

Gujarat State Petroleum Corporation Ltd.

FLARE GAS MONETISATION PROJECT
INSTRUMENTATION & CONTROL DESIGN BASIS

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1. INTRODUCTION

The scope of this document is to provide the Instrumentation and Control design basis for Flare Gas monetization Project QPS – SE #3.

2. DEFINITIONS / ABBREVIATIONS

2.1. Definitions of Terms

TERMS	DEFINITION
COMPANY	Gujarat State Petroleum Corporation Ltd.
DEC/EC	Design / Engineering Consultant appointed by COMPANY
CONTRACTOR/ LSTK/EPC	The entity / party who undertake lump sum turnkey / engineering, procurement, and construction contract
SUPPLIER / VENDOR	The entity / party who supplies equipment and services for the Plant and Facility.
OEM	Original Equipment Manufacturer (OEM)

2.2. Abbreviations

ABBREVIATION	DEFINITION
ACS	Access Control System
AFR	Air Filter Regulator
BFAP	Building Fire Alarm Panel
BFPD	Barrels of Fluid per Day
CCB	Central Control Building
CCR	Central Control Room
GSPCL	Gujarat State Petroleum Corporation Ltd.
ESD	Emergency Shutdown System
EPABX	Electronic Private Automatic Branch Exchange
ESP	Electro Submersible Pump
FGS	Fire & Gas System

H2S	Hydrogen Sulfide
ICSS	Integrated Control & Safety System
LAN	Local Area Network
IP	Ingress Protection
MCC	Motor control Centre
MCT	Multi-cable Transit
MMS	Machine Monitoring System
MMSCFD	Million Metric Standard Cubic Feet per Day
OPGD	Open Path Gas Detector
PAGA	Public Address and General Alarm
PCS	Process Control System
PCP	Progressive Cavity Pump
PLC	Programmable Logic Controller
PRM	Plant Resource Manager
PST	Partial Stroke Test
RTD	Resistance Temperature Detector
SCFM	Standard Cubic Feet per Minute
SCS	Safety Control System
SIL	Safety Integrity Level
SOW	Scope of Work
SOV	Solenoid Operated Valve
SS	Electrical Substation Building
T/C	Thermocouple
UPS	Un-interrupted Power Supply

3. SCOPE

The purpose of this document is to define the Basis of Design for Instrumentation and Controls to be implemented on Surface facilities for Flare Gas Monetization Project.

These shall be adhered to by Engineering/ Contractors or his subcontractors during detail engineering, procurement & construction.

The additional facility / modification envisaged as part of FGM project can be classified majorly into following:

The FGM scheme includes:

- Common inlet scrubber
- Water-cooled gas compressors (2W+1S)
- Membrane gas dehydration units (GDU) (2W)
- Odorization unit with accessories
- Custody metering system (2 streams)
- Emergency diesel generator set
- Air compressor system with dryers and receiver (1W+1S)
- Blowdown drum assembly
- Safety and relief system
- GC + Water Dew Point (WDP) monitoring system
- F&G detection system
- Lighting system
- Electrical integration and SCADA interfacing

Adequacy check of following items shall be carried out & necessary augmentation/modifications shall be identified and implemented.

- Firefighting facilities

The requirements laid out in this document shall be considered as minimum and CONTRACTOR may submit to the COMPANY, for deviations, if any for agreement, any possible solutions, with supporting calculation notes that could give technical and / or economic improvement.

Any omission in this requirement shall not relieve the CONTRACTOR of his responsibility to deliver the equipment along with other associated items, which are complete, of proven design, and conforms to the Performance Requirements.

4. SERVICE CONDITIONS

4.1. Climatic Conditions

Unless specified otherwise, the equipment shall be designed for out-door location, suited to corrosive, desert / salt laden and marine offshore environment. Climatic conditions under which equipment designed / operated shall be as per Equipment Datasheet.

4.2. Design Life

Equipment shall be designed and constructed for continuous operation, outdoor and for a minimum

service life of 20 years.

4.3. Area Classification

Instrumentation and Control equipment supplied part of mechanical equipment and packages shall be suitable for the applicable Hazardous Area Classification as specified in equipment datasheet.

4.4. Environmental Conditions

For designing the facility following environmental parameters shall be considered

- Location : Village Manipur, Taluka Daskroi, Dist. Ahmedabad
- Site elevation : 55m above MSL
- Avg. Max temperature : 40°C
- Avg. Min. temperature : 13°C
- Humidity : 35% - 90% Relative Humidity
- Annual avg. rainfall : 824 mm
- Basic wind load : 39 m/s
- Prevailing direction : The predominant wind direction is SSW.
- Seismic design criteria : Zone- III (Latest edition of BIS -1893)

It shall be ensured that all Instruments selected are suitable for the environmental conditions as specified in this design basis.

5. CODES, STANDARDS AND REFERENCE DOCUMENTS

5.1. International Codes and Standards

The design, materials, fabrication, inspection and testing of equipment shall be in accordance with this document and the latest edition (including addenda / errata) of applicable codes and standards as listed below.

STANDARD	DESCRIPTION
AGA Report No.3	Orifice Metering
ANSI/FCI-70-2	Control Valve Seat Leakage
ANSI/ISA 75.08.01	Face-to-Face Dimensions for Integral Flanged Globe- Style Control Valve Bodies (Classes 125, 150, 250, 300, and 600)
ANSI/ISA 75.08.06	Face-to-Face Dimensions for Flanged Globe-Style Control Valve Bodies (Classes 900, 1500, and 2500)
ANSI/ISA-75.08.08	Face-to-Centre line Dimensions for Flanged Globe-Style Angle Control Valve Bodies (Classes 150, 300, and 600)
ANSI/ISA-75.11.01	Inherent Flow Characteristic and Range ability of Control Valves

API PT 520	Sizing, Selection, and Installation of Pressure-relieving Devices in Refineries
API STD 526	Flanged Steel Pressure Relief Valves
API STD 598	Valve Inspection and Testing
API STD 607	Fire Test for Soft-Seated Quarter Turn Valves
API STD 609	Butterfly Valve: Double-flanged, Lug and Wafer
API STD 670	Machinery Protection Systems
API SPEC 6D	Pipeline Valves
API SPEC 6FA	Specification for Fire Test for Valves
API RP 551	Process Measurement Instrumentation
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.34	Flanged, Threaded, and Welding Ends
ASME B16.5	Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard
ASME B40.100	Pressure Gauges and Gauge Attachments
ASME PTC 19.3	Temperature Measurement
ATEX 94/9/EC	Equipment intended for use in Potentially Explosive Atmospheres
BS-5308-1	Instrumentation Cables – Specification for Polyethylene Insulated Cables
BS-5308-2	Instrumentation Cables – Specification for PVC Insulated Cables
BS EN 10497	Testing of Valves – Fire Type Testing Requirements
BS EN 62444	Cable Glands for Electrical Installation
BS EN ISO 5167-1	Measurement of Fluid Flow by Means of Orifice Plates, Nozzles, and Venturi Tube Inserted in Circular Cross- Section Conduits
BS EN ISO 5167-2	Measurement of Fluid Flow by Means of Pressure Differential Devices Inserted in Circular Cross-Section Conduits Running Full – Orifice

