall have journal bearing construction.
- Materials of construction for the journal bearing and rotor shaft shall be tungsten carbide. The
- material of construction for body and other wetted parts shall be suitable for hydrocarbon service as defined on the individual data sheet.
- The pickup shall be hermetically sealed or potted.
- Turbine Meters shall be designed for at least 130% of the flow range specified.
- Each Turbine Meter shall have a nameplate indicating the average pulse rate over the meter range specified.
- One copy of the calibration curve shall be provided by VENDOR with each Turbine Meter for
- CONTARCTOR review and approval.

- Strainers with the proper mesh size, material, and rating shall be installed preceding each meter.
- The VENDOR shall quote suitable mesh sizes for his Turbine Meters for the EPC CONTRACTOR'S review and approval.
- Turbine meters shall be supplied by VENDOR with their associated power supply units, which may have the following function in accordance with the individual requirements specified on the individual data sheets.
  a) Pulse signal repeater
  b) Pulse signal convert to analogue signal (4-20mA)
  c) Flow compensatory with temperature and/or pressure signals.

- Turbine Meters and their associated strainers, air-eliminators, and flow regulators shall have ASME flange process connections to ASME B16.5 in line with the pipe specification.
- Gasket contact surface finishes shall be as follows:
  Flange Face Finish
- Surface roughness shall be in accordance with ASME 16.5;
  125 to 250 AARH for raised Face Flanges and Flat Face Flanges
  63 AARH for Ring Joint Flanges

- Flanges shall be protected over the entire gasket surfaces adequately for shipping.
- Turbine Meters and their housing shall meet electrical certification requirements as stated on the data sheets. Hazardous area applications shall meet Explosion Proof EEXd or EXi requirements.
- Ingress protection and weatherproof requirements shall be IP65 as a minimum.
- Electrical connections shall be supplied with the threaded connection ISO M20x1.5.
- Flow direction shall be clearly and permanently stamped on the body of the meter.
- Meter accessories shall include but not limited to the following:
  a) Signal converter
  b) Flow straightener
  c) Read out electronics

- Turbine Meters require a straight length in the upstream piping. For the construction of turbine flow meters, two categories shall be distinguished according to the diameter of the pipe:
  - Type 1: Flow meters forming part of the process pipe (flanged pipe spool pieces) to 4 inches
  - Type 2: Insertion type flow meters. They shall be extractable while in operation

- Extraction and isolation system shall be part of the flow meter supply and shall be designed for safety of operators.
- 2 ½ inch turbine diameter is not allowed due to piping class constraints.

- Turbine flow meters may be protected by filters located upstream of the instruments. The filters/strainers may be temporary or permanent, especially for custody transfer metering purposes.
- Meters shall be protected, as far as practicable, against over-speed, reverse flow and shocks
- The performance of any instrument shall be as follows:
  - Meter linearity ± 0.25% or better

9.9 ULTRASONIC

- Where no restriction or a rangeability of more than 3:1 is required, Ultrasonic flow meters may be considered.
- Ultrasonic may be used for applications where minimum pressure loss is required due to the presence of flow meter, in pipelines applications with pigging requirements, or in flare lines.
- The presence of bubbles or impurities within the process fluid causes erroneous meter reading and as such care has to be taken in the application.
- Ultrasonic meters shall not be used in two-phase services.
- If Ultrasonic meters are to be implemented they shall be multi-path transit time type.
- System accuracy (meter and all compartments) shall be less than 1% of full scale. Error shall be reduced by careful determination of pipe ID and by increasing number of paths.
- Ultrasonic flow meters shall be the Transit Time / time of flight type. Single or multiple beam designs shall be considered depending on the application, the greater the number of beams, the less the sensitivity to velocity profile effects.
- Laminar or turbulent flows can be measured using the double path instrument.
- Ultrasonic flow meters shall be used for fluid measurement where no loss of pressure can be tolerated.
- Ultrasonic flow meters shall be considered for gas, or liquid without any second phase of operating conditions. Normal fluid velocities are between 0.3 and 15 m/s.
- Flow meters with insertion probes shall have retraction mechanisms to allow on stream probe maintenance.
- Clamp on type Ultrasonic flow meters shall be used only with approval from the CLIENT.
- The VENDOR shall supply the armoured signal cable and glands for connection between sensor and transmitter. Transmitter shall have Smart capabilities.
- Ultrasonic flow meters shall meet electrical certification requirements as indicated on the individual data sheets. Hazardous area applications shall meet Explosion Proof EExd or Exi requirements.
- Ingress protection and weatherproof requirements shall be IP65 as a minimum.
- Flow meters shall have ASME flange process connections to ASME B16.5 in line with the pipe specification.
- Flanges shall be protected over the entire gasket surfaces adequately for shipping.

- Materials for Ultrasonic flow meters shall be in accordance with piping specification of each line class as shown on the individual data sheets.
- NACE material requirements shall be in accordance with paragraph 11.3.5.
- Electrical power supply will be 110 VAC, 50 HZ (UPS) or 24 VDC. Signal output shall be 4-20 mA HART.
- The accuracy of the meter shall be ± 0.5% of F.S for liquid service and ± 1% of F.S for gas service.
- All electrical or electronic connections shall be threaded to ISO M20x1.5.
- Gasket contact surface finishes shall be as follows:
  Flange Face Finish
  Surface roughness shall be in accordance with ASME 16.5;
  - 125 to 250 AARH for raised Face Flanges and Flat Face Flanges
  - 63 AARH for Ring Joint Flanges

- Flow direction shall be clearly and permanently stamped on the meter body.