IEC 60331	Tests for Electric Cables Under Fire Conditions
IEC 60332	Tests on electric and optical fiber cables under fire conditions
IEC 60529	Classification of Degrees of Protection provided by Enclosures (IP code)
IEC 60534-3-2	Face to Face dimension of rotary valves except butterfly valves
IEC 60534-8.3	Industrial Process control valves, noise consideration, control valve aerodynamic noise prediction method
IEC 60534-8.4	Industrial process control valves, noise consideration, prediction of noise generated by hydrodynamic flow
IEC 60584	Extension and compensating cables –Tolerances and identification system
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 61000	Electromagnetic compatibility (EMC)
IEC 61508	Functional safety of electrical/electronic/ programmable electronic safety-related systems
IEC 61511	Functional Safety- Safety Instrumented Systems for the Process Industry Sector
IEC-60079	Explosive atmospheres — Equipment — General requirements
IS 2055	Reference Table for Platinum / Rhodium-platinum thermocouples
IS 2148	Electrical Apparatus for Explosive Gas Atmospheres – Flameproof Enclosures “d”
IS-7098 Part 1 & 2	Cross Linked Polyethylene Insulated PVC Sheathed Cables
ISA 5.1	Instrumentation Symbols and Identification
ISA 5.2	Binary Logic Diagrams for Process Operations
ISA 5.3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems
ISA 5.4	Instrument Loop Diagrams

ISA 12.13.03	Guide for Combustible Gas Detection as a Method of Protection
ISA-75-01	Flow Equations for Sizing Control Valves
ISO 10790	Measurement of Fluid Flow by Means of Orifice Plates, Nozzles, and Venturi Tube Inserted in Circular Cross- Section Conduits, Part 1: Orifice Plates, Nozzles, and Venturi Tubes Inserted in Circular Cross- Section Conduits Running Full
NFPA 70	National Electric Code
NFPA 72	National Fire Alarm Code
OISD 152	Safety instrumentation for process system in hydrocarbon industry.
OISD 153	Maintenance & inspection of safety instrument in hydrocarbon industry
OISD 163	Process Control Room Safety

All Instruments / Instrumentation Systems shall meet the requirements of the following:

1. Bureau of Indian Standards (BIS)
2. International Electro-Technical Commission (IEC) Standards
3. The Petroleum Act
4. The Petroleum Rules
5. The Explosive Act
6. The Environment (Protection) Act
7. The Environment (Protection) Rules

National Laws and regulations, together with any local by-laws for the country or state wherever the pipelines are laid / to be used must be complied with, by the CONTRACTOR.

6. UTILITIES

6.1. Power Supplies

The following UPS and Non-UPS Power supplies are available for Instruments and systems:

- UPS : 230 VAC \pm 10%, 1ph, 50 Hz \pm 1%
- Non-UPS : 230V \pm 10%, 1ph, 50 Hz \pm 1%,
- 24V DC : Derived from respective system (for all Instruments)

6.2. Pneumatic Supply

In general, the instrument air operating conditions shall be as indicated below.

Dew Point	-20°C
Pressure Minimum Operating	5.5 bar-g
Pressure Nominal Operating	7.5 bar-g
Pressure Maximum Operating	8 bar-g
Pressure Design	10 bar-g

7. INSTRUMENTATION REQUIREMENTS FOR HAZARDOUS AREA

- Instruments shall have ATEX/ IEC certification in case of imported material and ERTL/ CMRI for Indian manufacturer.
- Instruments within hazardous areas shall be Ex-‘d’ certified unless indicated otherwise specified on the Project Data Sheets.
- In case of non-availability of Ex-‘d’ Instruments, such as proximity switches, Machinery protection, proprietary equipment, etc., Ex-‘ia/ib’ certified Instruments shall be used by package Vendors (with safety barriers or isolators), subject to approval by COMPANY
- Hazardous area shall be considered as Zone-1, Gas Gr.IIA/ IIB, T3, unless otherwise specified and mode of protection shall be in accordance with IEC standard.
- Vendor shall ensure that all instrument equipment and installations (where applicable to the vendor’s scope of supply) meet the relevant requirements of IEC 60079 unless otherwise specified.
- Instruments and other auxiliary devices mounted inside enclosed buildings shall be suitable for operation in ambient temperatures between 0°C and 50°C.

8. INGRESS PROTECTION

- All the field instruments, enclosures in field, outdoor Cabinets and Panels shall have an ingress protection of IP 65 as a minimum, according to IEC 60529.
- All Indoor Cabinets and Panels shall have a certified Ingress protection of IP 42 as a minimum.
- For Instruments installed within Cellar pit, Instrument enclosure weather protection shall be IP67, minimum.
- All F&G devices inside the building shall have a certified Ingress Protection of IP 42 as a minimum.

9. ELECTROMAGNETIC COMPATIBILITY (EMC)

All electrical/electronic equipment shall be compliant with the following standards:

- Emissions shall comply with the Residential, commercial, and light industry Standard, IEC 61000 6-3.

- Immunity shall comply with the Industrial Standard, IEC 61000 6-2.

10. GENERAL REQUIREMENTS

- Instrument Tag Numbering shall be as per the Tag Numbering Philosophy of COMPANY.
- Diaphragm seal type instruments shall be used in dirty, congealing, viscous, toxic and above 600# service applications.
- For differential pressure having diaphragm seals with capillary connections, the capillary material shall be stainless steel or any other special alloy suitable for the process fluid conditions and shall be mechanically protected by flexible stainless steel armoring. The length of the capillary tubing shall suit the application and be at least 1m.
- For differential pressure applications with two remote seals, the capillary tubing shall be of the same length. Seal fill liquid shall be suitable for the upper and lower pressure/temperature limits of the process and shall not harm the process upon rupture of the diaphragm.
- Universal HART Type Hand held calibrator shall be considered for field calibrations of transmitters and positioners.
- Instrument process wetted parts shall be SS 316 as a minimum or Hastelloy C 276 as shall be specified in data sheets based on the respective services.
- Flanges of instruments are to be made of SS316L as a minimum in line with design conditions (Pressure & temperature).
- SIL rating of instruments used in Safety applications shall be in accordance with the SIL study. SIL certified instruments data shall be certified by certifying agencies like TUV/ Exida or equivalent. However, all ESD and F&G devices / Instruments / Vales shall be of Min SIL 2 rated.
- Voting logic shall be implemented for the field transmitters to meet the SIL requirement as identified by SIL study.
- All Field Switch devices (wherever used) including Proximity Type Limit Switches, shall have Single Pole Double Throw (SPDT) with contact rating (2A at 24V DC). Switches shall have an adjustable set point with a calibrated scale reference. The snap acting switch shall be hermetically sealed or have gold plated contacts and not be prematurely actuated due to vibration.
- All the electronic instruments shall have ½" NPT cable entries to accommodate EEx'd' certified cable glands. Unused Cable Entry shall be plugged with certified Nickel Coated Brass Plugs. Cable entry sizes shall be as below:
 - a. Signal Cables: Generally, ½" & ¾" NPT wherever required due to higher cable OD
 - b. Power Cables: ½" & ¾" NPT
- Electronic Instruments (Field transmitters & Loop power Indicators, positioners), Plant Fire and Gas detectors which are exposed to direct sun light, shall be provided with FRP Canopy and

sunshade for JB and outdoor panels.

- As a general, packages shall be aligned to plant philosophies upto the extent possible. However, package supplier's standard offering as per supplier's recommendation is also acceptable, subject to COMPANY's Approval.

11. FIELD INSTRUMENTS

11.1. Transmitters

Electronic transmitters shall be the preferred alternative over direct mounted process switches. Use of transmitters shall be mandatory in cases where alarms and trip contacts are required. Trip points shall be derived within the applicable instrument system.

Electronic instruments signal should generally be of the two wire 4-20mA HART DC system.

All field transmitters shall be provided with integral digital LCD indicators, digital 5 digit, configured in engineering units, an overall accuracy of $\pm 0.075\%$ of full scale as a minimum. For critical applications, gauges should be installed as backup to the transmitter as indicated in the P&ID.

Transmitters shall be of the two-wire type which does not require an additional field power supply unless the transmitter warrants otherwise. The transmitter shall be capable of working with a minimum load of 600 ohms and a 24 V DC supply. All electrical connections to the transmitter shall terminate on terminal blocks.

All electronic transmitters shall have automatic and continuous self-diagnostics capability. If any failure is detected during self-diagnostics, the transmitter shall drive the outputs to configured saturation values.

All instrument wetted parts shall be manufactured from AISI 316 Stainless Steel as a minimum. However superior material shall be selected depending on the properties of process fluid.

Transmitters shall be housed in a weather proof enclosure certified to IP65 and shall conform to the electrical area classification in which they are installed. Transmitter Housing material shall be of Epoxy coated Die cast Aluminum as a minimum.

Transmitters shall have two cables entries supplied with plug.

All transmitters shall be factory calibrated to the ranges mentioned in the data sheets. Transmitters shall be DN50 (2") pipe mounted preferably using standard SS316 brackets supplied by the vendor; other methods may be used in specialized cases. Due care shall be taken to insulate different materials while mounting. Mounting structure for field instruments and junction boxes shall be duly painted as per Project painting specification.

11.2. Flow Instruments

Differential pressure flow elements (Orifice, Venturi, flow nozzle, pitot, etc.) shall be used for clean fluids (liquid, gas, or air service) having no pulsating flow conditions and where adequate meter runs are possible.

Electromagnetic flow meter shall be used for monitoring the Polymer solution and shall be in

accordance with ISO 20456:2017 (Measurement of fluid flow in closed conduits — Guidance for the use of electromagnetic flow meters for conductive liquids).

Electromagnetic flow meters shall be installed so that the meter is always liquid full. Electromagnetic flow meters shall be grounded in accordance with manufacturer's recommendations.

Orifice flow measurement shall be by using square edged concentric orifice plate mounted between a pair of weld neck flanges of minimum 300# ANSI rating for line size 2" and above. For flow measurement in lines less than 2", integral flow transmitters shall be selected.

All orifice bores shall be sized using calculations according to ISO 5167. For orifice plates not covered in ISO 5167, sizing methods shall be as per ASME MFC-14M or AGA Report no. 3 or RW Miller Handbook. Adequate upstream and downstream straight run lengths shall be provided for all flow meters. Orifice or venturi flow meter shall have straight lengths in accordance to ISO 5167.

Orifice plate beta ratio shall be between 0.2 and 0.75. The flow range shall be selected such that normal flow rate is in between 50% to 70% of flow upper range value. Orifice plate material shall be 316 stainless steel as a minimum, higher grade materials may be selected depending upon process application.

Flange taps shall be used for line sizes up to 14" while "D-D/2" taps shall be used for line sizes 16" and above.

Orifice plates shall have handles with the details stamped on the upstream side. Orifice flange taps orientation shall be as follows: -

- Liquid Application : 45° below or Horizontal 180° apart
- Gas Application : 45° above or Vertical 180° apart

Differential range for orifice meter shall normally be 25 kPa (250 mbar). Other preferred ranges are 5, 12.5, 50 and 100 kPa. Sizing shall ensure the beta ratio criteria shall be met as well as Permanent Pressure Loss shall not exceed the Allowable Pressure Loss. DP transmitters range shall have 2bar measuring capsule.

In case of multi-transmitter installation from a single orifice, separate, independent set of tapings are to be provided for the separate transmitters i.e. no branching from a single tapping.

Restriction Orifice bore sizing shall be based on R.W. Miller. The construction of restriction orifice plates shall be in 316 stainless steel as a minimum or as specified in the data sheets. .

Multiple Hole/ Multi –stage restriction orifice shall be considered as required.

Venturi, flow nozzles shall be used, where relatively High accuracy is needed with low pressure drops. The design and uncertainties for Venturi Tubes shall be in accordance with the ISO 5167 standard.

Vortex meters may be considered where range ability is high (Reynold Number >20000 for liquids and >15000 for gases), and would be outside the capability of normal orifice plates to cover the whole range. Vortex meter application may also be considered for dry gas flows. Piezoelectric or capacitive type sensors shall be used for Vortex flow meters.

Vortex shall not be used in wet-gas or two phase applications and for high viscous and slurry type fluids.

Rotameters wherever used shall be for Monitoring purpose and shall be installed vertically.