9.10 MAGNETIC FLOW METER

- Magnetic flow meters shall be used for volumetric flow of conductive liquids, including slurries and corrosive or abrasive materials. Where no restriction or a range-ability of more than 3: 1 is required, electromagnetic flow meters may be considered. The fluid shall have a conductivity of at least 200 µS/m at a temperature below the specified limit.
- Electromagnetic flowmeters shall not be used for measuring non-conducting fluids such as hydrocarbon liquids. Electromagnetic flowmeters generally require a high power source of electricity to generate the magnetic field.
- Bipolar pulse type magnetic flow meters with low power consumption shall be used. Power supply connections shall be made generally to the flow converter only. A power isolating switch shall be provided to facilitate local power isolation.
- Where process fluids could be abrasive, counter flanges shall be provided with detector body to prevent damage to the internal lining. Construction of coil and internal lining shall be suitable for maximum rated temperature of the fluid.
- The detector body shall have flanged connections to ASME B16.5. Flange rating and material shall be minimum ASME 300#.
- Electromagnetic flow meters and their housing shall meet electrical certification requirements as indicated on the individual data sheet. Hazardous area applications shall meet Explosion Proof EExd or Exi requirements. Ingress protection and weatherproof requirements shall be IP65 as a minimum.
- The accuracy of the meter shall be ± 1% of FS and the repeatability shall be 0.25%.
- The Velocity through the tube shall determine the meter size in conjunction with the VENDOR’s recommended velocities.

- The process conditions indicated on the individual data sheet shall be considered in the selection of the lining, electrodes, and grounding requirements.
- Materials of construction for the meter body and expansion bellow shall be defined on the individual data sheet.
- The meter installation shall assure that the meter body remains full of liquid.
- All electrical and electronic connections shall be threaded to ISO M20x1.5.
- Flow direction shall be clearly and permanently stamped on the meter body.
- For hazardous area applications, the housing shall be suitable for Zone 1 as per IEC 60079-10.
- Flange Face Finish Surface roughness shall be in accordance with ASME 16.5;
  - 125 to 250 AARH for raised Face Flanges and Flat Face Flanges
  - 63 AARH for Ring Joint Flanges

9.11 THERMAL MASS FLOW METER

- This type of flow meter may be used in special cases where a very large range-ability is required, i.e. gas flow measurement in flare header.
- Thermal mass flow meters shall be used to measure gaseous fluids which have constant
- Composition. The main application is in measurements of gas flows in quality measuring systems and purge flow measurement to processes. Gas velocity shall not exceed 60 meter/second.
- Normal application is in pipe sizes or ducts up to 3”.
- Thermal mass flow element process connection shall generally be flanged to ASME B16.5. Flange rating and material shall be as per the pipe specification.
- Flanges shall be protected over the entire gasket surfaces adequately for shipping.
- Flange Face Finish Surface roughness shall be in accordance with ASME 16.5;
  - 125 to 250 AARH for raised Face Flanges and Flat Face Flanges
  - 63 AARH for Ring Joint Flanges

- The flow element design shall allow for field retractable packing gland assembly.
- All wetted surfaces shall be 316 stainless steel as a minimum.
- Transmitter signal output shall be HART 4-20 mA.
- Electrical power supplies available will be 110 VAC, 50 HZ (UPS) or 24 VDC derived from the control system (loop powered).
- Thermal mass flow element and transmitter enclosures shall meet electrical certification requirements as indicated on the individual data sheet. Hazardous area applications shall meet intrinsically safe, Eex(i) requirements. Ingress protection shall be weatherproof to IP 65 as a minimum.
- The accuracy of the meter shall be ± 0.5% of full scale.
- All electrical or electronic connections shall be threaded to ISO M20x1.5.

- The vendor shall supply the interconnecting cabling between the element, transmitter and the indicator display/keypad.
- Flow direction shall be clearly and permanently stamped on the meter body.

10.0 LEVEL INSTRUMENTS

- In general, displacer type level transmitters shall be used to measure the liquid level in which the range of level is less than 3048 mm. Differential pressure level transmitters shall be used for higher level and where this type of transmitter is preferred to displacer type level transmitter.
- Other level measuring devices, such as ultrasonic type, or radar type, etc. may be considered depending on process conditions, for special applications, other principles of measurement may be considered, such as ultrasonic instruments or instruments based on capacity, conductivity, radar/laser or bubble type.