Rotameters shall be of metal tube type. However, when the flow rates are too low for the use of metal-tube Rotameters, glass-tube Rotameters shall be used for low pressure applications i.e., 150#. The use of glass-tube Rotameters shall be restricted to purging, injection, and sampling systems. All wetted part material shall be 316 stainless steel as a minimum. Other higher grade material shall be selected to suit the process fluid and the flowing process condition or depending on the piping material specification.

Ultrasonic Flow meters shall be considered for use on large lines and high turn down ratios. Ultrasonic Flow meters are generally intended for use in Non-invasive measurements, bidirectional or no-pressure drop flow measurement, flare flow measurement.

Ultrasonic flow meters based on only the 'Transit time' or 'Time-of-flight' method. Weld-on Design Ultrasonic flow meter shall be considered for Flare Gas Measurements.

Multipath Ultrasonic Flow Meter shall be considered where the straight length requirement cannot be achieved with a single path meter. Nos. of probes shall be based on supplier input.

Thermal mass flow meters may be considered for gas applications such as vent stack gas. Thermal mass flow meters shall be weld-on / insertion type.

For normal measurement & control applications, accuracy shall be $\leq \pm 3\%$ for Liquid & Gas applications. For flare application, accuracy shall be $\pm 3\%$ for high flow rates of more than 1000 kg/hr. For flow rates of less than 1000 kg/hr. accuracy shall be $\pm 10\%$ or better.

11.3. Pressure Instruments

Pressure gauges shall be bourdon type. However, for pressure less than or equal to 98 kPag, diaphragm or Capsule type shall be used.

Case material shall be SS 316 minimum with dial size of 150mm and shall have features like screwed/ bayonet bezels, over range protection and blowout discs.

Glass shall be shatter proof. Solid front case shall be provided for gauge ranges above 5884 kPa-g and toxic and hydrocarbon services.

Over range protector (where design process pressure is more than 30% of the range of the pressure Gauge) and pulsation dampener (like pump discharge), whenever used, shall be of SS 316, as a minimum. Pulsation dampener shall be floating pin type, externally mounted and externally adjustable. For steam or high fluid temperature syphon will be used.

Gauge pointers shall be balanced and provided with a micrometer adjustment (external) so that zero shifts may be corrected without adjusting the movement.

Gauges dial size shall be 150 mm (6") diameter. However, for packages, supplier recommended dial sizes are also acceptable.

Pressure gauge ranges shall be selected such that normal working pressure is between 30 and 75 percent of scale wherever possible. All the Pressure gauges shall be equipped with SS316 integral 2-

valve integral manifold & for all the Differential pressure gauges, 5-valve integral manifold shall be used.

Pressure gauges shall have an accuracy of $\pm 1\%$ of full-scale range as a minimum. Differential pressures gauges may have an accuracy of $\pm 2\%$ of full-scale range. Diaphragm seal pressure gauges shall have accuracy of $\pm 2\%$ of full-scale range and Differential Pressure Gauge Diaphragm seal type shall have accuracy of $\pm 3\%$ of full-scale range.

11.4. Temperature Instruments

For local indication, bi-metal type dial thermometers shall be used for temperatures between (-) 45°C to 400°C . In temperatures below (-) 45°C gas-filled dial thermometers shall be used.

Dial thermometer ranges shall be selected such that the operating temperature is between 30 to 75% of scale ($^{\circ}\text{C}$) wherever possible. Gauges shall be bi-metal type 150mm (6") diameter minimum, with adjustable head (every angle), spring loaded. However, for packages, supplier recommended dial sizes are also acceptable. Gauge Casing material shall be SS 304.

In general, in case of excessive vibration applications Oil filled type with capillary extension shall be used. Capillary tubing shall be minimum of SS316 with stainless steel flexible armoring, having PVC covering over armor. Gauge glass shall be shatter proof type.

Gauges shall have an over range protection of at least 130% of specified range or maximum working temperature, whichever is higher.

For measurement upto 650°C , RTD shall be used as per IEC-60751. RTD shall be Simplex PT-100, 3-wire sensor, Mineral insulated (MgO), spring loaded, SS316 metal sheath type (6.35mm O.D).

Thermocouple shall be used where measuring temperature is more than 650°C or as per Package Supplier recommendations. Thermocouple shall be of mineral insulated SS 316 metal sheathed type, with the measuring junction free from earth (ungrounded).

The type of thermocouple shall be selected based on operating temperature conditions.

- Chromel-Alumel (ISA-Type-K) : 600 to 1200°C
- Platinum Rhodium-Platinum (ISA Type-S) : 1200 to 1600°C

Thermocouple materials shall be in accordance with IS 1519 and the characteristic shall be in accordance with the appropriate reference table IEC 60584.1, IS 2054, IS 2055, IS 2056, IS 2057, or IS 10625.

Class "A" / Class "1" Tolerance as per IEC-60751/ 60584-2 shall be specified for RTD/ thermocouple for Temperature measurement.

Thermocouple/RTD heads shall be Die-cast aluminium and Ex-d and weather proof IP 65 with following requirements:

- Stainless steel chain shall be provided between the head cover and the head body.
- The chain shall be riveted to the head cover and the head body.

- 1/2" union shall be provided on the head extension to give a nipple-union-nipple arrangement that shall allow orientation to allow the head to be rotated to give a bottom cable entry. Material of construction shall be 316 Stainless Steel.

Connection to the thermowell head shall be 1/2" NPT.

Thermowell shall be installed in a minimum line size of DN100 (4"). Wherever the Thermowell is required to be installed in a line size less than DN100, line shall be blown to DN100 by use of suitable expander or shall be installed in an elbow.

Material for thermowells shall be ANSI type 316 stainless steel as a minimum, machined from solid bar stock, generally in a tapered configuration.

Built-up thermowells shall be considered in low pressure and low velocity services like in fired heaters and also where longer thermowell immersion length is required (greater than 610 mm).

Flange rating and facing of thermowell as a minimum shall be as per the Pipe class on which the thermowell is installed.

Wake frequency calculations shall be as per ASME PTC 19-3 TW2010 and shall be submitted by thermowell manufacturer for approval.

Bore diameter of the thermowell shall be suitable for element diameter.

Thermowells shall be projected a minimum of 150mm out of the pipe/vessel for non-insulated cases and 225mm out of the pipe/vessel for those with external insulation, jacketing or heat trace. Lagging shall be standard length such that the head extends at least 38 mm (1.5") outside the insulation.

In general, immersion length of thermowells shall be as follows:

Line Size	Immersion length for Pressure rating upto 2500# (nozzle height – 175mm)
From 4" to 6"	250mm
From 8" onwards	320 mm
Vessels / columns	Maximum insertion length shall be to the vessel center line or 610mm (24") whichever less.

Test wells shall be provided with DN15 (1/2") threaded stainless steel plug and chain.

In case thermowell is failing in wake frequency calculations due to High velocity, then thermowell thickness shall be increased or immersion length can be reduced in line with ASME PTC-19.3 TW 2010.

11.5. Level Instruments

Generally Magnetic level gauges shall be used for hydrocarbon services. Magnetic level gauges shall not be used for interface level measurement and be preferred for viscous, sour, toxic services. Single Magnetic Level Gauge shall be used. In case of multiple level gauges, minimum overlap shall be 50 mm. Other type of level gauges are also acceptable as per the Package Vendor recommendations.

Float & Tape Level Gauge may be used in Non-pressurized tanks.

Gauge glasses if specified shall be 'transparent' or 'reflex' type with chambers and covers made of carbon steel and heat resistant borosilicate toughened glass. All gauge glass shall be supplied with automatic shut off valve on the top and bottom mountings and a full bore drain valve. Single transparent level gauge visible range shall be 1500mm Max.

Reflex type level glasses may be used where a liquid-gas interface exists and the liquid is clean, colourless, and does not leave deposits on the glass.

Transparent gauges with illuminator may be used for acid, caustic, dirty or dark-colored liquids, liquid interface, and high viscosity fluids application. Illuminator shall be Explosion Proof EEx'd' certified suitable for Zone-1, Gas Gr.IIA/ IIB, powered from 240VAC Non-UPS supply.

A side mounted graduated scale (millimetres) shall be provided with level gauges and shall be of corrosion resistant material.

Separate Nozzles shall be considered for Level Instruments connected to PCS and ESD system respectively.

For external Level measurement in PCS, combined unit of Magneto-Restrictive Level Gauge with inbuilt Transmitter shall be considered up to 5500mm. In case the level measurement exceeds 5500 mm, Separate Magnetic level gauge and Guided Wave Radar (GWR) type Transmitter shall be considered with separate nozzles. External chamber size of Magneto- Restrictive Level Transmitter/ Gauge shall be of as per Manufacturer Standard offering considering the suitability of the chamber size for the application and chamber material shall be Non-Magnetic (SS 316 Minimum). .

Single Rigid Type GWR mounted in External chamber shall be used for maximum C-C length 3000 mm. For ranges more than 3000 mm, flexible rope type with anchor weight or segment rod type design may be used. External Type GWR level transmitter shall be used for maximum lengths of 6000mm.

Flange rating and facing of the Level Instruments shall be as per the Vessel Trim.

Top mounted level measurements shall be either of GWR or Non-contact Type Radar Level Transmitters.

Wherever GWR does not seem to be feasible, D/P type or other type (like Non-Contact level instruments) can be selected.

Wherever applicable, remote diaphragm sealed differential pressure type level transmitters shall be used for level measurements with a range greater than 910mm except for liquid to liquid interface.

For internal top mounted level instruments, stilling well shall be provided in the vessels which has pulsating liquids due to Agitators, submersible pumps etc. or as per Level Instrument supplier recommendation. Stilling well design shall be as per level instrument recommendation.

Accuracy of Level Transmitter shall be ± 3 mm or better.

Bridle/ Stand pipe shall be considered in case more than 4 Nos. of Level Nozzles are required for Local Gauges and Control Monitoring Level Transmitters.

Bridle/ Standpipe shall be of 3" size and with minimum rating of 300#.

11.6. Control Valves

Control Valves shall be normally globe type, single seated or double seated (as specified in datasheet) with a minimum leakage class of IV, as per ANSI/ FCI 70.2.

Butterfly type control valve shall be considered to meet the minimum pressure drop requirement or where the large valve size is required.

Sizing of control valves shall be as per ISA-75-01. Rated Cv for the Control Valves shall be selected such that the % opening for the same shall be not be less than 10% for the minimum flow conditions and not more than 90% for the maximum flow conditions.

Butterfly shall be sized considering 60° opening at maximum flow. Supplier recommended higher opening is also acceptable.

Minimum body size of the Globe type control valve shall be 1" and for Ball type is 2". Reduced trim shall be considered for cases where 1" valve size may be required due to very low flow. Below 2" ball type control valve shall be avoided.

Valve size should not be more than two sizes smaller than the pipe size or half of the line size, whichever is higher. If the Valve size must be reduced more than two pipe sizes, piping engineers should validate the piping mechanical stresses.

Face to face dimensions of globe type control valve shall be in accordance with ANSI/ ISA

75.08 / IEC 60534-3.

Less than or equal to 2" sized Control Valves shall have a minimum ANSI class rating of 300#. Valves larger than 2" shall be in accordance with relevant piping specification. Valve body rating shall never be lower than the Flange rating. Valve body material and flanges shall conform to the piping specification applicable to the process conditions in accordance with ASME/ANSI B16.5 or ASME 16.34, as applicable

For higher pressure drops, erosive, flashing services, hard-surfacing of plug seat rings and seating area of inner valve with stellite shall be used.

For Cavitation cases, dividing the valve pressure drop into several stages by using special trim, multistage etc. (i.e. selecting a low pressure recovery valve).

Spring-return pneumatic diaphragm actuators are preferred one. Extension or radiation bonnet shall be provided for valves having high temperature (above 200°C).

Control valve positioner shall be Smart type with HART protocol. The smart positioners shall be provided with necessary hardware/ software for maintenance, diagnostics, programming etc.

In general, Equal percentage characteristics shall be used for control valves. However, where the special trim like Multi-stage, Low dB etc. modified equal % shall be considered. For Level Control Valves, Split Range, Anti surge control valves, linear characteristics shall be considered.

- All rotary type of control valves shall be with equal % or modified %.
- Wherever equal % or modified % is not suitable for the specified process parameters, supplier

recommended characteristic is also acceptable.

Teflon packing should be used for control valves in service from -40°C (-40°F) to 230°C (450°F). Laminated and Filament Graphite should be used in service where extension bonnets or bellow bonnets are not practical and in temperatures greater than 230°C (450°F).

Gaskets shall be of the spiral wound type. The gasket material shall be ANSI 316 type stainless steel, graphite filled unless otherwise dictated by process conditions.

Maximum allowable noise for control valves is 85 dBA SPL (Sound Pressure Level). Source treatment for noise shall be performed by using special trims like anti-noise trims. Supplier shall offer path treatment mechanism like diffuser plate/ silencer etc. over source treatment in case the noise is higher than 85 dBA after source treatment.

Self-operated service regulators of standard MANUFACTURER's construction and materials may be used for low pressure fuel, air, inert gas, or water, where 10% deviation from the set point is permissible.

The line pressure sensing for self-actuated regulators shall be internal in general. Where external sensing line is required, the sense line size shall be ½" as minimum.