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10.1 DIFFERENTIAL PRESSURE LEVEL MEASUREMENT

- The required measuring range will normally be equal to the distance between the instrument process connections, however it may be smaller. Also, the required scale zero reading may not coincide with the location of the lower process connection.
- Differential pressure transmitters have faster response characteristics than external cage displacement transmitters and require less range for stable control.
- Applications of displacement transmitters include remote control and remote indicating or recording of liquid level. This type of transmitter (usually the blind type) generally has an adjustable range and can have a high span elevation/ suppression capability. A receiver-type indicator on the output signal may be provided for local indication.
- Constant head may be maintained on the external or reference leg of the transmitter, because displacement of the measuring element with measurement changes is minimal even with condensable, no seal pot is required.
- A flange-connected, direct-tank mounted transmitter is used advantageously for measurement of slurries or viscous fluids. If required, the sensing diaphragm can be mounted flush with the inside of the vessel.

10.2 DISPLACEMENT TYPE LEVEL MEASUREMENT

10.2.1. Electronic Transmitter

- All transmitters shall be installed in the instrument cases associated with the displacer cages. Instrument performance shall meet or exceed the following requirements:
  - Maximum error 0.1% of span
  - Hysteresis not more than 0.2% of span
- A means of correction for specific gravity shall be provided, if required.
- Level displacement transmitters shall be torque tube type.

10.2.2. Displacer and Cage

- External chamber (cage) displacer type transmitters shall normally be used, and be flanged mounted in accordance with ANSI B 16.5 standard, Displacer level instruments shall be externally mounted.
- Flange connections shall be 2” and minimum 300# rating. Flange surface shall be as per piping specifications.
- Displacement type level transmitters are recommended for use in liquid / liquid interface applications.
- The following standard ranges shall be used:
- 356 mm (14"), 813 mm (32"), 1219 mm (48"), 1524 mm (60”), 1829 mm (72”), 2134 mm (84”), 2438 mm (96”), 2743 mm (108”),3048mm(120”).
- External type displacement level transmitters, Upper and lower connections, shall be side/side type.
- All external displacement type instruments with a side connection shall have rotating heads.
- Each displacement type level instrument shall be installed in its own dedicated external cage and have sufficient clearance for installation, removal, and cleaning.
- The bottom of all float cages with a side bottom connection (a side nozzle for lower connection) shall be drilled and tapped 3/4” NPT for drain piping. Also the top of all float cages with a side nozzle for upper connection shall be drilled and tapped 3/4” NPT for vent. Top mounted internal displacers or floats may be used on vessels where an external arrangement is not possible e.g. for buried or underground applications.

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- Floats shall have limit stops.
- Displacer type instruments shall normally have carbon steel body material with stainless steel displacer and Inconel torque tube unless higher grade material is required

10.3 GUIDED WAVE RADAR LEVEL MEASUREMENT

- Guided wave radar transmitter shall be considered where eliminating echo interference is needed.
- If the transmitter is installed directly on the vessel and in the presence of turbulence, a stilling well shall be used.

10.4 LEVEL GAUGES

- Level Gauge Glasses, transparent or reflex types, shall be generally used for local indication and to cover the operating range of all level-measuring instruments with the exception of tank gauges.
- Reflex gauge glasses shall be used only for all clean, non-viscous liquids except the following where transparent gauge glasses shall be used:
  - Interface between two liquids.

  - When the liquid temperature is below 0°C. Gauge glass shall be provided with frost extensions.
  - Liquids requiring protecting shields (mica or other). Mica shields shall be used on steam and corrosive services.
- Gauge glasses are prohibited for LNG/LPG service.

According IPS-E-IN-140, Reflex Gauges should be used on all other clean services, provided the product does not dissolve the paint or other coating on the inside of the gauge, thereby leaving a bare metal back-wall which in turn reduces the effectiveness of the prisms. And Transparent Gauges should be used in installations involving acid, caustic, or dirty (or dark-colored) liquids, in high-pressure steam applications, for liquid-liquid interface service, and in any application where it is necessary to illuminate the glass from the rear.

- In service applications involving liquids that may boil, large chamber reflex or transparent gauge glasses often are used. These are designed to give an accurate level indication of liquids that boil or tend to surge in the gauge.
- Multiple-section gauge glasses are made up of more than one standard-length section and can be connected to the vessel. For greater visibility and safety, gauge glasses should be limited in length to four sections 1.5 meters between connections. In services at 200°C or higher, length to be limited to three sections, In noncritical level applications and where temperatures are less than 200°C, longer gauge glasses often are used, whenever four or more section glasses are used, additional support may be required. Expansion and contraction, which result from temperature changes, should be considered to determine the need for installing offsets or expansion loops.
- Each section shall have a visible length of approximately 300mm.
- All transparent gauge glasses shall be equipped with plastic wedge shaped type illuminators that meet the electrical area classification requirements.
- Supply voltage of illuminators shall be 220 VAC (50 Hz).
- Where more than one column is required, they shall overlap with a minimum of 50 mm visible length
- Unless stated otherwise, all gauge glasses shall be transparent or reflex type with chambers and covers made of carbon steel, and heat resistant borosilicate glass.
- Gauge glasses shall have 1/2” NPT, top and bottom connections. Seal welding shall not be provided on these connections.
- Unless stated otherwise, 1" or 2” flanged connection shall be used.
- All gauge glasses shall be provided with gauge cook valves to set off flow in the event of the gauge failure or rupture.
- Gauge cock valve shall be quick closing and lever operated.

The following center to center of nozzles shall be selected:

Section × Size Type of glasses	Visibility	Distance between centers
1× 9	320	600
2× 9	680	950
3× 9	1040	1300
4× 9	1400	1650
5× 9	1760	2000

- Level gauges shall be installed so that the visible length covers the full operating range of the vessel including transmitter spans and level alarm or shutdown points.
- Where greater measuring range is required, multiple gauge-glasses shall be installed. Where two or more gauge glasses are required, they may be installed either on a standpipe or on independent vessel connections. Control and indication Level transmitter may be installed in same standpipe together with gauges.
- Level instruments on level shutdown service shall have independent direct vessel connections.
- Magnetic level gauges may be used in services where glass is subject to becoming dirty from process fluids, thus making it easier to interpret liquid level.
- Magnetic type gauges are preferred where glass failure is likely to occur due to vibration, fluids being handled and where the release of toxic gases, flammable liquids, and so forth is to be avoided. For services rated at 900 lbs ANSI and higher, and for dirty products, the use of magnetic type gauges shall be considered.
- Alloy or 316 stainless steel construction shall be used for all wetted parts, as the minimum requirement.
- Gauge glass gaskets shall be suitable for use in the specified process fluid.
- The gasket material shall be asbestos free and capable of sealing under continuous pressure and temperature conditions of the gauge glass.
- All gauge glasses shall be provided with gauge cook valves to set off flow in the event of the gauge failure or rupture.

11.0 PRESSURE INSTRUMENTS

- Pressure gauge and other pressure instruments shall be provided with a 316 stainless steel valve manifold.
- The sensing element of the transmitters shall be of direct sensing, sealed capsule type (strain gauge, capacitance sensing, etc.)
- Over range pressure protection shall be provided, up to1.3 times design pressure.
- For differential pressure transmitters over range pressure protection shall be able to protect the sensing element from 1.3 times of the maximum design pressure applied to each side with the opposite side vented to atmosphere.

11.1 DIFFERENTIAL PRESSURE TRANSMITTERS:

- Diaphragm-type transmitters with a continuously adjustable range shall be used.

11.1.1 Differential Pressure Transmitters

- All meter internals in contact with the process (wetted parts) shall be 316 stainless steel, unless stated otherwise in the individual data sheets.
- Measuring elements must be capable of withstanding pressure up to the body rating in either direction with neither damage nor zero shifts greater than 1% of the span.
- Elements shall be properly fixed and stress relieved to provide minimum hysteresis.
- Ambient temperature effects on all measuring elements shall be kept to an absolute minimum. All measuring elements shall have minimum thermoelastic coefficient.
- The gasket material shall be suitable for the process operating pressure and temperature in the event of sensing element failure.
- Accuracy of all measuring devices shall be at least 0.1% of the full span.
- Flow transmitters shall be of the electronic type. Sensing element shall be similar to the elements used for pressure transmitters.
- Over range protection equal to the body rating shall be provided.
- The application of diaphragm sealed flow transmitters shall be the same as those described for pressure transmitters.
- Flow transmitters shall be provided with a 316 stainless steel five way valve manifold and stainless steel nameplate.
- Process connection shall be 1/2” NPT.

11.1.2 DP Type Flow Transmitters

- The above mentioned general requirements for flow transmitters are applicable to differential pressure transmitters.

11.2 PRESSURE TRANSMITTER

- Guaranteed transmission, indication or recording accuracy of the variable shall be at least 0.1% of the instrument range. (With adjustable calibrated range)
- Pressure elements shall be furnished with over-range protection to at least 1.5 times the maximum range of the instrument, and elements in vacuum services shall be capable of withstanding full vacuum regardless of ranges and without shifting calibration more than 0.5% of range.
- Pressure elements shall be 316 stainless steel as the minimum.
- Pressure element connections shall be 1/2” NPT male.
- In general, the pressure transmitters shall be provided with a 316 stainless steel two way valve manifold for isolation and vent / drain requirements.
- Pressure transmitters shall be provided with a 316 stainless steel two way valve manifold (isolation and vent/drain) and stainless steel nameplate.

- Pressure range of transmitters shall be selected so that normal operating pressure will be within 50% and 85% of calibrated range.
- Diaphragm seal elements may be used to eliminate purging, winterizing and corrosion except for vacuum services.
- For measurement of viscous fluids, fluids containing solids, highly corrosive fluids or where temperature changes may influence the fluid conditions, the use of remote diaphragm seals and capillaries may be considered.
- Diaphragm Seals and capillaries shall be considered to be an integral part of the instrument.

11.3 PRESSURE GAUGE

- Pressure elements shall be bourdon tub0e for normal pressure service (from 1Bar up to 1000 Bar) and diaphragm or bellows type for low pressure applications (below 1 Bar) as specified in individual data sheets.

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- Guaranteed gauge accuracy shall be within 0.6% of full scale range(For Wellhead, Manifold and Pipeline work package) and 0.5% of full scale range(For GCS work package)
- Case material shall be stainless steel.
- Pressure gauge window shall be made of acrylic or shatterproof glass with a transparency of 75% or better.