11.7. Safety Relief Valves

In general, the body material shall be as governed by Piping Material Specification. Pressure Relief Valves (ASME VIII valves) shall be sized as per API 520/ 521.

All pressure relief devices shall be full nozzle full lift type. Thermal Relief devices shall have modified nozzle type. For pilot operated valves, where vendor's standard provides only semi nozzle design the same is acceptable.

Safety Relief Valves shall be UV stamped in accordance with ASME section VIII. Type of relief safety valves shall be:

Valve Type	Applications
Conventional Type	1. Conventional type relief valves are used when venting is to atmosphere. 2. When Back Pressure is constant and there is no variable back pressure.
Balanced bellows Type	1. Where PSV discharge is connected to Flare or Closed systems. 2. When Built up Back Pressure + Variable Superimposed Back Pressure is greater than 10% of the set pressure but less than 50%.

Relief valve inlet and outlet flange rating shall be as per the Piping Material Specification.

The minimum pressure Safety Valve inlet size shall be DN 20 (¾") threaded or DN25 (1") flanged. Smaller sizes shall be allowed with the approval of COMPANY. Relief valves for liquid service with DN20 (¾") or less inlet sizes shall have screwed inlet and outlet connections. All other relief valves DN25 (1") and larger shall have flanged inlet and outlet connections.

Sizes shall be identified in accordance with API RP 526 showing inlet size - orifice area — outlet size.

Thermal relief valve process connection shall be ¾ "x 1" or as indicated in the P&ID's and typically 0.38 cm² orifice size.

Centre to centre flange face dimensions shall be in accordance with API Standard 526 except for pilot relief valves.

11.8. Pressure & Vacuum Relief Valve (PVRV)

For Buffer Vessel like application, where vacuum pulling condition can occur, pressure cum vacuum relief valves shall be used to prevent the build-up of excessive pressure or vacuum which can unbalance the system or damage the storage vessel.

Direct acting pressure / vacuum relief valves (also known as breather valves) are low pressure devices specifically designed to protect tanks, process systems and equipment from excessive pressure and vacuum.

The set Range of the PVRV shall be combined pressure/vacuum and with flanged outlets or vented to atmosphere.

PVRV Material of Construction shall be as governed by process, SS316 as minimum.

Control operation shall be by weighted pallets or springs and can be combined to provide the required pressure/vacuum settings. It is preferred to combine pallet and spring systems in one unit i.e. pressure settings require a spring section, whilst the vacuum settings use the pallet method.

11.9. Shutdown Valves

Shutdown valves shall be tight shut-off, quarter turn, ball valves with flanged ends and shall be rated for the relevant pipe class. Valves shall meet API 598 requirements of Inspection and Testing to ensure the leakages are within acceptable limits.

Material of construction for valve body & type, trim, gasket, bolts, studs & nuts shall be as per Piping Material Specification as a minimum for the respective piping class or as per the Valve Material Specification (VMS). However instrument specification shall take preference based on service.

Flange rating & finish for valves shall be as per the piping class.

Shutdown valves shall be provided with single acting, spring return pneumatic actuators. Aluminium actuators shall not be used for emergency shutdown applications.

Limit switches shall be mounted on the actuator to provide valve open / close status to the PCS. Pneumatic connection for the shutdown valve shall be 1/2" NPTF.

ESD valves shall be as “fire safe” as per API 6FA & API 607.

Wherever identified in the P&IDs by Process, Partial Stroke Testing (PST) shall be provided for Shutdown valves.

Valves identified with PST requirement, shall be equipped with Smart Positioner with 4-20mA HART protocol connected in series with Solenoid valve.

PST scheme shall be in such a way that failure of PST device shall not cause a spurious trip. All Shutdown valves including accessories shall be minimum SIL2 rated.

Instrument tubes and fitting shall be minimum SS 316/ 316L, 1/4” OD (min), 0.065 inches’ wall thickness and double compression type. However, manufacturer shall determine the tubing diameter so as to achieve the required stroking time.

Pneumatic Actuator shall be sized considering the minimum pneumatic supply pressure. However, actuator shall be suitable to withstand the pneumatic design pressure.

The maximum process differential pressure for actuator sizing shall be the difference between atmospheric pressure and the maximum upstream pressure (line design pressure) with the valve fully closed.

The safety factor shall be as below

- Shutdown valves: 2 times the torque required at Break-to-Open. For the rest of the positions, the Safety Factor 2.0 shall be maintained
- On-Off Valves: 1.5 times the torque required at Break-to-Open. For the rest of the positions, the Safety Factor 1.5 shall be maintained.

The stroking time shall be as defined in Datasheets. In case no stroke timing is specified, 1.0 seconds per inch port size as minimum for both directions shall be considered. If faster stroking times are required, high capacity valve positioners, boosters, or quick-exhaust valves shall be considered.

Actuator shall be designed to move the valve to the failure position. Fail Lock relay shall be provided in case Failure position identified in the Datasheet as “Fail Lock”.

The air filter regulator shall be of the reducing-relief valve type, with drainage facilities and bolt adjustments provided with a locking facility. AFR body material shall be Stainless Steel as a minimum and shall be provided with minimum one number of pressure gauges at the outlet. Glass (bowl type) filters shall not be used.

Air filter material shall be sintered bronze. Filter size shall be maximum 5 microns.

Solenoid valves shall be of stainless steel body material, Ex (d) certified, IP67/IP68, low wattage (less than 4 watts), 24V DC, 3 way, continuously energized (fail safe) with ½” NPT Electric connection.

Actuators supplied shall be suitable for cellar pit installation, water ingress protected and corrosion resistant.

SOV shall be extended via tubing from actuator inside cellar pit installation.

12. INTEGRATED CONTROL & SAFETY SYSTEM (ICSS)

12.1. General

ICSS shall provide overall control, monitoring and safety functionality of the plant. ICSS shall be an integrated system comprising of the following: -

- Process Control System (PCS)
- Emergency Shutdown System (ESD)
- Fire and Gas Detection System (FGS)
- Interface with Other Third-Party Systems such as Packages Unit Control Panels, Building Fire Alarm Panel (BFAP), Machine Monitoring System (MMS) etc.

12.2. Spare Philosophy

It is mandatory that Plant Spare philosophy of 20 % minimum spare shall be maintained after all the modification / addition of the New signals.

12.3. Fire & Gas Detection System

The fire and gas system is a part of Plant ESD system with I/O segregation between Plant F&G and Plant ESD functions.

All New F&G signals required to be added as part of the project shall meet the following requirements:

Redundant IO modules shall be used for all IO signals (AI, DI, DO).