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- Pressure gauges shall be solid front.
- Pressure Gauges allowable Ranges :
  - For pressures above atmospheric pressure Following range shall be selected:
    From 0 up to 1, 1.6, 2, 2.5, 4, 6, 10, 16, 25, 40, 60, 100, 160, 250, 400, 600 and 1000 barg.
  - For negative pressure gauges:
    From -1 up to 0 barg.
  - For pressure below 1 barg and/or combined pressure/vacuum gauges :
    Range according to requirement.
  - Dual scale (barg and %) shall be used when a pressure gauge is used as mean to indicate a level.

- Range of the gauge shall be specified in a manner that the pointer operate in the middle third of the scale at normal service condition and the maximum working pressure (relief valve setting) does not exceed the range.
- Pressure sensing elements shall be made of ANSI 316 stainless steel unless the process conditions require a better /high material.
- Pressure gauges that will be subjected to vibration shall be liquid filled.
- Pressure gauges shall be able to withstand 1.3 times the maximum process design rating. When this is not possible gauge protection devices may be employed.

- Over-range protection shall be provided where operating pressure exceeds 1.3 times the maximum scale. Over-range stops shall be provided for the above specified over-range limit.
- Pointer stops shall be fitted on the dial so that the pointer can pass the maximum value by not more than 30 degree in order to indicate the overhang condition. The pointer shall stand clear of any end-stop when reading zero.
- Bourdon tubes shall be welded to socket and tip and stress relieved as required.
- Unless stated otherwise, 316 stainless steel shall be used for the bourdons, sockets and tips material.
- Movement for all gauges shall be stainless steel or anodized aluminum and nylon. Cases shall be solid front stainless steel with screwed ring (base plate) type.
- Dials shall have diameter of 150mm and shall be white face, non-rusting metal, with black figures over 270°. Pointers shall be adjustable without removing them from their shafts. All the pressure gauges shall be scaled in BARG & PSIG.
- Pressure gauges shall be suitable for direct mounting with 1/2” NPT bottom connection with wrench flats
- Pressure gauges shall have rubber blow-out disc located in the back of the case.
- Pressure gauges shall be equipped with screwdriver slot type adjustment facilities for calibration purposes.
- Diaphragm seal or chemical attachment shall be used where the fluid is corrosive or has the potential to crystallize or has a high content of impurities.
- Oil-filled system or Pulsation dampeners shall be supplied for all pressure instruments and gauges in vibrating or pulsating services.
- Unless stated otherwise, siphons shall be provided for all services containing liquid and steam with temperature higher than 100 °C. Siphons shall be of coiled type preferably.
- Pulsation dampeners or oil-filled system shall be supplied for all pressure instruments and gauges in vibrating or pulsating services.
- Pulsation dampeners shall have 1/2" NPT connections and shall be of the externally adjustable type. Body material shall be 316 stainless steel or as specified in the individual data sheet
- Weep holes shall be provided on the case bottom of all gauges, unless the case already has sufficient ventilation.

12.0 TEMPERATURE INSTRUMENTS

12.1 THERMOWELL

- Thermowells shall normally be drilled bar stock and tapered.
- Thermowell material shall be stainless steel AISI 316 unless process conditions require higher materials. Thermowells located in the piping or on equipment shall be flanged. The entry to thermowell shall normally be 1/2 NPT.

- The design of the wells shall be verified by means of stress analysis, resulting from stream velocity condition.
- Process connection for thermowells shall be at least 300# ANSI, Flange material shall be the same as specified for the associated Thermowells.
- All thermowells shall be protected with a suitable closure to prevent the entrance of foreign materials into the well during shipment and construction
- Test thermowells shall be furnished with a plug of knurled head which is tied with a stainless chain, but without a thermometer.
- Material designation and nominal well length shall be stamped on the hex flat surface of the well with a letter size of min. 1/8” high.
- Thermowells should only be installed in process lines of 4” or larger. Smaller pipe should be swaged up to 4”.
- Thermowells shall be constructed in accordance with project standards from one-piece Stainless Steel 316/316Lmaterial as minimum or higher grade alloy as specified in datasheet.
- On small lines where adequate immersion cannot be obtained by the thermowell inserted perpendicular to the line, the well shall be inserted at 90 degrees bend in the line.
- Well material, nominal well length, rating and tag number shall be stamped on the side of the flange.
- When test wells are specified, the thermowell shall be furnished with a plug of knurled head and tied with a stainless steel chain, but without a thermometer. Thermowell U-length shall follow this table (Flange Type):

Line Size D04	4”	6”	8”	10”	12”	14”	16”	18”	20”
Length U (mm)	200	250	300	300	350	350	350	350	350
On Vessel (Horizontal installation on Vessel side)	500								
On Vessel (Vertical installation on Vessel Top)	To be design based on application and Vessel dimension								

(*) Length to be confirmed with wake frequency analysis (by vendor)

12.2 TEMPERATURE GAUGES

12.2.1. Bi-Metal

- Bi-metallic every angle dial thermometers shall be used for local indication. Dial size shall be 150 mm diameter unless otherwise specified in the data sheet.
- Casing and pointer shall be AISI 304 or aluminum, safety glass front with gasket. Dial material shall be aluminum, unless otherwise specified.
- Dial color shall be white, non-rusting metal with black figures.
- Local zero adjustment shall be possible.