F&G detectors shall be provided in the field for flammable gas detection, toxic gas detection and fire detection. Hooter, beacon, Manual call points shall be provided in the field, control rooms, support facility area and the logistic area.

The detection and actuation system as well as the critical parameters monitoring shall be included in the Logic Diagram.

Types of detectors are:

- Flame detector – Triple IR type
- Flammable Gas Detector - IR Point type & OPGD

2ooN fire detector reading shall give confirmed fire alarm and there shall be audio & visual alarm in control room as well as in field.

All F&G related plant shutdowns shall follow COMPANY requirements. Minimum 2ooN voting is required for any executive action on Flame/Fire/Gas detection.

12.4. Electrical Instrument Interface

All the electrical drive (Motor/ Heater) signals shall be hardwired with ICSS.

Hardwired Electrical Interface b/w ICSS and MCC of different type of signals shall be as follows: -

- Command Signals (DO) from ICSS through interposing relays located in the ICSS marshalling cabinet and supplied by ICSS Supplier. Interposing Relay contact ratings shall be suitable for MCC control supply at ICSS end.
- Feedback Signals (DI) to ICSS shall be potential free suitable for 24 VDC. Accordingly, relay shall be considered at MCC end. (No additional relays at ICSS Marshalling end).

SIL rating of relays used for ESD functions shall be SIL 2 rated as minimum. Winding Temperature Elements shall be connected directly to Substation as required and indicated in the P&ID.

13. PACKAGES

Wherever identified, Package Unit Control Panel (UCP) shall be responsible for the control and safe shutdown of the packages. PCS/ESD will perform monitoring of the package via serial communication and shall be hardwired in case of emergency trip.

Redundancy of the package PLC shall be as follows: -

- Redundant Controllers
- Redundant Power Supplies
- Redundant Communication Modules in case available.
- Redundant I/O Modules — For Closed loops, Sequential Interlocks, Emergency Trip related signals.
- Simplex I/O Modules — For Monitoring signals, Open Loop Control signals and Digital Output signals
- All critical control signals, inter-trips, ESD, FGS signals shall be hardwired

The packages shall be aligned to plant philosophies upto the extent possible. Package Vendor's standard offerings are also acceptable.

F&G and ESD functionality of packages shall be ensured and shall be interfaced with Plant ICSS by EPC Contractor.

Package UCP shall interface with PCS through Redundant Modbus over TCP/IP or Modbus RS- 485 link for Alarms and monitoring parameters.

Analog signal modules shall be HART compatible and able to integrate with centralized Plant Resource Management (PRM) System. In case HART compatible cards are not available, HART multiplexer shall be provided to communicate the HART signals with PRM System.

Dedicated Anti surge controllers shall not be required and anti-surge function shall be implemented in Package PLC as per Supplier recommendation.

UCP cabinets design shall be as per Package Supplier recommendation.

14. JUNCTION BOX / LOCAL PANEL

Die cast Aluminium may be used for Ex 'd' and SS 316 shall be used for Ex'e' junction boxes. Stainless steel JB shall be weather proof IP 65 & Ex(e) certified suitable for Zone 1, Gas Gr IIA/IIB, T3. However, Ex'd' certified JB suitable for the specified area classification as part of package supplier recommendation is also acceptable.

The terminals shall be spring loaded, vibration proof, screw type, mounted on nickel plated steel rails complete with end cover and clamps on each row. All terminals shall be suitable for accepting 2.5 sq. mm copper conductor.

All junction boxes / local panels shall be sized to keep at least 25% spare terminals in each. The color of terminal shall be Grey for NIS and blue for IS.

All junction boxes / local panel shall have a minimum of 150.2 mm (6") of clearance between the terminal strips and the top, bottom, and sides of the box to permit neat layout and easy access for future modifications.

Cable entries shall be from Bottom for all single / Multi pair/triad cables through cable glands. Spare entries shall be plugged.

All junction boxes/ local panels shall have terminals for termination of cable shield/ drain wires. Ferrules shall be heat shrinkable printed sleeve type.

Sunshade to be provided for Junction Boxes / Local Panels, installed in direct sunlight. Junction boxes shall be provided with breather/ drain connection.

Junction boxes, Local panels shall be provided with NPT threads for cable entries.

Segregation philosophy of Junction Boxes shall be as per the following philosophy: -

- Separate JBs for signals connected to PCS ,ESD, FGS, UCP
- Cable Type i.e. Pair, Triad, Core
- Analogue Signals (4~20 mA)
- Digital Signals
- Thermocouples/ RTDs
- IS/ Non-IS

15. CABLES & CABLE GLANDS

Cables shall be suitable for both direct buried and cable tray installation in high ambient condition. Cables shall be designed for rated performance at extreme site conditions as specified in section 6.

In general, all cables shall be Flame Retardant type for cables connected to PCS/ UCP / MMS for control / monitoring signals. Cables used for Trip, Fire & Gas applications shall be Fire Resistant type. The fire resistance cable shall have integrity as per IEC 60331. Flame retardant cables shall be as per IEC 60332 Cat. A.

All cables shall be armoured type.

Primary insulation shall be cross link poly ethylene XLPE. Thickness shall be 0.5 mm minimum. Conductor shall be stranded annealed electrolytic bare copper conductor.

Inner jacket colour shall be black. Outer jacket colour shall be black except, for cables to be used in intrinsically safe systems where it shall be light blue. A rip cord shall be provided for inner jacket. Thickness of the sheath shall be as per IS 7098 part 1.

Cable shall be provided with polyamide yarn in place of lead sheath and outer sheath shall be UV resistant.

Amour over inner jacket shall be galvanized steel wire as per IS- 7098 Part 1.

A pair shall have twisted cores and number of twists shall be not less than 10 per meter. Color of core insulation shall be as follows:-

- For Pair cables – Black (-ve) and Blue (+ve)
- For Triad Cables – Black (-ve), Blue (+ve), and Brown (Signal).

The pairs shall be individually numbered on the outside of the insulation conductor 1, 2, 3... for each pair beginning with 1 on the centre pair.

Inner and outer jacket shall be made of extruded flame retardant 90 °C Low Smoke Low Halogen PVC to IS 5831-Type ST2. Oxygen index of PVC shall be minimum 30%. Temperature Index shall be minimum 250 °C.

Individual pair shall be shielded. Shield shall be Aluminium backed by Mylar / polyester tape bonded together helically applied with the metallic side down with either side 25% overlap and 100% coverage. Minimum shield thickness shall be 0.05 mm. Drain wire shall be 0.5 mm² multi- strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with Aluminium side of the shield.