12.2.2. Liquid Filled System Thermometers

- Where Bi-metallic types are not suitable, gas or liquid filled capillary instruments may be used. Mercury filled systems shall not be used.
- All capillary tubing shall be corrosion resistant and sheathed or armored. Length shall be 3m to 10m (maximum). Capillary tubing shall be supported throughout its length. The capillary material shall be Min 316/316L alloy unless otherwise specified.

12.2.3. Over-Temperature Protection

- Temperature elements shall be capable of withstanding intermittent over-ranging to 1.5 times the maximum scale.

12.2.4. Accuracy

- Guaranteed gauge accuracy shall be ±1% of full span.
-

12.2.5. Standard Ranges

- All thermometers shall be scaled in form of C°/F°. Regardless the process temperature variation in this project the temperature gauges preferred to be standardized as per below list:

Ranges	
-30°C(-22°F)	To 70°C(158°F)
0°C (32°F)	To 100°C(212°F)
20°C (68°F)	To 120°C(248°F)
0°C (32°F)	To 160°C(320°F),
0°C (32°F)	To 250°C(482°F),
0°C (32°F)	To 400°C(752°F)

12.2.6. Connection

- The thermometer stem shall be 6 mm (1/4”) diameter, with min SS 316/316Lmaterial and thermowell with flange process connection.

12.3 TEMPERATURE TRANSMITTERS

- RTD shall be used as means of temperature measurement. The choice between resistance thermometers and thermocouples shall take the following into consideration:
- Where accuracy of measurement is required greater than obtainable with a thermocouple, a resistance thermometer shall be used.
- Resistance thermometers shall not be used where high frequency vibration is present, e.g. in high velocity steam or gas streams.
- Where narrow range duty is required i.e. less than 100°C range a resistance thermometer shall be used.

- Thermocouples and resistance thermometers pocket assemblies shall be provided with weatherproof terminal heads certified for the appropriate area classification. Heads shall be orientated to prevent ingress of water.
- Transmitter shall be smart type and designed to allow the fitting of either an integral or remote located process variable indicator, where specified on the instrument Data Sheet. The design of transmitter and local indicator combination shall be such that failure of the indicator electronics will not affect the operation of the transmitter.
- The connection of electrical transmitters to control center shall be via safety barriers. Where transmission from hazardous areas is required, installations shall be Intrinsically Safe EExia suitable for Zone 2- IIB T4.
- Supply voltage shall be 24 V DC. The input signal shall be galvanically isolated from the output and ground.
- The ambient temperature effect shall be less than ±0.2% of span.
- Temperature transmitters shall be head mounted or remote mounted where line vibration is high.

12.3.1. Resistance Temperature Detector (RTD)

- RTD's shall be platinum preferably 3-wire. Two-wire is not permitted. RTD PT100 shall comply with BS 1904 and have a resistance of 100 ohms at 0°C and a fundamental interval of 38 ohms. They shall be of the grade of accuracy appropriate to the application.
- The use of RTD's is normally considered for applications where very narrow spans and high accuracy are required. The guaranteed transmission, indication or recording accuracy of the variable shall be at least 0.1% of the range of the instrument.
- RTD extension wires shall be copper and color coded with polyvinyl insulation. The RTD's shall be used for the range not exceeding 200°C. 3 wires type for RTD used on process general application, according to need.

12.3.2. Thermocouples

- Thermocouples shall generally be used for remote temperature reading for all services.
- Thermocouples shall be two-wire type with terminal blocks enclosed in a weatherproof head (IP-65) having a female threaded, gasket cover
- Thermocouple elements shall be in accordance with the latest ISA/ANSI-MC 96.1 standards.
- Terminal heads shall have a cast metal base containing floating terminal blocks, mounted on non-conducting heat resistant material for single element. Terminal blocks shall be identified. The cast metal cap shall be fastened to base by a small chain on a swivel. It shall be provided with a screw driver slot, a heat and moisture resistant gasket and shall have female threads. Cable entry connection on the terminal head shall be ISO 20mm.
- Magnesium Oxide insulated sheath type thermocouple assemblies should be considered where applicable
- Color code for thermocouple wires shall be in accordance with ANSIMC 96.1 table 4
- Initial calibration tolerances for thermocouples shall be in accordance with the standard tolerances of table 8 of ANSI-MC 96.1.

- All specifications of thermocouples shall be in accordance with IPS-E-IN-120(Part 7).
- Thermocouples shall be mineral insulated, sheathed to 6mm (1/4") diameter in accordance with IEC-60584 and with hot junction insulated from the sheath. Thermocouple heads shall be EExia suitable for Zone 2- IIB T4. Thermocouple head terminals shall be marked with positive and negative symbols. The signal from any thermocouple used in conjunction with a shutdown system shall not be connected to any other device.

13.0 CORROSION COUPON AND PROBE

13.1 CORROSION COUPONS

- The preferred method for internal corrosion and erosion monitoring is to use weight loss coupons in which the weight loss of the coupons is representative of the weight loss of the pipe. Other methods such as pre-stressed coupons or scale coupons may be considered in special cases.
- The coupons are made of the same or similar material as the pipe being monitored.
- Coupons shall be of 3"/6" strip, flush disc, or disc type depending on the process data and installation conditions. Other special types like rod coupons, ladder strip coupons may be used in case of Vendor advice.
- Shape, size and surface area of corrosion coupons shall be predetermined and their weights have to be measured in about 0.0001 gram accuracy. They shall have a uniform reproducible surface finish and a distinguishing serial number; and have to be stored in a protective container.
- All coupons shall be of retrieval type and shall be installed using proper access fitting, solid plug assembly and heavy duty protective cover. Required tool clearance shall be advised by the vendor.
- Access fittings shall provide safe access to pressurized pipelines for corrosion monitoring coupons.

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- Mounting Position for Gas services should be at 12 O'clock Position and 6 O'clock Position for Liquid services is required , however location shall be finalized at site due to access and position of each item.

13.2 CORROSION PROBES

- Electrical Resistance (ER) or Linear Polarization Resistance (LPR) methods shall be used in corrosion probes. Ultrasonic Examination, Acoustic Emission and other methods may be used individually or in combination with other methods if the Vendor advises.
- Corrosion probes shall be exposed to the same corrosive medium as the process facilities in order to determine and monitor corrosion type, level and rate.
- For sour services, ER type probes are not a good case; whereas LPR probes are recommended for these services. LPR probes may be used for highly conductive fluids as well.

- Transmitted electronic signals shall use a nominal voltage level of 24 VDC on a two-wire or four-wire transmission circuit (two-wire is highly preferred).
- Transmitter shall preferably be integrally mounted on the probe. Otherwise the special connecting cable between transmitter and probe shall be furnished by Vendor.
- Remote mounted transmitters shall be equipped with stainless steel mounting accessories for wall or yoke mounting (on 2" pipe).
- Electronic units which have to be installed inside control panels shall be of DIN rail mounting type.
- Unit of measurement for Corrosion probes shall be millimeter, micrometer and Mils.

D04

- Mounting Position for Gas services should be at 12 O'clock Position and 6 O'clock Position for Liquid services is required , however location shall be finalized at site due to access and position of each item.

14.0 VENDOR DOCUMENTATION

14.1 GENERAL

- As a minimum, VENDOR is responsible to provide documentation for the equipment. VENDOR is responsible for all documentation in strict accordance with the requirements of the specifications. The VENDOR shall furnish soft copies of drawings/documents that are of suitable first generation quality. Drawings that are, in PURCHASER's opinion, not of suitable quality will be returned to the VENDOR for resubmission or at PURCHASER's option may be redrafted by PURCHASER or their representatives at the VENDOR's expense.
- The VENDOR shall submit all approval documents (design calculations, detailed drawings etc.) within the time frame as specified after receipt of purchase order.
- Fabrication shall not commence until calculation, drawings are approved by PURCHASER. VENDOR shall obtain and provide all VENDOR data, drawings, test results as specified in codes, regulations, standards and specifications including, but not limited to:
  - All material and final inspection test reports and certification certificates.
  - Drawings including details and bills of material.
- Parts list, recommended spare parts inventory, operating and maintenance instructions, and any special tools necessary to properly service and maintain the instrument.
- VENDOR shall complete each data sheet (included in requisition) with the required information and submit along with the bid.
- In addition to hard copy, the VENDOR shall provide two (2) sets of CD-ROM, which shall include operation and instruction manual, result of factory test and commissioning test.
- Documentation shall be prepared also in PDF format and indexed.

14.2 DOCUMENTATION REQUIRED WITH PROPOSAL

The following information shall be included with the proposal:

i) Complete data sheets
ii) Utility requirements, weight details, and other interface data
iii) Technical Specification
iv) QA Document Requirement
v) Design, Manufacturing and Delivery Plan
vi) Table of Compliance
vii) Commissioning and recommended two years spare parts
viii) Overall scope of work definition
ix) Training details
x) List of Proposed VENDOR/Sub-VENDORS
xi) Application List/Manufacturing and Training facilities
xii) Project Team/Resumes/Execution details

14.3 DOCUMENTS FOR REVIEW/APPROVAL

- Consistent with the attempt to minimize documentation only documents, which provide key information, will be required for review by the CLIENT. In addition, in order to verify compliance with the project requirements, certain other documents will also be subject to CLIENT's approval. The scope of documentation for review will be discussed and agreed jointly by the CLIENT and the VENDOR during the technical discussions (following the Technical Bid submission) based on the VENDOR Documentation.

14.4 SPECIFIC REQUIREMENTS

- The PURCHASER shall be given minimum fifteen (15) working days excluding courier time for review and approval of VENDOR drawings.
- VENDOR shall supply all documents and drawings in files/books, with proper indexing to indicate documents/files within each. Two sets of CD-ROM's shall be supplied for software and final drawings.
- The equipment Installation, Operation and Maintenance Manuals shall include a list of special tools, equipment maintenance and instructions on how to use them.

14.5 CERTIFICATION

VENDOR shall provide the following certification as a minimum:

a) Material Certificates
b) Test/Calibration Certificates
c) Certificate of Conformance

15.0 INSPECTION AND TESTING

- Instruments shall be fully inspected and tested at the VENDOR's works to ensure satisfactory operation before packing and shipping. A schedule for testing and inspection shall be detailed in the manufacturing quality plan. The tests will be witnessed by the CONTRACTOR and CLIENT.