Overall shield shall be of Aluminium backed by Mylar / polyester tape bonded together helically applied with the metallic side down with either side 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075 mm. Drain wire shall be 0.5 mm² multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with Aluminium side of the shield.

Fire resistant cables shall have Mica tape with overlap as fire resistant layer Extruded XLPE insulated per IS7098 Part-1 / BS EN 50288-7/IEC-60502-1.

Testing for Low Smoke Fire resistance cables shall be in accordance with IEC 60331-32 (750 °C for three hours).

Sequential marking of the length of the cable in meters shall be provided on outer sheath at every one meter and shall be legible and indelible.

Single pair & Triad shielded cables each core shall be 1.5 mm² (for Field) and 1.0mm² (for buildings) made of 7 stranded annealed bare electrolytic copper conductor. Each strand shall be

0.53 mm dia. (for 1.5mm² cable) and 0.43mm dia. (for 1.0mm² cable).

Multi pair cable with individual pair/triad shield and overall shield conductor size shall be minimum

0.5 mm² made of 7 stranded annealed electrolytic copper conductor. Each strand shall be 0.3 mm dia.

Multi triad cable with individual pair/triad shield and overall shield conductor size shall be 1.5 mm² made of 7 stranded annealed bare electrolytic copper conductor. Each strand shall be 0.53 mm dia.

Core cables shall be of stranded copper conductors with minimum 2.5 mm² overall dia.

Cable conductor diameter size shall be considered to ensure the minimum voltage required to operate the instrument as per vendor recommendation is available at instrument end.

Tolerance in overall diameter of cable shall be ± 2 mm over offered value.

Multi-Conductor Cable insulation shall be suitable for operation at voltages up to 500 Volts R.M.S. core to earth and 500 Volts R.M.S. core to core.

Multi pair/Triad/core cables shall be 5 pair/10 pair/ 20 pair, 5T/10T with individual and overall shielded and 2core/10core/20core without shield.

Pair/ Triad Cables shall be used for Analogue Signals.

Cable for Solenoid Valves shall be Core cable of minimum 2.5 mm² conductor size as a minimum. For other digital signals, Core or Multipair cable can be considered depending upon the grouping density.

Cable glands shall be Nickel-plated brass, double compression type suitable for armoured cables. Slipper type PVC sleeves (cable shrouds) shall be provided for all cable entries in junction boxes and instruments.

Cable Glands for Instruments installed inside Cellar pits shall be IP 67/68 rated.

16. EARTHING

I&C and Telecom shall be connected with clean earth.

Cable screen shall be earthed at one point only i.e. at Control Room end.

Cabinets in field as well as control room shall be provided with separate earth bar for clean instrument and safety earth.

The IS and Non-IS earth shall be connected to clean instrument Earth.

Earthing cable shall be Green with Yellow Stripes for Safety Earth & Green insulated for instrument earth.

Cabinet earthing within the control room shall be done by looping all cabinets and connecting the loop to earth bar from two ends.

Earthing cable from inside Cabinet till nearest earth bar in control room shall be of conductor size 35 mm².

Safety earth cable from all Junction Boxes shall be of conductor size 10 mm² and from instruments shall be of conductor size 6 mm² to the nearest earth bar.

All the Earthing like clean and IS earth shall be connected to dedicated earth pit (i.e. Triangle earth) and potential earth (dirty earth) shall be connected to electrical earth grid.

Material of Earth bar shall be Copper with Aluminium coating.

17. MISCELLANEOUS

Instrument impulse tubing shall be minimum SS316L tube, ½" OD size with double compression tube fittings of minimum SS316 material.

MOC of Instrument Impulse Tubing shall be as per application or service. Instrument tubing shall be supported on trays and same tray shall not be shared between cables or air tubing or process tubing.

Instrument Air Distribution to the users shall be via Instrument Air Valve Manifold. Instrument air valve manifold shall be fabricated type with material of construction of Stainless Steel SS316 (min.)

Direct Buried trenches shall be considered in the plant. At least 40% spare space shall be considered in Instrument Cable Trays and trenches.

Cables shall be laid in up to maximum 6 tiers in direct buried trench as shown on the layout drawings.

No electrical cable shall share the Instrument Cable Tray/ trench.

Cable tray shall be of Hot Dip Galvanized Iron. All cable trays shall be provided with cover and shall be devoid of sharp edges which will damage the cable during pulling and dressing. All nuts coming inside the cables trays shall be mushroom headed only so as to avoid damage to cables. Nuts and bolts used for the trays shall be of SS316 material only.

SS 316 tag plate shall be provided for all instruments, gauge boards and local panels located in field. For Instruments and panels installed in Buildings/Control Room, tag plate material shall be Traffolyte.

Tag plates for all instruments connected to ESD systems shall be with Red font. Instruments connected to all other systems shall be with Black font.

Radiography, IBR testing, Post Weld Heat Treatment, Stress relieving requirement etc. wherever applicable shall be carried out as per PMS/ VMS.

Threaded end connections for instruments shall be to NPT as per ANSI B 1.20.1. Flanged end connections shall be as per ANSI B 16.5. All flanges and flanged valves shall have smooth surface finish (125 — 250 AARH) as per ASME B46.1.

Cable entry into the Control building shall be through MCT blocks. MCT shall be sized considering 50% future spares of each type of cable and future spares shall be blocked with inserts.

18. INSPECTION & TESTING

Contractor shall carry out factory testing & inspection of all instrument items by Supplier's authorized representatives, company, unless specified otherwise.

19. SPARES

19.1. Installed Spares shall be defined as follows:

Each Junction Box shall be designed to accommodate all 25% spare cables (wired terminations). Cable Tray / trench shall have 40 % spare space for future cables.

Instrument Air Sub-header size shall be 1" up to Instrument Air Manifold (IAM). Further 8 to 10 users IAM shall be used for air supply to individual consumers.

Multi Cable Transit (MCT) / Conduit shall have 50 % spare space for future cables and blanks shall be suitably plugged.

19.2. Spare Conductors

Each multi-conductor cable running into rack rooms shall have as a minimum 25% spare conductors, or conductor pairs. All spares on each cable shall be landed on appropriate terminal strips and labelled as "SPARE" with proper conductor identification tags.

20. TRAINING

The VENDOR/SUPPLIER shall identify training course requirements for all systems and critical field instruments which shall be presented by the relevant VENDOR/SUPPLIER representatives. This is to familiarize the COMPANY Engineers, Technicians, and Operating personnel with the Instrumentation equipment, general software, configuration, operation, and maintenance procedures. Training courses will be carried out at the site.

21. PAINTING

The painting for Instrumentation shall be as per standard specification.