15.1 INSPECTION AND TESTING PROCEDURES

- The VENDOR shall submit detailed procedures and test sheets for CLIENT and CONTRACTOR approval which cover the Factory Acceptance Testing 8 weeks before FAT. These procedures shall adequately cover both the VENDOR's own equipment/design and that of any sub-vendors.
- Where sub-supplied equipment/design is not explicitly covered by the VENDOR's procedures, then this must be covered by documentation provided with the sub-supply. The VENDOR is responsible for the inspection, co-ordination and retention of the documentation.

15.2 INSPECTION AND TESTING DOCUMENTATION

- The VENDOR shall maintain up to date documentation at all times reflecting the inspection/testing status of the equipment. The VENDOR will be required to formally submit certain parts of the documentation as defined in the CONTRACTOR's order. However, the submitted documentation shall not be regarded as the total requirements.
- The CONTRACTOR and CLIENT will wish to inspect retained documentation such as internal test results, equipment logs and fault correction records. The original signed test procedures and test sheets shall be supplied to the CONTRACTOR and CLIENT at the completion of the tests.
- The main basis tests of instruments shall be the latest edition of IPS-I-IN-100.

15.3 FACTORY ACCEPTANCE TEST (FAT)

- Prior to advising the CONTRACTOR and CLIENT that the equipment is ready for the Factory Acceptance Test (FAT), the VENDOR shall have completed his own 100% in-house test of each cabinet/panel. On successful completion of this, the VENDOR shall then undertake the FAT.
- The CONTRACTOR and CLIENT will wish to witness the FAT prior to releasing the equipment for shipment. The VENDOR shall be responsible for conducting the test and providing all necessary facilities, test equipment and personnel.
- Factory acceptance test (FAT) shall be performed to demonstrate that the FGS performs as per specification, including any site specific configuration.

- Each different type of input (e.g. fire/gas detectors) shall be tested through use of an actual field/interface device, where practicable. Simulators may be used by the agreement of the Principal.
- Each output shall be demonstrated through the simulation of inputs, thus proving logic and outputs.
- FAT will be performed against a procedure, provided by Vendor, and subject to Principal approval. Test results shall be accurately recorded, including any simulators used and any ad hoc tests performed.

15.4 COMMISSIONING SUPPORT

- VENDOR specialist services will be required during commissioning of the equipment. A comprehensive proposal to provide the required specialists for commissioning support shall form part of VENDOR's scope. Proposal shall include details of the skill and the hourly rates offered.

15.5 SITE SUPERVISION

- When specified in the Purchase Order, the VENDOR shall provide representatives to assist the CLIENT during installation, commissioning and initial start-up for all aspects of the equipment.

16.0 SPARE PARTS AND SPECIAL TOOLS

- The Vendor shall provide certain quantities of consumable for the installation, pre-commissioning, commissioning, start-up and up to the end of the guarantee period.
- The quantities shall be estimated by Vendor and shall be based upon the Vendor's experience. The following two periods shall be taken into account:

    - Pre-commissioning and commissioning period where the consumption of consumable is greater
    - Normal use of the System

- The VENDOR shall provide lists of recommended spare parts, which shall include the original part numbers with prices for commissioning, start-up and two years operation. All spare parts shall be identified individually.
- Spare parts for commissioning and start-up; a qualified and complete list based on PROJECT SPARE PART SUPPLY PROCEDURE (Doc. No. E&D-QC-SP-1).
- Spare parts for two years operation; a qualified and complete list based on PROJECT SPARE PART SUPPLY PROCEDURE (Doc. No. E&D-QC-SP-1).
- The VENDOR shall be able to provide spares back up and support for the plant life of at least 20 years.
- SPIR form shall be approved by CLIENT prior to procurement.

16.1 SPECIAL TOOLS

- Special Tools (as option / if any; to be recommended by Vendor)

17.0 PACKING & PRESERVATION

17.1 PACKING

- The equipment shall be securely packed for shipment from VENDOR's location to the actual equipment destination. All items must be protected from handling damage either by protective packing with cartons, crates, etc. or by securing to pallets.
- All material must be packed in a way that handling with forklift truck or crane is possible. If there is a risk of damage to equipment and other appurtenances during transportation, they shall be disconnected and tagged. All components shall then be securely packed as above.
- Equipment shall be adequately packed to withstand at least 12 months storage at construction site prior to installation. The VENDOR shall recommend any necessary procedures to be imposed during storage.
- Spare Parts shall be packed separately and clearly marked "Spare Parts". Weights (in kg) and center of gravity diagrams should be marked on packages.

17.2 PRESERVATION

- All equipment shall be thoroughly cleaned internally and packaged free of loose foreign materials. VENDOR shall replace all parts which have defects due to loose debris left from fabrication / shop tests of his own cost.
- All surfaces not painted with the prescribed painting system, shall be coated with corrosion protective grease for transportation and 12 months storage in Iran, Tropical condition.
- All openings shall be covered or capped to protect the inside from dust, rust and moisture. Dry ant shall be enclosed in the package for absorption of moisture.
- Flanged openings shall be provided with gasket metal closures securely fastened with bolts or clamps.